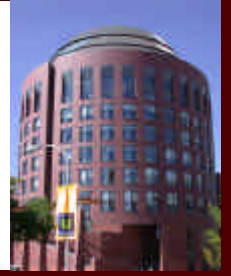




**Wharton**  
UNIVERSITY of PENNSYLVANIA



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# TRIA AND BEYOND

## TERRORISM RISK FINANCING IN THE U.S.

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A Report issued by the  
**Wharton Risk Management and Decision Processes Center**  
The Wharton School, University of Pennsylvania

August 2005



## **THE WHARTON RISK MANAGEMENT AND DECISION PROCESSES CENTER**

Since its creation 17 years ago, the mission of the Wharton Risk Management and Decision Processes Center has been to carry out a program of basic and applied research to promote effective corporate and public policies for low-probability events with potentially catastrophic consequences. The Risk Center has focused on natural and technological hazards through the integration of risk assessment and risk perception with risk management strategies. After 9/11, research activities extended to national security issues (e.g., terrorism risk insurance, protection of critical infrastructure).

Building on the disciplines of economics, decision sciences, finance, insurance, marketing and psychology, the Center's research program has been oriented around descriptive and prescriptive analyses. Descriptive research focuses on how individuals and organizations interact and make decisions regarding the management of risk under existing institutional arrangements. Prescriptive analyses propose ways that individuals and organizations, both private and governmental, can make better decisions regarding risk. The Center supports and undertakes field and experimental studies of risk and uncertainty to better understand the linkage between descriptive and prescriptive approaches under various regulatory and market conditions. Risk Center research investigates the effectiveness of strategies such as risk communication, incentive systems, insurance and regulation.

The Center is also concerned with training decision-makers and promoting a dialogue among industry, government, interest groups and academics through its research and policy publications and through sponsored seminars, roundtables and forums. A regular Newsletter and Snapshots provide an update of Center activities and publications.

The members of the Wharton Risk Center *TRIA and Beyond* research team are Neil Doherty, Esther Goldsmith, Scott Harrington, Paul Kleindorfer, Howard Kunreuther, Erwann Michel-Kerjan, Mark Pauly, Irv Rosenthal and Peter Schmeidler. Editorial and research assistance: Hannah Chervitz.

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## PREFACE

Terrorism risk poses fundamental challenges to our national security that must be seen in a dynamic perspective as the threat is continuously evolving. One of these challenges is associated with terrorism insurance coverage. Careful research and policy development are needed in the current debate on the future of terrorism insurance to assure economic and social continuity in the case of new terrorist attacks in the U.S. Indeed, as illustrated by the events of September 11<sup>th</sup> 2001 in the U.S, March 11<sup>th</sup> 2004 in Madrid and the recent attacks in London as well as other alerts, the threat of terrorism is likely to remain an issue for a long time to come.

The goal of this Wharton Risk Center report on *TRIA and Beyond* is to provide policymakers, key industry representatives and other interested parties with an analysis of the question as to what roles the public and private sectors can and should play with respect to terrorism risk coverage in the United States in the post-9/11 world.

This study builds on research undertaken by the Wharton Risk Center over the past 4 years coupled with the 20 years of experience the Center has had in undertaking research on managing and financing low probability-high consequence events. The study also benefited from ongoing work on terrorism insurance programs developed here and abroad as part of the Organization for Economic Cooperation and Development (OECD) Task Force on Terrorism Insurance (30 countries including the U.S.)<sup>1</sup>.

During the past year, the Wharton team has had fruitful meetings and discussions with key players on the issues associated with terrorism insurance and its relationship to other strategies for reducing and managing this risk. These parties include:

- industry sectors
- insurers and reinsurers (including brokers)
- international organizations
- media
- modeling firms
- public interest groups
- public sector agencies
- research institutions
- trade associations
- universities

On February 25, 2005 the Wharton Risk Center devoted the annual meeting of its Managing and Financing Extreme Events Project to the topic of “*TRIA and Beyond: What Would Be the Most Effective and Sustainable Way for the Nation to Recover from Mega-Terrorist Attacks?*” Approximately 60 people from 25 organizations (federal government, industry, academic and research institutions) participated in the meeting. This report has

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<sup>1</sup> Kunreuther and Michel-Kerjan both served on this Task Force established in 2002 after the OECD was mandated by the ministers from its 30 world highest-income member countries to develop policy analysis and recommendations on the financial management of terrorism risk.

benefited from the fruitful discussions that took place that day and the very helpful interchange with participants and the feedback we received in the weeks following the meeting. In the next two pages we list the organizations participating in the February 25<sup>th</sup> workshop, the Wharton Risk Center Corporate Associates and the sponsors of this research. Their intellectual and financial support has been greatly appreciated. The conclusions and analyses contained in this report, however, are those of the members of the Wharton Risk Center team and do not necessarily reflect the views of these public and private organizations.

Some findings from this study have been informed by surveys of insurers, reinsurers and real-estate investors undertaken in the spring of 2005. We thank the American Insurance Association, the National Association of Real Estate Investment Trusts, the Property Casualty Insurers Association of America and the Reinsurance Association of America for helping us develop the survey instruments and for distributing them to their members on our behalf. Several other organizations have provided us with their own data, which we have used to undertake specific empirical analyses for this report. They include Aon, A.M. Best, Moody's, RAND, Risk Management Solutions, Standard & Poor's, the States of Hawaii and Vermont. We thank them for their willingness to provide us with this information.

A draft report was circulated to a select group of organizations on June 15, 2005 and comments were received from them prior to the issuance of the U.S. Treasury study on TRIA that was released on June 30, 2005. This Wharton Risk Center report on *TRIA and Beyond* reflects the very helpful comments we received from individuals associated with these organizations.

The analysis and preparation of this report has been a team effort. The conclusions of the report by and large reflect a consensus among the team members. Not surprisingly in view of the complexity of the issues, consensus does not necessarily imply unanimity.

Finally, Hannah Chervitz of the Wharton Risk Center deserves special thanks for the time and energy she put into the report. She provided research assistance, organized all the meetings and went through the many preliminary drafts of the report with a fine tooth comb.

**Philadelphia, August 2005**

**ORGANIZATIONS PARTICIPATING IN WHARTON RISK CENTER FEB. 25<sup>TH</sup>,  
2005 WORKSHOP ON THE “FUTURE OF TERRORISM RISK INSURANCE”:**

ABS Corporate Solutions  
ACE INA  
AIR Worldwide  
AM Best  
American International Group (AIG)  
American Insurance Association  
American Re  
American Reinsurance Association  
Congressional Budget Office (CBO)  
Department of Homeland Security  
DuPont Company  
EQECAT  
Government Accountability Office (GAO)  
Liberty Mutual  
Lockheed Martin  
Moody's  
National Association of Real Estate Investment Trusts (NAREIT)  
Property Casualty Insurers Association of America (PCIAA)  
Reinsurance Association of America  
Risk Management Solutions  
Rohm and Haas Company  
Standard and Poor's  
State Farm  
Swiss Re  
Wyndham Partners Consulting, Ltd. (An Affiliate of Renaissance Re Holdings, Ltd.)  
Zurich Insurance

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American Insurance Association\*

American International Group (AIG)\*

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Louisiana Workers' Compensation Corporation

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Property Casualty Insurers Association of America (PCIAA)\*

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State Farm Fire and Casualty Company\*

Sunoco

Swiss Re\*

Tillinghast-Towers Perrin

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Wyndham Partners Consulting, Ltd. (An Affiliate of Renaissance Re Holdings, Ltd.)\*

Zurich North America\*



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## EXECUTIVE SUMMARY

Since September 11<sup>th</sup>, 2001, members of the Wharton Risk Management and Decision Processes Center team have been studying the issue of terrorism insurance as part of a longer range Wharton Risk Center project on *Managing and Financing Extreme Events*. The goal of this report on *TRIA and Beyond* is to provide policymakers, key industry representatives and other interested parties with an analysis of the roles that the public and private sectors can play with respect to terrorism risk coverage in the United States in the post-9/11 world.

This Executive Summary is divided into four parts: *Principal Findings*, *Proposed Solutions*, *Open Issues* and *Next Steps*.

### 1. Principal Findings

#### *Insurability Issues for Terrorism and Extreme Events*

The characteristics of terrorism risks make its insurability by the private sector alone very problematic. Foremost among these characteristics are the significant potential for financial ruin, uncertainty about the probabilities and potential severities of losses, high correlation of risk across entities exposed to loss and interdependencies, such as would arise if a building that had been damaged by a bomb collapsed on another structure that was not a direct target of the terrorists. Moreover, government influences the level of terrorism risk as it fulfills its constitutional role in assuring the security of our nation via foreign policy, counter-terrorism and homeland security.

Insurers, indeed all stakeholders, have difficulty dealing with the tremendous uncertainty of terrorism risk. The likelihood of an attack is highly ambiguous and the attack modality is subject only to the limitations of the terrorist's ingenuity. In other words, terrorism is an intentional act. The limited confidence in the accuracy of likelihood estimates has given rise to insurers' use of deterministic approaches (e.g. a typical scenario is a 2 to 5 ton truck bomb exploding in a major metropolitan area) rather than the usual probability-based approaches for managing insurance risk exposures. These features distinguish terrorism risk from other low probability-high consequence risks, such as hurricanes and other natural catastrophes, resulting in higher charges for risk transfer than if insurers could estimate the likelihood of these events more accurately.

#### *Impediments to a Private Market Solution for Terrorism Insurance*

Two major forms of state regulation significantly impede the ability of firms and insurers to manage terrorism risk through the private market alone:

- (1) Mandatory requirements, including compulsory coverage of workers' compensation claims caused by terrorism (including chemical, biological,

radiological and nuclear attacks) in all states. In 18 states fire losses due to a terrorist attack is covered for those purchasing a fire insurance policy. A few states also prohibit terrorism exclusions in their property insurance policies.

- (2) Prior approval and other regulatory controls of rates for property/casualty insurance covering losses caused by terrorism.

A survey of reinsurers as part of the Wharton study suggests that they will not provide additional coverage for catastrophic losses from terrorism if the federal government does not renew TRIA. Similarly, there is no evidence to date that significant numbers of catastrophe bonds for terrorism losses will be issued in the near future as an alternative for covering these potential losses. Moreover, federal tax policy significantly increases the costs to insurers and reinsurers of holding the large amounts of capital (surplus) necessary to insure terrorism and other extreme events.

### ***Demand for Terrorism Coverage***

Under TRIA, with its requirement that insurers offer coverage to commercial firms, sufficient insurance coverage for so-called “certified” acts of terrorism is available today at moderate cost for commercial and residential properties in most of the country where the threat of a terrorist attack is not viewed as extremely high, and/or where the resulting damage is not anticipated to be major. The principal problems related to demand remain for large metropolitan areas where insurers must manage their concentrations of risk so as not to expose their firm to a ruinous financial loss.

To date, about 50 percent of commercial enterprises have purchased TRIA-line terrorism insurance. A portion of these firms receive terrorism coverage as part of their standard commercial property insurance without having to pay anything extra for this coverage because they are located in regions that are perceived as being at minimal risk of a terrorist attack. Demand for terrorism insurance varies widely by industry sector, type of firm and region of the country, with the high-risk regions of the country having the greatest interest in coverage. As part of this report, we undertook econometric analyses of data on terrorism and property insurance purchased by large clients of the insurance broker Aon. These analyses confirm that take-up rates and premiums for terrorism coverage vary significantly across regions and industries. Premiums for terrorism coverage as a percentage of property premiums were highest in the Northeast and lowest in the Southeast and West, even after controlling for differences in average insurable values across regions.

The rationale for corporate demand for such insurance depends on a number of factors, including the ability of companies to diversify their assets and undertake mitigation activities. It can also depend on mandatory aspects. For instance, according to the survey of members of the National Association of Real Estate Investment Trusts (NAREIT) undertaken by the Wharton Risk Center as part of this study, most lenders require terrorism coverage for their real estate loans. Alerts last year issued by the federal government on possible new attacks in the U.S. also influenced the demand for coverage. Demand for insurance is weaker in the chemical and retail sectors.



Evidence from the Departments of Insurance of Vermont and Hawaii, the two states with the most domestic captive insurance companies, indicates that many corporations are eligible for TRIA protection by purchasing terrorism insurance through their captives for their operations nationwide. For example, approximately 60 industry captives at the end of the year 2004 provided terrorism coverage on a stand-alone basis (under “separate terrorism policies”) in Vermont, with limits of coverage that totaled approximately \$30 billion.

Several behavioral and institutional features undermine incentives for commercial enterprises to buy adequate insurance and aggressively mitigate risk. They include: the perception by some firms that they are not a potential target of terrorism, the current levels of coverage that might not be adequate for some firms, the price of coverage that might be viewed as too expensive for some, as well as the mandatory inclusion of terrorism coverage in workers’ compensation policies in all states and in standard fire policies in some states, and the expectation that post-event government disaster assistance will be available to non-insured entities that suffer a loss from a terrorist attack. These issues need to be considered in detail when designing any future terrorism insurance program.

### ***Who Bears the Cost of Terrorism Insurance Under TRIA?***

Due to the ambiguity in the probabilities of terrorism losses, insurers use a survival constraint to determine the extent of coverage that they are willing to offer. The essence of the survival constraint is to write coverage so that an insurer’s aggregate exposure ( $E$ ) under an assumed scenario will not exceed a certain percentage of its policyholders’ surplus ( $S$ ). By specifying a maximum acceptable  $E/S$  ratio, one can determine how much any particular insurer will have to pay for claims under TRIA by calculating its deductible/surplus ( $D/S$ ) ratio.

Using data on the top 451 insurance firms operating in the U.S. property and casualty and workers’ compensation markets, this study determines the evolution of each insurer’s  $D/S$  ratio under TRIA between 2003 and 2005. In 2003, 36 insurers had a  $D/S$  ratio above 20%; there were 80 such insurers in 2004 and 162 in 2005 (including 8 in the top 30). We also undertake prospective analyses for 2006 and 2007.

Based on their  $D/S$  ratios for 2005, when losses are as large as \$25 or \$40 billion under TRIA, most insurers may well bear the entire loss they cover from a terrorist attack because of the relatively high TRIA deductible (i.e.  $D=15\%$ ). We present the result of our analyses for cities in three states: Dallas and Houston (Texas), Los Angeles and San Francisco (California), and New York City (New York). Only when aggregate losses are in the area of \$100 billion does the general taxpayer bear a substantial portion of the loss. Although this report analyzes such a scenario based upon simultaneous 5-ton truck bomb attacks, losses of this magnitude could be caused by chemical, biological, radiological and nuclear (CBRN) devices used by terrorists.

In states such as California and New York, where only a few companies insure the largest portion of the workers compensation market, these insurers are likely to bear the largest portion of the losses as well. Should a large-scale terrorist attack occur and inflict mass casualties, their loss would then greatly exceed their TRIA deductible. Under the

current operation of TRIA, 90 percent of the losses above their deductibles would initially be covered by the federal government and eventually be paid by all policyholders and taxpayers. Since workers' compensation providers are not able to exclude terrorism from their policies, if TRIA is not renewed some of these insurers are likely to become insolvent after a large terrorist attack unless they were able to obtain protection against catastrophic losses from the private sector.

We also show that if TRIA is renewed *indefinitely* and insurers decide to provide terrorism coverage up to a maximum exposure of 10 percent of their surplus, then those insurers with a very low deductible/surplus ratio may want to write considerably more terrorism coverage than they currently do. This creates inequities, since the government recoups 90 percent of the losses they paid out from all commercial policyholders and general taxpayers.

TRIA's design also creates considerable uncertainty as to how much each of the affected parties would be responsible for covering insured losses and the timing of their payments. In particular, the law is far from clear on the recoupment process by the federal government for losses that they cover after a terrorist attack. Given the absence of publicly available information on current insurers' coverage, one can only provide illustrative examples as to who bears the losses following a terrorist attack. In this report we use specific terrorist attack scenarios in selected cities and analyze loss sharing arrangements using available public data on market shares of insurers.

## **2. Proposed Solutions**

The study concludes that there is a role and responsibility for government in collaboration with the private sector to provide protection against terrorism losses. There are several reasons for this public-private partnership:

- Federal government policy and actions significantly influence the risk of terrorism.
- Although insurers' equity capital has increased recently, the private market has limited capacity to provide coverage for extreme losses from terrorism. This is, in part, due to federal tax policy, which significantly increases insurers' and reinsurers' costs of holding the large amounts of capital necessary to back the sale of terrorism and other catastrophe insurance.
- The mandatory coverage of terrorism losses for workers' compensation policies in all states and for any losses from fires that occur following a terrorist attack in approximately one third of the states leaves insurers exposed to possible large losses that could lead to insolvencies for some of them. In addition, state regulatory constraints on terrorism insurance rates impede the private sector's ability to manage this risk.
- The expectation that the federal government will provide considerable assistance to uninsured victims of a terrorist attack distorts incentives for buying insurance and investing in loss reduction measures.

- Federal disaster assistance following a major attack will likely be significantly greater with a commensurately higher cost to taxpayers if there is no predefined public sector role in a terrorism insurance program.
- The creation of a pure government program would exclude the insurers' expertise as well as financial and operational capacity.

In discussing solutions that include a role for the public sector, such as the modification of TRIA, we caution that federal or state involvement in insurance has shortcomings that may impede their ability to improve upon the problems that beset private markets. While public sector insurance programs might seek to enhance economic efficiency, they represent the outcome of a political process in which interest groups lobby for advantage.

Thus, while we cautiously favor a temporary extension of TRIA, subject to increasing the threshold for certification of losses and a clarification of the recoupment process, as described below, we oppose any expansion of the scope of federal protection during this renewal period.

### ***Modification of the Current TRIA Program***

The private-public partnership established by TRIA should be modified so it is more equitable and efficient than the current program. We recommend that consideration be given to other arrangements and policies to deal with catastrophic losses in the long-run. These include allowing insurers to established tax-deferred reserves, actions that could stimulate private reinsurance, actions that could facilitate the use of capital market instruments, the possible creation of mutual pools and federal reinsurance with explicit premium charges. The development of a strategy for managing catastrophic losses needs to be based upon careful analyses of these and perhaps other programs in collaboration with key interested parties. In our view this process cannot be completed within the short deadline for determining whether or not TRIA should be renewed. Hence we recommend maintaining the federal backstop provision in its present form but only for a relatively short period of time.

If the federal backstop provision is maintained, we recommend that Congress raise the trigger for providing TRIA coverage from \$5 million to \$500 million.<sup>2</sup> This means that any event where the aggregate losses are less than \$500 million would be covered entirely by private insurance. This change would reduce the likelihood that captives and other insurers with very low deductible/surplus ratios will pass on their losses after a terrorist attack to all commercial policyholders and/or U.S. taxpayers. An increase in the certification limits should also encourage demand for additional private reinsurance, especially for small firms with relatively low surpluses who otherwise would stand to lose a considerable amount of their capital should a terrorist attack occur with aggregate losses in the \$50 to \$500 million range.

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<sup>2</sup> We proposed this increase in certification limits in the June 15, 2005 draft report of *TRIA and Beyond* circulated to sponsors and other parties who provided us with data for this study. We were pleased to see the same recommendation made in the U.S. Treasury report on TRIA issued June 30, 2005.

Another short-term modification we recommend is the clarification of the recoupment process to all policyholders whether or not they have purchased terrorism insurance. Indeed, aside from the equity issues associated with this feature of TRIA, the law is unclear as to the loss sharing process between the insurers, all commercial policyholders and taxpayers.

### ***Long-term Options***

If a TRIA-like program is renewed for a short period of time, then the following options involving the private and public sectors need to be considered in designing a long-term program. These options are not mutually exclusive and can be seen as playing complementary roles for different risk-sharing arrangements.

*Deploy Capital of Potential Target Firms* When a firm buys insurance, it is using the insurer's capital to bear that risk rather than its own. This often makes sense because the insurer can diversify the risk. But using the insurer's capital is not always the cheapest way to allocate risk. Indeed, the so-called "market failure" in terrorism insurance (low supply and high prices) is a reflection of the very high capital charge that insurers must incur to write this form of coverage. Modern enterprise risk management has shown that in some instances it makes sense for a commercial firm to use its own capital management strategy to absorb risk rather than insuring. For example, the firm may lower its use of debt finance in relation to equity to be able to tolerate more risk. Other more focused strategies include the use of structured debt (e.g. warrants, convertible and forgivable debt) and more recently the use of contingent capital (financing arrangements, such as catastrophe bonds, that provide capital contingent on specified events).

Thus, we would envision that a large part of terrorism risk is, and will continue to be, absorbed by the commercial firm's own capital, so that it is, in fact, self insured. Moreover, in the case of commercial property, institutions providing long-term debt financing to developers could possibly underwrite potential losses from terrorism and charge higher interest rates to reflect the additional risk. In effect this would spread part of the risk across all of their shareholders.

*Reduce Insurers'/Reinsurers' Tax Costs of Holding Capital* The private sector's capacity to offer coverage for losses from terrorism would expand if insurers and reinsurers were allowed some form of tax-deferred reserves for terrorism coverage. Such a policy could reduce the costs to insurers and reinsurers of holding the large amounts of capital necessary to provide coverage. This should increase supply and reduce premium rates. These benefits should be weighed carefully against possible drawbacks that include short-term reduction of tax revenues, disadvantages of industry-specific tax rules and significant tax deferrals unrelated to the program's objectives of expanding the capacity to insure losses from terrorism and possibly other extreme events.

*Deploy Capital of Reinsurers* There needs to be a more detailed analysis as to the role that private reinsurance could play in providing protection against catastrophic losses from terrorism. One possibility would be a TRIA-like program without individual insurer deductibles that would only provide payments from the government once losses exceeded a large aggregate threshold. This approach would stimulate the demand for reinsurance and avoid some of the distortions associated with individual insurer deductibles and inclusion of captives in the program. Another possibility would be to base any federal reimbursement of terrorism losses on net (i.e., after reinsurance) losses without requiring that reinsurers make terrorism coverage available. Such a change might significantly increase the scope of reinsurance and associated risk spreading. The terms of reinsurance would reflect the federal backstop, i.e., the reinsurers' ability to be reimbursed for losses, so that reinsurance prices would decline. Primary insurers would be free to either buy reinsurance if available at an affordable price or keep the same exposures they now have under the current system.

*Facilitate the Use of Terrorism Catastrophe Bonds* A catastrophe bond transfers the risk of a large loss from the insurance/reinsurance industry to the financial markets. A significant market for catastrophe bonds to cover losses from terrorist attacks has *not* emerged since 9/11 (only three terrorism-related issuances to date). There are a number of reasons for the limited market for terrorism cat bonds. These include the reluctance of reinsurers to cover this risk, which plausibly gives investors reasons to be cautious, current tax policy and regulatory constraints as well as the inability of the modeling firms to provide credible assessments to investors of the risk. A study needs to be undertaken to determine what are the institutional and regulatory obstacles to the development of a more robust market for terrorism cat bonds and what steps could be taken to modify the current situation.

*Mutual Insurance Pools* Another alternative would be for insurers to form an insurance pool to deal with specific lines of terrorism coverage, possibly with limited federal backing in the event of a large-scale terrorist attack. Such pools have been developed in several European countries before and after 9/11 and were established in combination with a government backstop. By studying how pools operate in other countries, we should have a clear understanding of their strengths and limitations, and their relevance to the situation in the United States.

*Publicly Administered Mutual Insurance* If the probability of a terrorist attack is highly uncertain and the maximum possible loss is considered to be large relative to the amount of private reinsurance and catastrophe bonds available to insurers, then another possible solution is to create a publicly administered mutual insurance program. Under one such arrangement, each insurer would choose a level of protection through the mutual pool and pay an estimated premium. If either no loss or minor losses occurred, any excess premiums above a predefined threshold would be returned to insurers in proportion to their original purchases. In the event of large losses that exceed the plan's accumulated resources,

policyholders would be assessed additional amounts to cover claims according to the terms of the arrangement.

*Federal Reinsurance with Explicit Premiums* A primary motivation for federal reinsurance for large terrorism losses is the limited capacity by private insurers and reinsurers to provide coverage against catastrophic losses. An alternative to a TRIA-like arrangement, where there is no upfront charge to insurers for the federal backstop, would be a federal reinsurance program with explicit premium charges levied *ex ante* by the government. Federal reinsurance would thus reduce the need for *ex post* recoupment against all policyholders. There needs to be a more detailed analysis as to how such a federal reinsurance program could complement private market alternatives for providing financial protection against terrorism risks.

### 3. Open Issues

There is a set of other issues that the report does not analyze in detail but that need to be considered.

*Gaining Knowledge of Terrorism Premiums Collected* To date no one has collected and made public the total terrorism premiums levied by insurers for the different TRIA-lines over the three-year operation of the program. This information would be relevant for undertaking a more detailed analysis of the effectiveness and impact of TRIA and possibly alternative programs on insurers and other impacted parties.

*Possible Federal Pre-emption of Certain State Regulations and Requirements* Consideration should be given to federal pre-emption of state regulation of terrorism insurance rates as part of any long-term federal involvement in terrorism insurance markets. Consideration likewise should be given to federal pre-emption of state requirements that fire insurance policies cover fire losses following terrorism, as there is no economic basis for such selective restrictions. An analysis should also be undertaken as to whether there is a need for mandatory coverage of terrorism losses in workers' compensation insurance and possible alternatives to this requirement.

*Including Domestic Terrorism* Consideration should be given as to whether it is desirable to also cover losses from domestic terrorism attacks in a global national terrorism insurance program. The analysis should examine whether the economic rationale for government involvement in covering the risk of large losses from domestic terrorism is different from that of international terrorism, the nature of current threats posed by international and domestic terrorism, and the problems resulting from the arbitrary distinction introduced by TRIA between so-called "foreign" and "domestic" terrorist acts.



*Developing Incentive Programs for Mitigation* Further analyses are needed to determine whether one can develop incentive programs for encouraging private sector investment in measures for reducing the risks associated with terrorism and providing resiliency following an attack. Some incentives to consider are lowering the price of terrorism risk transfer mechanisms (e.g. insurance, reinsurance, catastrophe bonds) and/or providing more favorable tax treatment to reflect the lower estimated risks due to adoption of mitigation measures.

#### **4. Next Steps**

The United States faces an ongoing threat of terrorism. With the passage of TRIA, Congress and the White House recognized a role and responsibility for both the federal government and the private sector in providing adequate protection against terrorism. Although TRIA has provided an important and necessary temporary solution to the problem of how terrorism insurance can be provided to commercial firms, we do not believe it constitutes an equitable and efficient long-term program.

The challenges associated with terrorism risk financing are clearly fundamental, but they will not be solved overnight. This Wharton Risk Center study on *TRIA and Beyond* provides conceptual and empirical evidence that argues for a modified terrorism insurance program. Such a program would enhance the role that the private sector can play in reducing risk and providing funds for recovery after a terrorist attack while utilizing the public sector to provide financial protection against catastrophic losses.

As an important step in developing such a program, we urge that Congress or the White House establish a national commission on terrorism risk coverage before permanent legislation is enacted. The American public deserves such an initiative given the importance of this issue for national security.





# **PART A**

## **SETTING THE STAGE**



## CHAPTER 1

### Introduction

#### 1.1 Terrorism Insurance in the Context of Homeland Security

At the end of 2002 Congress passed the Terrorism Risk Insurance Act (TRIA) as a temporary measure to increase the availability of risk coverage for terrorist acts<sup>3</sup>. TRIA is based on risk sharing between the insurance industry and the federal government. The Act expires on December 31, 2005. Today it is unclear what type of terrorism insurance program, if any, will emerge in the U.S. Government's overall plan for dealing with the economic and social consequences of terrorist attacks.

In the July 2002 National Strategy for Homeland Security, President Bush defined *homeland security* as "the concerted effort to prevent attacks, reduce America's vulnerability to terrorism, and minimize the damage and recover from attacks that do occur."<sup>4</sup> The goal of this study on *TRIA and Beyond* is to evaluate the pros and cons of alternative terrorism risk insurance programs for preparing and recovering from a terrorist attack, an analysis that can be used by key stakeholders in the current policy debate. Although the U.S. has been successful during the past three years at preventing terrorist attacks on its soil, the impact on the economy as a whole of another mega attack or series of coordinated attacks is of serious concern to the government and the private sector (Kunreuther and Michel-Kerjan, 2005)<sup>5</sup>.

The evolution of international terrorism is now well accepted: from generally local political actions to include extremist religious and other groups seeking to inflict fear, mass-casualties and maximum disruption to the nation's social and economic continuity. An analysis of the world's 14 worst terrorist attacks (based on the number of casualties) reveals that all of them occurred after 1982. Eighty percent took place between 1993 and 2004. U.S.-related interests and personnel continue to suffer a very large portion of all large terrorist attacks in the world. The Madrid, Spain train bombings on March 11, 2004 and the coordinated London, England bus and underground bombings of July 2005, attacks against two countries that were allies of the United States in the war in Iraq, suggest that this country remains a principal target for several international terrorist groups adhering to al-Qaeda's ideology.

As security has been reinforced around federal buildings, the commercial sector constitutes a softer target for these groups, and hence another way to inflict mass-casualties

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<sup>3</sup> U.S. Congress (2002). *Terrorism Risk Insurance Act of 2002*. HR 3210. Washington, DC, November 26.

<sup>4</sup> The White House (2002), *National Strategy for Homeland Security*. Washington, DC., July.

<sup>5</sup> Kunreuther, H. and Michel-Kerjan, E. (2005), "Terrorism Insurance 2005. Where Do We Go from Here?" *Regulation*. Spring, pp. 44-51.

and stress on the nation<sup>6</sup>. Most decision-makers recognize that our national preparedness for additional terrorist attacks is an important tile within the mosaic of national security. While the physical impact of a terrorism strike may be local, the economic and social impacts are likely to be national and global. These broader threats require that the country as a whole develop strategies to prepare for and recover from a (mega-) terrorist attack.

Figure 1.1 presents a set of public and private strategies for coping with terrorism risk. Based on its knowledge of the threat collected by intelligence services, the government can address this risk through a combination of foreign policy initiatives, international cooperation in counter-terrorism, security measures of various types, crisis management preparedness (at local, state and federal levels) and strategies to cushion the economic impact ranging from paying compensation to the victims to stimulation of the economy after an attack. At the same time, about 85 percent of critical infrastructure in the U.S. is operated by the private sector<sup>7</sup>, which in turn is likely to have a good understanding of what makes large operating infrastructures safer and more resilient to a successful attack. Commercial enterprises have a set of strategies that they can use for dealing with terrorism that includes mitigating risks by investing in protective measures, self-insuring against potential losses and transferring risk through insurance, reinsurance or through the capital markets.

In the context of Figure 1.1, the case for renewing TRIA requires that one demonstrate that there are efficiency or equity gains to society from continuing with the current program compared to other alternatives including a private market solution were it to be available. To demonstrate this, one cannot simply indicate that TRIA is necessary because insurance was unavailable or expensive after 9/11. Indeed, the scarcity of insurance capital has led many firms to manage their risks through alternative strategies (e.g. contingent capital, structured debt, etc.) that may be more efficient given the scarcity of insurer and reinsurer surplus.

In our view, the evaluation of alternative terrorism insurance programs should take into account their social and economic impacts. To do this, one needs to consider the relationship of insurance to the other private sector strategies depicted in Figure 1.1. Recognizing that insurance is only one element in managing the risks of terrorism, this report focuses on the short-term question as to whether TRIA should be renewed in its current form and suggests long-term options for providing financial protection to firms from losses due to terrorist attacks.

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<sup>6</sup> We discuss some features of the evolution of international terrorism over the past 20 years in Section 3.3.

<sup>7</sup> Office of the President (2003), *The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets*. Washington, DC, February.

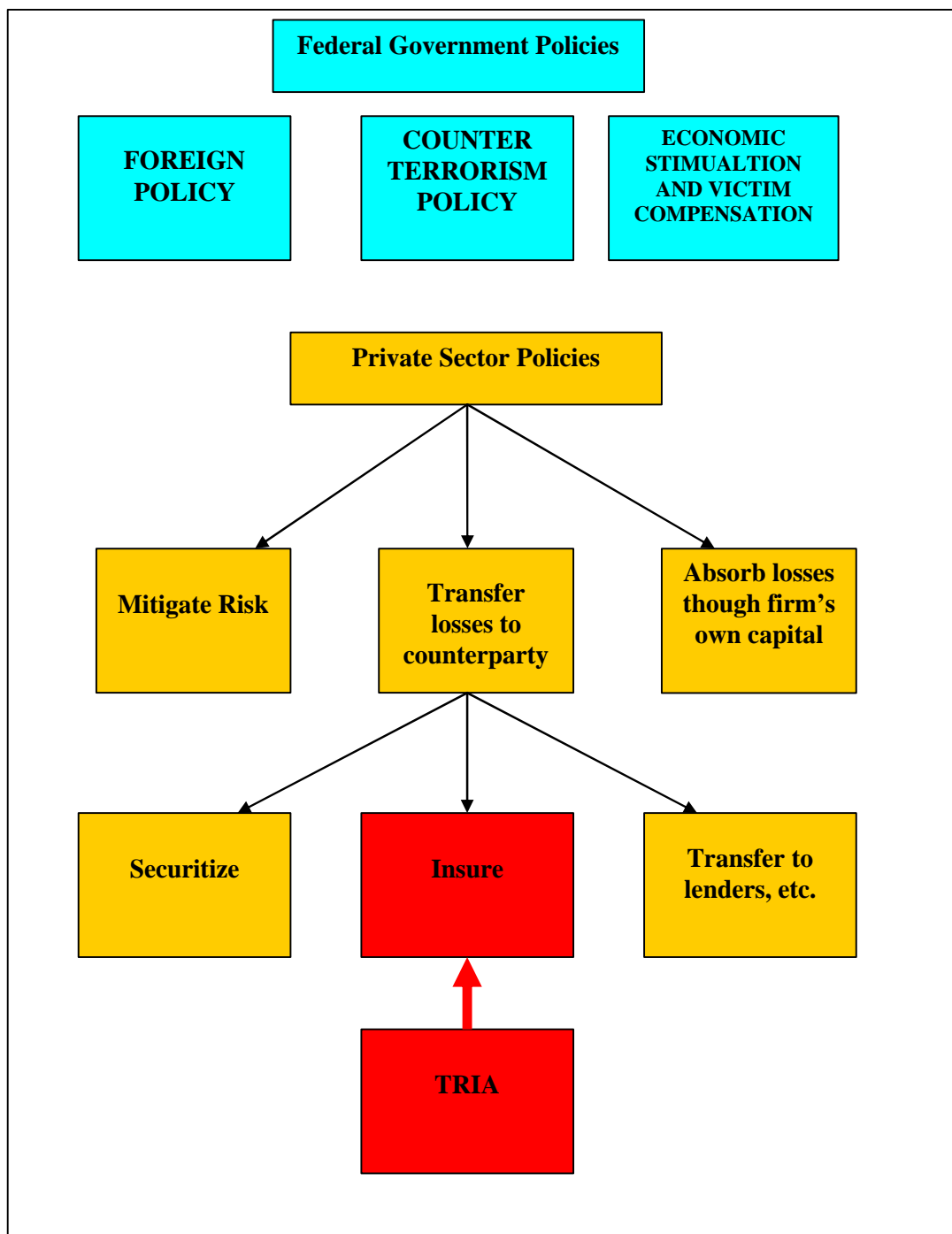


Figure 1.1 Strategies and Policies to Deal with Terrorism Threats

The next subsection discusses the current TRIA framework in more detail by focusing on two aspects of the program: eligibility for coverage and public-private risk sharing.

## **1.2 The Terrorism Risk Insurance Act of 2002 (TRIA)**

The lack of availability of terrorism insurance soon after the 9/11 attacks led to a call from some private sector groups for federal intervention. For example, the U.S. Government Accountability Office (GAO, formally General Accounting Office) reported in 2002 that the construction and real estate industries claimed that the lack of available terrorism coverage delayed or prevented several projects from going forward because of concerns by lenders or investors (U.S. GAO, 2002)<sup>8</sup>. In response to such concerns, the Terrorism Risk Insurance Act of 2002 (TRIA) was passed by Congress and signed into law by President Bush on November 26, 2002<sup>9</sup>.

### ***Eligibility for Coverage***

Under TRIA, insurers are obliged to offer terrorism coverage to all their commercial insureds, but firms are not required to purchase this insurance unless mandated by state law, such as workers' compensation (see Section 5.3 for a more detailed discussion of this point). The stated coverage limits and deductibles must be the same as for losses from other events covered by the firm's current policy<sup>10</sup>. This implies that if there are restrictions on a standard commercial insurance policy, then terrorism coverage will also exclude losses from these events. Thus the risks related to a terrorist attack using chemical, biological, radiological and nuclear (CBRN) weapons of mass-destruction are covered under TRIA only if the primary policy includes such coverage.

While this report focuses on commercial terrorism coverage, it seems important to mention here how individuals at risk are covered against terrorist attacks. Life insurance policies typically cover loss of life from terrorism attacks with the proceeds paid to the beneficiary designated in the policy. Standard homeowners insurance policies include coverage for damage to property and personal possessions resulting from acts of terrorism. Indeed, these policies cover the homeowner for damage due to explosion, fire and smoke which are likely to be the causes of damage in a terrorist attack. Auto insurance normally covers terrorism if the insured has a comprehensive policy but does not if the person only has liability coverage (Insurance Information Institute, 2004)<sup>11</sup>. TRIA does not provide

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<sup>8</sup> U.S. General Accounting Office (GAO) (2002), "Terrorism Insurance: Rising Uninsured Exposure to Attacks Heightens Potential Economic Vulnerabilities." Testimony of Richard J. Hillman before the Subcommittee on Oversight and Investigations, Committee on Financial Services, House of Representatives, February 27.

<sup>9</sup> The complete version of the Act can be downloaded at: [http://www.treas.gov/offices/domestic-finance/financial-institution/terrorism-insurance/claims\\_process/program.shtml](http://www.treas.gov/offices/domestic-finance/financial-institution/terrorism-insurance/claims_process/program.shtml)

<sup>10</sup> In most instances, this "make available" requirement means that insurers are required to offer a policy without a terrorism exclusion or limitation. Once an insurer has satisfied this offer requirement, the insurer is permitted to offer other terrorism coverage options, such as a policy with a sub-limit.

<sup>11</sup> Insurance Information Institute (III) (2004), "Terrorism and Insurance", New York, July. III's article states "Auto insurance policies will cover a car that is damaged or destroyed in a terrorist attack only if the

insurers with special protection against any of these individual risks (i.e., life, homeowners, automobile)<sup>12</sup>.

Commercially insured losses are eligible for coverage under TRIA only if the event is certified by the Treasury Secretary (in concurrence with the Attorney General and Secretary of State) as an “act of terrorism.” One of the conditions for certification is that total losses from the attack must be greater than \$5 million<sup>13</sup>. Moreover, according to TRIA, an “act of terrorism” has to be “committed by an individual or individuals acting on behalf of any foreign person or foreign interest, as part of an effort to coerce the civilian population of the U.S. or to influence the policy or to affect the conduct of the U.S. Government by coercion.” (TRIA, 2002). Therefore, an event like the Oklahoma City bombing of 1995, which killed 168 people and had been the most damaging attack on domestic soil prior to 9/11, would not be covered under TRIA because it would be considered “domestic terrorism.”<sup>14</sup>

### *Structure of the Partnership*

Under TRIA’s 3-year term scheduled to end December 31, 2005, there is a specific risk-sharing arrangement between the federal government and insurers for a certified event. Figure 1.2 depicts the public-private loss sharing for one insurer when total insured losses are less than \$100 billion. Should the loss suffered by an insurance company  $i$  be below its deductible specified by TRIA ( $ID_i$ ), the insurer does not receive any reimbursement from the federal government. This situation is illustrated by an insured loss of  $L_1$  in Figure 1.2 where the insurer’s payment is represented by the blue oblique lines. When the insured loss due to a certified terrorist attack is above its deductible, as depicted by  $L_2$  in Figure 1.2, the federal government will reimburse the insurer for 90 percent of the losses above its deductible, and the insurer will end up paying only 10 percent of it up front. The federal payment is represented by black horizontal lines in the figure. This federal backstop provision is equivalent to free *upfront* reinsurance above the deductible. As discussed below, the federal government will recoup part or all of this payment from all commercial policyholders.

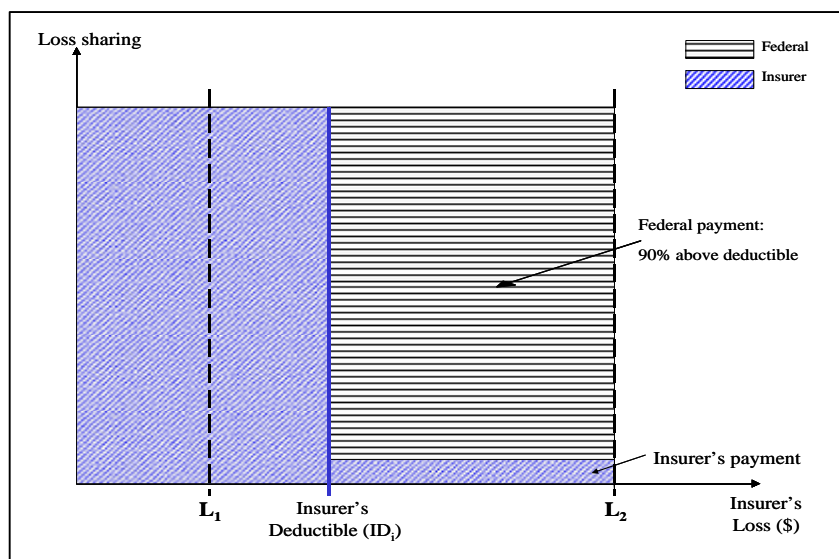
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policyholder has purchased “comprehensive” coverage. Most people who have loans on their cars or lease are required by lenders and leasing companies to carry this optional form of coverage.”

<sup>12</sup> After initial discussions in 2002 about the possibility of having life insurance benefit from TRIA protection, Treasury decided not to extend TRIA to group life. It concluded that since insurers had continued to provide group life coverage after 9/11 even though the availability of reinsurance was reduced, there was no need to include this coverage as part of the TRIA program. Government Accountability Office (GAO) (2004), “Terrorism Insurance: Effects of the Terrorism Risk Insurance Act of 2002”, GAO-04-806T, Washington, DC, May 18.

<sup>13</sup> We discuss some of the implications of this \$5 million threshold in more detail later in Chapter 10 of the report.

<sup>14</sup> The distinction between what would be a “certified” event covered by TRIA and a so-called “domestic” terrorist event may difficult to establish. For example, would attacks on the U.S. soil similar to the ones perpetrated in London on July 7, 2005 be considered domestic or international? See discussion in Chapter 10.



**Figure 1.2 Loss Sharing under TRIA Between Insurer and Federal Government**

The insurer's deductible is determined as a percentage of its total direct commercial property and casualty earned premiums of the preceding year for TRIA lines and not just the premiums of clients that purchase TRIA coverage. If an attack occurs in 2005, insurers will be responsible for losses equal to 15 percent of the direct commercial property and casualty earned premiums in 2004.<sup>15</sup> This deductible plays a very important role in determining loss sharing between insurers and the federal government and can be very large for many insurers. Using data provided by A.M. Best on their estimates of TRIA retentions for major publicly held insurance companies for 2005, we determined this deductible to be \$3.6 billion for AIG and \$2.5 billion for St. Paul Travelers. Four other companies in the top 10 insurers based on TRIA lines direct earned premiums (Zurich, Liberty, Chubb and ACE) have TRIA deductibles between \$800 million and \$2.1 billion in 2005. Chapter 6 (including Appendix 6B) of the report provides an extensive analysis of this issue both for the Top 30 and Top 451 insurers in the U.S.

If the insurance industry suffers terrorism losses that require the government to cover a portion of their claims, then these outlays shall be fully or partially recouped *ex post*. More specifically, the federal government will recoup the portion of its payment between the total insurers' outlays and a market aggregate retention amount, which is defined by the law (\$15 billion in 2005); that is called the "mandatory recoupment"<sup>16</sup>. This amount will be recouped by levying a surcharge on all commercially insured policyholders. Taxpayers will pay insured losses between \$15 billion and \$100 billion.

<sup>15</sup> In 2003 the deductible under TRIA was 7% of direct commercial property and casualty earned premiums the previous year and 10% in 2004.

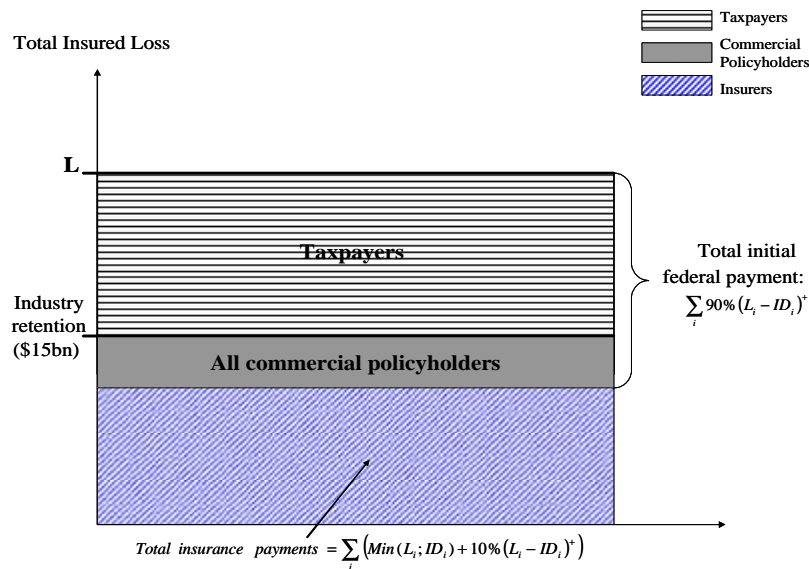
<sup>16</sup> The law is ambiguous on what will happen should the total insurers' outlays be above \$15 billion.



Should the insured losses exceed \$100 billion during the year, then the U.S. Treasury determines how the losses above this amount will be covered<sup>17</sup>.

According to TRIA, government outlays after a terrorist event shall be partially recouped by the U.S. Treasury through a mandatory policy surcharge levied against *all* property and casualty insurance policyholders. This surcharge “may not exceed, on an annual basis, the amount equal to 3 percent of the premium charged for property and casualty insurance coverage under the policy” (TRIA, Section 103(e)(8)(C)). Insurers play the role of intermediaries by levying this surcharge against all their property and casualty policyholders<sup>18</sup>, whether or not they had purchased terrorism insurance, and transfer the collected funds to Treasury.

Figure 1.3 depicts the repayment schedule in 2005 between the insurers (the area comprised of blue oblique lines), all commercial policyholders (solid gray area) and the taxpayers (area comprised of black horizontal lines) after the federal government has reimbursed all insurers for 90 percent of their claims payments above their deductible level (for those suffering loss above their TRIA deductible). In the example we consider here, since the total insured loss  $L$  is greater than \$15 billion but total payments by insurers are below the market aggregate retention of \$15 billion, we assume the government recoups a portion of its payments from commercial policyholders with the remaining amount paid by U.S. taxpayers.



**Figure 1.3 Loss Sharing under TRIA between Insurance Industry, All Policyholders and Taxpayers in 2005**

<sup>17</sup> The TRIA legislation states that “If the aggregate insured losses exceed \$100,000,000,000, (i) the Secretary shall not make any payment under this title for any portion of the amount of such losses that exceeds \$100,000,000,000; and (ii) no insurer that has met its insurer deductible shall be liable for the payment of any portion of that amount that exceeds \$100,000,000,000. Congress shall determine the procedures for and the source of any payments for such excess insured losses.” §103(e)(2)(A).

<sup>18</sup> There is no statement in the legislation or its interpretation that specifically indicates that only the commercial policyholders are taxed. We have discussed this point with insurers and reinsurers and they have assumed that since TRIA applies only to commercial enterprises, this is what Treasury will do after a terrorist attack.

### **1.3 Transferring Risk: Institutional Arrangements and Interested Parties**

In the current debate on terrorism insurance, it is important to examine the roles of the key interested parties concerned with the risk. They include insurers who provide direct protection to individuals and firms, reinsurers and the capital markets who protect the insurer against catastrophic losses, and rating agencies, regulators and lenders who are concerned with measuring the solvency and financial stability of either those supplying protection against the risk or those who are at risk.

#### ***Insurers***

Insurers provide financial protection to those facing the risks of potentially large losses from events covered by a policy (e.g., fire, earthquake, terrorist attack). They do this by charging a relatively small amount (“premium”) compared to the potential damage suffered by the insured, and in return agree to pay all or a portion of the financial losses incurred from a covered event.

Insurers who write policies for a large number of properties in a single geographic area face the possibility of large losses from a single event (e.g. earthquake, terrorist attack). Due to the potential impact of such losses on their surplus, insurers want to limit the amount of coverage they provide to property owners and employers in these hazard-prone areas in order to keep the chances of severe losses at an acceptable level. Insurers are more willing to provide coverage when they believe they can estimate the likelihood of the events against which they are offering protection and the extent of losses they will incur. When there is considerable ambiguity associated with a particular risk, they often consider it uninsurable unless they are able to protect themselves against catastrophic loss through some type of risk transfer. Chapters 2 through 7 of the report discuss in detail insurers’ roles and challenges in covering terrorism risk.

#### ***Reinsurers***

Reinsurers provide protection to private insurers in much the same way that insurers provide coverage to their policyholders, with a focus on providing protection against the catastrophic portion of a loss that insurers would not want to cover themselves. In this type of arrangement, the reinsurer charges a premium to indemnify an insurance company against a layer of the catastrophic losses which the insurer would otherwise be responsible for covering.

Reinsurers concern themselves with concentration of risk for the same reason that insurers limit their coverage. They are concerned with a possible large loss of surplus. Hence they restrict their exposure in catastrophe-prone areas to keep the chances of severe losses at an acceptable level. Large reinsurers who operate worldwide can diversify their risk geographically and per line of coverage much more easily than most insurers can.

Discussions with insurers and reinsurers indicate that there is relatively little private reinsurance to cover portions of insured losses below the TRIA deductible in urban areas

and/or the price of reinsurance is prohibitively high relative to the premium that insurers can charge for coverage to commercial firms<sup>19</sup>. A questionnaire distributed by the Reinsurance Association of America on behalf of the Wharton Risk Center to some of its members in spring 2005 confirms their reluctance to provide large amounts of terrorism protection under TRIA<sup>20</sup>. For example, one reinsurer indicated that:

*“Overall market capacity for TRIA retention coverage is very minimal in current property catastrophe programs, with availability only in programs with minimal urban exposure.”*

Similar comments were obtained in personal discussions with reinsurers. Appendix 1A contains sample questions from the reinsurers’ survey and a summary of responses from the 7 reinsurers who completed the questionnaire.

### **Brokers**

Brokers link those demanding financial protection with those who supply coverage. The broker can facilitate transactions between firms who would like to buy insurance and those who are willing to offer policies. Similarly, the broker can bring together insurers who want coverage against catastrophic events and reinsurers who are in the business of providing this protection. For medium to large businesses, the broker normally represents the insurance buyer. Brokers have been very active in placements of TRIA-backed coverage and broader terrorism coverage for non-certified events and foreign properties. They also have played an active role in advising firms about the ability to access TRIA protection through a captive insurer and providing services related to those arrangements.

### **Capital Markets**

Capital markets have emerged in the 1990s as a complement to reinsurance for covering large losses from natural disasters through new financial instruments, some of them known as *catastrophe bonds* or *cat bonds*. Several factors have led to this development. The shortage of reinsurance following Hurricane Andrew in 1992 and the Northridge Earthquake in 1994 led to higher reinsurance prices and made it possible for insurers to offer bonds with high enough interest rates to attract capital from investors. In addition, the prospect of an investment, which is uncorrelated with the stock market or general economic conditions, is also attractive to capital market investors. Finally, catastrophe models have emerged as a tool for more rigorously estimating loss probabilities, so that disaster risk can be more accurately quantified than in the past, and then priced.

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<sup>19</sup> Current estimation of the global terrorism reinsurance capacity is about \$5-6 billion. See Nutter, F. (2005), “Testimony of Franklin W. Nutter, President Reinsurance Association of America. Oversight of the Terrorism Risk Insurance Program before the Committee on Banking, Housing and Urban Affairs”, Washington, DC, April 14.

<sup>20</sup> We thank Frank Nutter and Cindy Lamar of Reinsurance Association of America (RAA) for distributing this questionnaire to their members.

There has been limited placement of cat bonds to date with the total amount of these risk-linked securities issued since their inception in 1996 at less than \$10 billion, primarily for protection against losses from natural disasters<sup>21</sup> (Swiss Re, 2004)<sup>22</sup>. To put it simply, cat bonds enable an insurer or reinsurer to access funds if a severe disaster producing large-scale damage occurs. If the losses exceed a pre-specified trigger (e.g., a major natural disaster or a series of events that inflict insured losses above \$1 billion over a prespecified period of time) or the event exceeds a prespecified index (e.g. an earthquake greater than 7.0 on the Richter scale with its epicenter within 20 miles of San Francisco), then the interest on the bond, the principal, or both, are forgiven and the funds from the cat bond are provided to the insurer to help cover its claims from the event. In return for providing this capital in the event of a disaster, capital market investors receive a higher than normal interest rate on the bonds when no disaster occurs. This interest is paid through premiums collected from the insurer or reinsurer protected by the bond.

It is not clear, however, whether a market for terrorism cat bonds will emerge in the short term. Indeed, only three terrorism-related cat bonds have been issued since 9/11, but none of them covers terrorism only; terrorism is part of multi-risk coverage (e.g. natural catastrophes, pandemics) and claims will be paid under very restrictive conditions (for more details see Section 10.2).

### ***Rating Agencies***

Rating agencies, such as A.M. Best, Standard & Poor's, Moody's and Fitch, provide independent evaluations of insurers' and reinsurers' financial stability and their ability to meet their obligations to policyholders. The rating assigned to an insurer has significant consequences on how it does business. For example, many large public companies have requirements that they only deal with insurers that have a rating above a certain minimum level. Similarly, insurers are less willing to cede risk to a poorly rated reinsurer. Rating agencies also evaluate cat bonds and hence play a key role in their potential development. A poor rating has an impact on the premium an insurer or reinsurer can charge or the amount of coverage it is able to sell, and is likely to have a negative effect on the share price of publicly traded firms.

To illustrate how ratings are determined consider A.M. Best. It assigns ratings through a quantitative analysis of an insurer's balance sheet strength, operating performance and business profile. Evaluation of catastrophe exposure plays a significant role in the determination of ratings, as by definition these are events that could threaten the solvency of a company. Projected losses at specified return periods (100-year windstorm and 250-year earthquake) and the associated reinsurance programs to cover them are an important component of the rating questionnaires required to be completed by insurers. For several years now, A.M. Best has been requesting such information for natural disasters. Their approach has been an important step forward in the incorporation of catastrophe risk

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<sup>21</sup> It is worth noting that these cat bonds tend to attach at the 1% probability of loss – none has ever paid out on a claim over this 10 year period.

<sup>22</sup> Swiss Re (2004), *Insurance-linked securities quarterly*. New York: Swiss Re Capital Markets Corporation, January.

into a company's capital adequacy requirements. In their rating questionnaire for the year 2004, A.M. Best requested similar information for terrorism protection. It is still unclear how these data will be utilized for determining ratings. A discussion of how rating agencies currently deal with terrorism risk is provided in Section 3.3 of the report.

### ***State Insurance Commissioners***

In the United States, insurance is regulated at the state level with the principal regulatory authority residing with insurance commissioners. For insurers, two important and somewhat frequently conflicting goals of this regulation are solvency regulation and consumer protection (in the form of rate regulation and policy form control). Domestic reinsurers are subject to solvency regulation but not to rate or policy form regulation. Solvency regulation addresses the question as to whether the insurer or reinsurer is sufficiently capitalized to fulfill its obligations if a significant event occurs and inflicts major losses on its policyholders. Insurance commissioners presumably regard solvency as part of product quality that they would like to protect even at the cost of higher premiums. However, they also want insurance to be sold at premiums people find economically affordable and politically acceptable, and hence are concerned with the consumer protection aspect of rate regulation. In balancing the solvency and consumer protection goals, insurance regulators are concerned that rates are adequate, not excessive and not unfairly discriminatory. These terms are somewhat imprecise, so regulators have some latitude in controlling insurer behavior.

Solvency and rate regulations are closely related and must be coordinated. Regulation of rates and market practices will affect insurers' financial performance; solvency regulation ensures adequate capital. The trade-off between the two is not easy. The greater the regulation protects solvency by allowing premiums to be higher, the more likely these actions will be viewed as unreasonable by some buyers and consumer advocates.

### ***Construction Industry***

Real estate agents, architects, developers, engineers, contractors and other service providers also play a supporting, yet important role in the management of risk from catastrophic events. For instance, in regions prone to natural disasters, federal or state regulations require real estate agents to inform the new owner of potential hazards. Examples include the location of a home relative to an earthquake fault line or within a 100-year flood plain. However, a study on the impact of a California requirement, which states that purchasers of residential property within a certain distance of a known earthquake fault be told about the hazard, showed that most home buyers did not understand or recall the risk warning (Palm, 1981)<sup>23</sup>. Terrorism threats pose specific challenges, as real estate agents cannot be expected to accurately inform owners of

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<sup>23</sup> Palm, R. (1981), *Real Estate Agents and Special Studies Zones Disclosure*. Boulder: Institute of Behavioral Science, University of Colorado.

terrorism risk when even insurers do not know what that risk is. They may be charged, however, with the obligation to provide some kind of information.

Engineers and contractors play a significant role in managing risk in high hazard areas. For example, structures designed and built to high standards with inspections by reputable building officials can protect against life and property loss. Indeed, life and property loss are often attributable to inadequate design and construction practices. On the other hand, contractors gain from the revenues from repairing or rebuilding property should a loss occur, and probably will gain more if insurance coverage is present. Hence, their interests are somewhat mixed.

### ***Lenders***

Lenders also play a role in managing catastrophic risks. Banks and other financial institutions enable individuals in the United States to purchase a home or business by providing mortgages so the buyer only has to use a limited amount of his or her own capital. The property is the collateral in the event that the owner defaults on the mortgage. Lenders thus have a stake in the risk management process, as they are unlikely to recover the full value of a loan on a structure completely destroyed by catastrophe if the owner is not covered by insurance. Lenders can also influence buying decisions with loan covenants or by varying interest rates.

### **Summary of Chapter 1**

In the mosaic of national security, terrorism insurance plays an important role as part of its recovery component. This report focuses principally on the role that the insurance industry can play in the process, but recognizes that insurance is only one of the policy tools for managing the risks of terrorism. Indeed, economic stimulation and victims' compensation need to be viewed as complementary to insurance. One must consider these strategies in the context of United States foreign policy and counter-terrorism efforts as well.

The passage of the Terrorism Risk Insurance Act (TRIA) at the end of 2002 created a specific terrorism risk insurance program the main features of which are discussed in this chapter --eligibility for coverage and the design of the public-private risk sharing arrangements including the federal backstop provision and loss-sharing arrangements.

The chapter also discusses the roles of the key interested parties involved in the current debate on TRIA renewal. They range from insurers, reinsurers and capital markets, to brokers, rating agencies and insurance commissioners, as well as construction industry and lenders.





## APPENDIX 1A

### Summary of Responses to Reinsurance Questionnaire (7 Respondents)

**Please identify the coverage limits that you generally offer to your clients. Please distinguish by line of coverage if appropriate.**

*“Varies significantly. Most common is \$5M-\$25M.”*

*“The limits offered depend on the attractiveness of the pricing. Our largest authorization of limit is approximately \$200 million, and covers only WC risks, however we could also write this limit for a cover including property risks (at the right pricing).”*

*“We can go up to \$100million depending on the excess threshold”*

*“WC: Generally up to \$10MM / Property: Generally up to \$10MM”*

**Which exclusions are generally applied to your coverage (e.g., CBRN)? Please distinguish by line of coverage if appropriate.**

*“CBRN including exclusion for fire following”*

*“It depends on the pricing, but generally we exclude NBCR as buyers don’t want to pay for the additional coverage. We also have a limit as to how much capacity we can provide particularly for NBCR – which is a fraction of our surplus.”*

**Please comment on the overall capacity in the market (stand alone cover, catastrophe programs and facultative) for terrorism risk for the retention level of primary insurers under TRIA as it currently exists.**

*“RAA analysis of \$5-6bn gives an approximate industry capacity. Generally sufficient reinsurance capacity for insurer demand for coverage of retention under current TRIA. Likely insufficient capacity if retentions increase and demand for coverage of retention increases”*

*“Overall capacity is woefully inadequate to “save” insurers in the event of any material NBCR loss. In general reinsurance capacity can support a reasonable supply of ex-NBCR capacity.”*

*“Capacity is often available for clients deemed to be low hazard. Stand alone capacity is generally only sought by very large insurers. The market for CBRN is quite small. Overall market capacity for TRIA retention coverage is very minimal in current property catastrophe programs, with availability only in programs with minimal urban exposure.”*

*“Treaty capacity is increasing as we continue to distance ourselves from the WTC loss”*

**If TRIA is not extended, what reinsurance products do you see developing for the retention layer of primary insurers covering terrorism risk? Please indicate if you believe your company would be active in selling these reinsurance products should demand for them exist.**

*“If TRIA expires there is no “retention layer”. More of the reinsurance coverage is likely to be full terrorism, with no distinction between foreign and domestic acts of terrorism. In any event, if TRIA expires, our company is likely to REDUCE the terrorism reinsurance coverage it provides.”*

*“Products will be driven on a case by case basis for the first year by demand, after a while a market ‘norm’ will exist which will define the general shape of products. Buyer pricing concerns will also impact the product shape. We would consider the attractiveness of products against available capacity and support as economically attractive.”*

*“There would be no change to our present position.”*

*“If TRIA is not extended the retention layer becomes moot. Insurance companies are going to need cover for the exposure formally covered by TRIA as well as what they had previously retained. All studies to this point show that there is not sufficient capacity in the market to take-up the shortfall if TRIA is not extended.”*

*“I do not see additional capacity provided by the reinsurance market; except if insurers are willing to pay a very high price. And even in that case, it is not clear whether reinsurer will want to allocate their capacity to terrorism. There are a lot of other risks that we better appreciate to cover.”*

**Please comment on the overall capacity in the market (stand alone cover, catastrophe programs and facultative) for terrorism risk in the United States if TRIA is not extended.**

*“If TRIA is not extended and no replacement is enacted, additional capital is likely to enter the market, for example, cat bonds. Nonetheless, the total available capacity will be far less than possible losses from a single event.”*

*“With or without TRIA there is inadequate capital in the entire industry for NBCR perils. Beyond this there is probably enough for all but the more extreme scenarios – to be fair the bigger issue is the inability for insurers to be paid adequately for their capital due to rate control exerted by state regulation.”*

*“To the extent that demand increases and prices become more attractive, it is possible that additional capacity could emerge. Market capacity for CBRN and fire following will most likely remain minimal.”*

*“Should TRIA expire we are likely to allocate capacity we used to provide for reinsurance to our insurance business. That would result in less reinsurance capacity from us.”*

## CHAPTER 2

### Insurability Concepts and Insurance Programs for Extreme Events

This chapter discusses the factors that determine the insurability of a risk and the extent of coverage offered by the private sector to provide protection against extreme events where there is a low probability of a catastrophic loss. Such events include natural disasters, catastrophic industrial accidents and terrorism. We begin the discussion by focusing on insurance for natural hazards, such as earthquakes, hurricanes and floods for several reasons. First, natural disasters are extreme events that have been studied for many years. Second, the concepts that define insurability of natural disasters are also applicable to terrorism risk. The chapter concludes by discussing how federal and state governments supplement private insurance with respect to natural disasters, so that one might consider alternative roles that the public sector can play in the future for dealing with terrorism risk.

#### 2.1 Determining Premiums and Coverage

##### *Basic Concepts*

The insurance business, like any other business, has its own vocabulary. A *policyholder* is a person who has purchased insurance. A *premium* is the amount that a policyholder pays in return for the promise of a payment from the insurer should he suffer a loss covered by his policy. The term *benefit* denotes the payment by the insurer to the policyholder given that he has suffered a reduction in wealth due to a loss. A *claim* means that the policyholder is seeking to recover financial payments from the insurer for damage covered by the policy. A claim will not result in a payment by the insurer if the amount of the insured's financial loss is below the stated *deductible* (i.e. the amount or proportion of an insured loss that the policyholder agrees to pay before any recovery from the insurer) or if the loss is subject to policy exclusions (e.g. war or insurrection). However, insurers will still incur expenses in investigating the claim.

Insurer *capital* represents the net worth of the company (assets minus liabilities). Capital enables the insurer to pay any losses above those that were expected. It serves as a safety net to support the risk that an insurer takes on by writing insurance and helps ensure that the insurer will be able to honor its contracts. As such, it supports the personal safety nets of homeowners, business owners, workers, dependents of heads of households and others who rely on insurance to provide financial compensation to rebuild their lives and businesses after covered losses occur. Insurer capital is traditionally referred to as *policyholders' surplus*. Despite the connotation of the term "surplus," there is nothing superfluous about it – it is, in fact, an essential component supporting the insurance promise. The cost of that capital is an insurer expense that must be considered in pricing

insurance, along with expected losses, sales and administrative expenses for policies written<sup>24</sup>.

The capital needed by an insurer varies directly with the risk that the insurer takes on. If an insurer wishes to take on more risk, it must have capital to support that risk. *Insurance regulators* and *rating agencies* (see Section 1.3) in their efforts to assure policyholders that insurers will be able to pay their losses, devote significant efforts towards evaluating the adequacy of insurer capital relative to the amount and types of risk they are taking on. Holding an adequate level of capital is critical to the continued viability of an insurer.

Insurance markets function best when the losses associated with a particular risk are independent of each other and the insurer has accurate information on the likelihood of the relevant events occurring and the resulting damage. By selling a large number of policies for a given a risk, the insurer is likely to have an accurate estimate of claim payments it expects to make during a given period of time. To illustrate this point with a simple example, consider an insurer who offers a fire insurance policy to a set of identical homes each valued at \$100,000. Based on past data, the insurer estimates that the likelihood that the home will be destroyed by fire next year is 1/1,000 and that this is the only loss that can occur. In this case the expected annual loss for each home would be \$100 (i.e.  $1/1000 \times \$100,000$ ).

If the insurer issued only a single policy to cover the full loss from a fire, then there would be a variance of approximately \$100 associated with its expected annual loss<sup>25</sup>. As the number of policies issued,  $n$ , increases, the variance of the expected annual loss, or the mean loss per policy, decreases in proportion to  $n$ . Thus, if  $n = 10$ , the variance of the mean loss will be approximately \$10. When  $n = 100$  the variance decreases to \$1, and with  $n = 1,000$  the variance is \$0.10. It is thus not necessary to issue a very large number of policies to reduce significantly the variability of expected annual losses per policy if the risks are independent. This model of insurance works well for risks such as fire, automobile and loss of life where the above assumptions of independence and ability to estimate probabilities and losses are satisfied. As will be shown in the next chapter, terrorism risk does not satisfy the above conditions, so it is more problematic to insure.

### ***Catastrophe Models***<sup>26</sup>

Before insurance providers are willing to offer coverage against an uncertain event they feel they must be able to identify and quantify, or at least partially estimate, the

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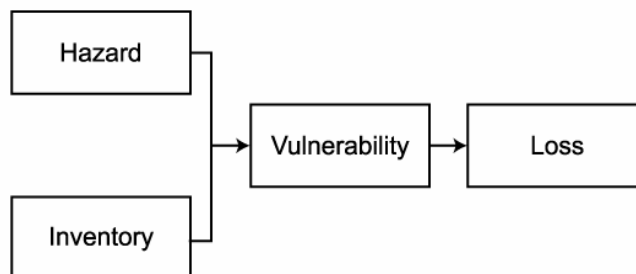
<sup>24</sup> Consider, for example, insurance for property damage caused by hurricanes. An insurer's expected losses are relatively low, because in a typical year, the policyholder will not suffer a hurricane loss. However, it is possible that losses will be quite high – far in excess of those expected at the time policies are priced. In the event of a serious hurricane, a substantial portion of the loss must be paid from insurer capital. For terrorism coverage, maximum losses are extremely high relative to expected losses, so the capital issue is critical.

<sup>25</sup> The variance for a single loss  $L$  with probability  $p$  is  $Lp(1-p)$ . If  $L = \$100,000$  and  $p = 1/1,000$ , then  $Lp(1-p) = \$100,000 (1/1,000)(999/1,000)$ , or \$99.90.

<sup>26</sup> This section is based on Grossi, P. and Kunreuther, H. (eds.) (2005), *Catastrophe Modeling: A New Approach to Managing Risk*. New York: Springer, Chapter 2.

chances of the event occurring and the extent of losses likely to be incurred. Such estimates can be based on past data (e.g., loss history of the insurer's portfolio of policyholders, loss history in a specific region) coupled with data on what experts know about a particular risk through the use of catastrophe models.

The four basic components of a catastrophe model are: hazard, inventory, vulnerability and loss, as depicted in Figure 2.1, and illustrated for a natural hazard such as a hurricane. First, the model determines the risk of the *hazard* phenomenon, which in the case of a hurricane is characterized by its projected path and wind speed. Next, the model characterizes the *inventory* (or portfolio) of properties at risk as accurately as possible. This is done by first assigning geographic coordinates such as latitude and longitude to a property based on its street address, zip code or another location descriptor, and then determining how many structures in the insurer's portfolio are at risk from hurricanes of different wind speeds and projected paths. For each property's location in spatial terms, other factors that characterize the inventory at risk are the construction type, the number of stories in the structure, and its age.



**Figure 2.1 Structure of Catastrophe Models**

The hazard and inventory modules enable the calculation of the *vulnerability* or susceptibility to damage of the structures at risk. In essence, this step in the catastrophe model quantifies the physical impact of the natural hazard phenomenon on the property at risk. How this vulnerability is quantified differs from model to model. Based on this measure of vulnerability, the *loss* to the property inventory is evaluated. In a catastrophe model, loss is characterized as direct or indirect in nature. Direct losses include the cost to repair and/or replace a structure. Indirect losses include business interruption impacts and relocation costs of residents forced to evacuate their homes.

Catastrophe models were introduced in the mid 1980s but did not gain widespread attention until after Hurricane Andrew hit southern Florida in August, 1992 causing insured losses of over \$21.5 billion (in 2004 prices). Until 9/11 this was the largest single loss in the history of insurance. Nine insurers became insolvent as a result of their losses from Hurricane Andrew. Insurers and reinsurers thought that, in order to increase the chances of remaining in business, they needed to estimate and manage their natural hazard risk more precisely. Many companies turned to the modelers of catastrophe risks for decision support.

### Exceedance Probability Curves<sup>27</sup>

Based on the outputs of a catastrophe model, the insurer can construct an exceedance probability (EP) curve that specifies the probabilities that a certain level of losses will be exceeded. The losses can be measured in terms of dollars of damage, fatalities, illness or some other unit of analysis.

To illustrate with a specific example, suppose one were interested in constructing an EP curve for an insurer with a given portfolio of insurance policies covering wind damage from hurricanes in a southeastern U.S. coastal community. Using probabilistic risk assessment, one would combine the set of events that could produce a given dollar loss and then determine the resulting probabilities of exceeding losses of different magnitudes. Based on these estimates, one can construct a mean EP curve, such as the one depicted in Figure 2.2. The x-axis measures the loss to insurer in dollars and the y-axis depicts the probability that losses will exceed a particular level. Suppose the insurer focuses on a specific loss  $L_i$ . One can see from Figure 2.2 that the likelihood that insured losses exceed  $L_i$  is given by  $p_i$ .

An insurer utilizes its EP curve for determining how many structures it will want to include in its portfolio given that there is some chance that there will be hurricanes causing damage to some subset of its policies during a given year. More specifically, if the insurer wanted to reduce the probability of a loss from hurricanes that exceeds  $L_i$  to be less than  $p_i$  it will have to determine what strategy to follow. The insurer could reduce the number of policies in force for these hazards, decide not to offer this type of coverage at all (if permitted by law to do so) or increase the capital available for dealing with future hurricanes that could produce large losses.

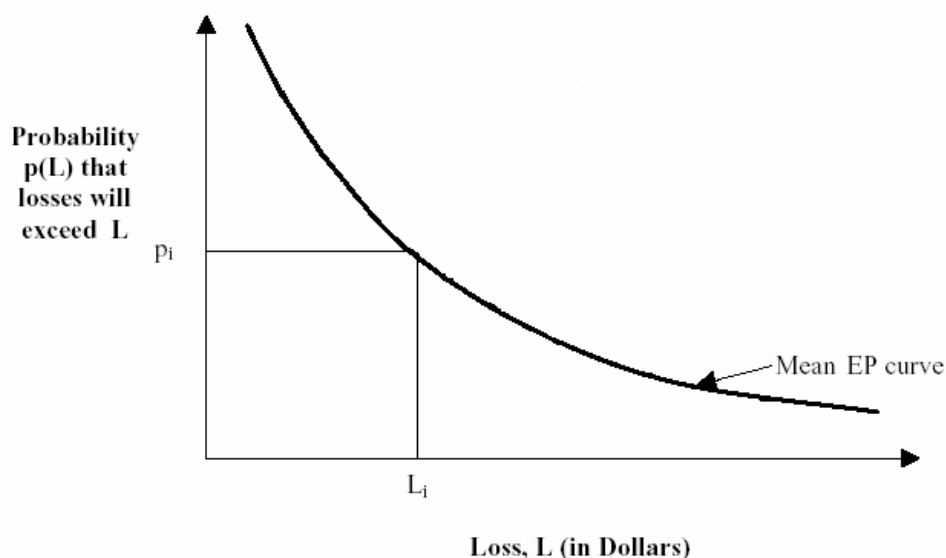


Figure 2.2 Sample Mean Exceedance Probability Curve

<sup>27</sup> This subsection is based on material in Kunreuther, H. Meyer, R. and van den Bulte, C. (2004), *Risk Analysis for Extreme Events: Economic Incentives for Reducing Future Losses*. NIST Monograph GCR 04-871.

Federal and state agencies may want to use EP curves for estimating the likelihood that losses to specific communities or regions of the country from natural disasters in the coming year will exceed certain levels in order to determine the chances that it will have to provide disaster assistance to these stricken areas. At the start of the hurricane season in 2004, Florida could have used an EP curve to estimate the likelihood of damage exceeding \$21 billion. Although this probability would have been extremely low, we now know that a confluence of events (i.e. Charley, Frances, Ivan and Jeanne) produced an outcome that exceeded this dollar value.

The uncertainty associated with the probability of an event occurring and the magnitude of dollar losses of an EP curve is reflected in the 5 percent and 95 percent confidence interval curves in Figure 2.3. The curve depicting the uncertainty in the loss shows the range of values,  $L_i^{.05}$  and  $L_i^{.95}$  that losses can take for a given mean value,  $L_i$ , so that there is a 95 percent chance that the loss will be exceeded with probability  $p_i$ . In a similar vein one can determine the range of probabilities,  $p_i^{.05}$  and  $p_i^{.95}$  so that there is 95 percent certainty that losses will exceed  $L_i$ . For low probability-high consequence risks, the spread between the 5 percent and 95 percent confidence intervals depicted in Figure 2.3 shows the degree of indeterminacy of these events.

The EP curve serves as an important element for evaluating risk management tools. It puts pressure on experts to make explicit the assumptions on which they are basing their estimates of the likelihood of certain events occurring and the resulting consequences.

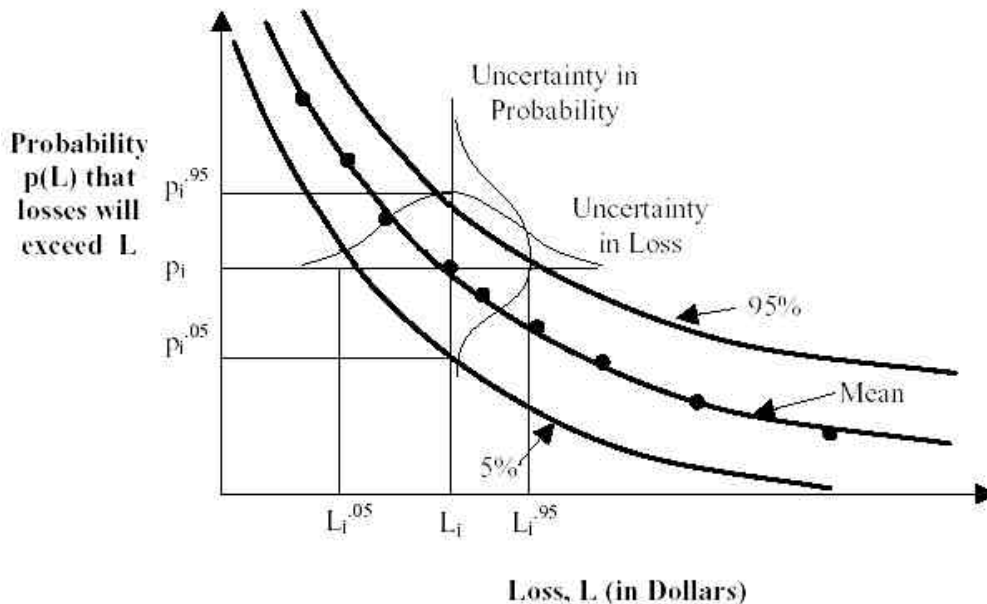


Figure 2.3 Confidence Intervals for a Mean Exceedance Probability (EP) Curve



### ***Determining Whether to Provide Coverage***

In his study on insurers' decision rules as to when they would market coverage for a specific risk, Stone (1973)<sup>28</sup> develops a model whereby firms maximize expected profits subject to satisfying a constraint related to the survival of the firm.<sup>29</sup> An insurer satisfies its *survival constraint* by choosing a portfolio of risks with an overall expected probability of total claims payments greater than some predetermined amount ( $L^*$ ) that is less than some threshold probability,  $p_1$ . This threshold probability is determined by the insurer to reflect the tradeoff between the expected benefits of another policy and the costs to the firm of a catastrophic loss that reduces their surplus by  $L^*$  or more. This threshold probability bears no necessary relationship to what would be efficient for society. The value of  $L^*$  is determined by concerns with insolvency and/or a sufficiently large loss in surplus that the insurer's credit rating will be downgraded by a rating agency.

A simple example illustrates how an insurer would utilize its survival constraint to determine whether a particular portfolio of risks is insurable with respect to hurricanes. Assume that all homes in a hurricane-prone area are equally resistant to damage such that the insurance premium,  $z$ , is the same for each structure. Further assume that an insurer has  $A$  dollars in current surplus and wants to determine the number of policies it can write and still satisfy its survival constraint. Then, the maximum number of policies,  $n$ , satisfying the survival constraint is given by:

$$\text{Probability [Claims Payments } (L^*) > (n \cdot z + A)] < p_1 \quad (2.1)$$

The insurer will use the survival constraint to determine the maximum number of policies it is willing to offer, with possibly an adjustment of the amount of coverage and premiums and/or a transfer of some of the risk to others in the private sector (e.g. reinsurers or capital markets) or it will rely on state or federal programs to cover catastrophic losses.

Following the series of natural disasters that occurred at the end of the 1980s and in the 1990s, insurers focused on the survival constraint to determine the amount of catastrophe coverage they were willing to provide because they were concerned that their aggregate exposure to a particular risk did not exceed a certain level. Rating agencies, such as A.M. Best, focused on insurers' exposure to catastrophic losses as one element in determining credit ratings, so insurers paid attention to this risk.

In particular, some insurers were unaware of the potential large loss they could suffer from hurricanes in Florida and earthquakes in California. Some were very surprised to discover that how much they had lost from the Hurricane Andrew in 1992 and the Northridge earthquake in 1994<sup>30</sup>. Following Hurricane Andrew insurers only marketed coverage against wind damage in Florida because they were required to do so and state

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<sup>28</sup> Stone, J. (1973), "A Theory of Capacity and the Insurance of Catastrophic Risks: Part I and Part II", *Journal of Risk and Insurance*, 40, pp. 231-243 (Part I) and 40, pp. 339-355 (Part II).

<sup>29</sup> Stone also introduces a constraint regarding the stability of the insurer's operation. However, insurers have traditionally not focused on this constraint in dealing with catastrophic risks.

<sup>30</sup> Hurricane Andrew inflicted \$21.5 billion and the Northridge earthquake caused \$17.8 billion in insured losses, respectively (price indexed to 2004). See Swiss Re (2005), "Natural catastrophes and man-made disaster in 2004: more than 300 000 fatalities, record insured losses", *Sigma* no 1/2005.



insurance pools were formed to limit their risk<sup>31</sup>. In California, insurers refused to renew homeowners' earthquake policies after the 1994 Northridge earthquake and the California Earthquake Authority was formed by the State of California in 1996 with funds from insurers and reinsurers (Roth, Jr., 1998)<sup>32</sup>.

### Setting Premiums

If the insurer decides to offer coverage, it needs to determine a premium rate that yields a profit and satisfies its survival constraint given by (2.1). State regulations often limit insurers in their rate-setting process, and competition can play a role in what may be charged in a given marketplace. Even in the absence of these influences, an insurer must consider problems associated with *ambiguity of the risk*, asymmetry of information (*adverse selection* and *moral hazard*), and degree of *correlation* of the risk in determining what premium to charge. We will examine each of these factors in turn.

*Ambiguity of the Risk*      The ambiguities associated with the probability of a terrorist attack and with the outcomes of such an attack raise a number of challenges for insurers with respect to pricing their policies. As shown by a series of empirical studies, actuaries and underwriters are so averse to ambiguity that they tend to charge much higher premiums when the likelihood and/or consequences of a risk are highly uncertain than if these components of risk are well specified.

Kunreuther et al. (1995) conducted a survey of 896 underwriters in 190 randomly chosen insurance companies to determine what premiums would be required to insure a factory against property damage from a severe earthquake<sup>33</sup>. The survey results examine changes in pricing strategy as function of the degree of uncertainty in either the probability and/or loss. A probability is considered to be well-specified when there is enough historical information on an event that all experts agree that the probability of a loss is  $p$ . When there is wide disagreement about the estimate of  $p$  among the experts, this ambiguous probability is referred to as  $Ap$ .  $L$  represents a known loss — that is, there is a general consensus about what the loss will be if a specific event occurs. When a loss is uncertain, and the experts' estimates range between  $L_{min}$  and  $L_{max}$ , this uncertain loss is denoted as  $UL$ . Combining the degree of probability and loss uncertainty leads to the four cases shown in the columns of Table 2.1.

To see how underwriters reacted to different situations, four scenarios were constructed as shown by the rows in Table 2.1. Where the risk is well-specified, the probability of the earthquake is either .01 or .005; the loss, should the event occur, is either

<sup>31</sup> Grace, M., Klein, R., Kleindorfer, P. and Murray, M. (2003), *Catastrophe Insurance: Consumer Demand, Markets and Regulation*, Boston: Kluwer.

<sup>32</sup> Roth, R., Jr. (1998), "Earthquake Insurance Protection in California," in *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States*, Kunreuther, K. and Roth, R., Sr., eds., Washington, D.C. : Joseph Henry Press, Chapter 4.

<sup>33</sup> Kunreuther, H., Meszaros, J., Hogarth, R. and Spranca M. (1995), "Ambiguity and underwriter decision processes", *Journal of Economic Behaviour and Organization*, 26, pp. 337-352.

\$1 million or \$10 million. The premium set by the underwriter is standardized at 1 for the non-ambiguous case; one can then examine how ambiguity affects pricing decisions.

Table 2.1 shows the ratio of the other three cases relative to the non-ambiguous case ( $p, L$ ) for the four different scenarios, which were distributed, randomly to underwriters in primary insurance companies. For the highly ambiguous case ( $Ap, UL$ ), the premiums were between 1.43 to 1.77 times higher than if underwriters priced a non-ambiguous risk. The ratios for the other two cases were always above 1, but less than the ( $Ap, UL$ ) case. Since the likelihood and consequences of terrorism risk are even more ambiguous than earthquake risk, one would expect that the ratio of ( $Ap, UL$ ) relative to ( $p, L$ ) would be higher if underwriters were asked the same questions for setting terrorism insurance premiums.

**Table 2.1 Ratios of Underwriters' Premiums for Ambiguous or Uncertain Earthquake Risks Relative to Well-Specified Risks\***

| SCENARIO                 | CASES |      |      |       | N** |
|--------------------------|-------|------|------|-------|-----|
|                          | 1     | 2    | 3    | 4     |     |
|                          | p,L   | Ap,L | P,UL | Ap,UL |     |
| P=.005<br>L=\$1 million  | 1     | 1.28 | 1.19 | 1.77  | 17  |
| P=.005<br>L=\$10 million | 1     | 1.31 | 1.29 | 1.59  | 8   |
| P=.01<br>L=\$1 million   | 1     | 1.19 | 1.21 | 1.50  | 23  |
| P=.01<br>L=\$10 million  | 1     | 1.38 | 1.15 | 1.43  | 6   |

\*Ratios are based on mean premiums across number of respondents for each scenario.

\*\*N= number of respondents

Source: Adapted from Table 3 in Kunreuther et al (1995)<sup>34</sup>

We now turn to three important issues arising from the existence of asymmetry of information about the risk between the insured and the insurer.

**Adverse Selection** If the insurer cannot differentiate *ex ante* from the risks facing two groups of potential insurance buyers and each buyer knows her own risk, then the insurer is likely to suffer losses if it sets the same premium for both groups by using the entire population as a basis for this estimate. If only the highest risk group is likely to purchase coverage for that hazard and the premium is below its expected loss, the insurer will

<sup>34</sup> Kunreuther, H., Meszaros, J., Hogarth, R. and Spranca M. (1995), "Ambiguity and underwriter decision processes", *Journal of Economic Behaviour and Organization*, 26, pp. 337-352.

constitute a portfolio of “bad” risks. 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<sup>35</sup>.

The problem of adverse selection only emerges in unregulated markets if those considering the purchase of insurance have more accurate information on the probability of a loss than the firms selling coverage. If the policyholders have no better data than the insurers, both sides are on an equal footing. Coverage will be offered at a single premium based on the average risk, and both good and poor risks will want to purchase policies. If adverse selection should occur, the primary inefficiency is the underpurchase of coverage by the lower risks, but there may be equity issues associated with charging high premiums to the poor risks that may lead to premium regulations. In the context of the terrorism risk, adverse selection will be a minor problem since those at risk are unlikely to have an informational advantage over the insurer (see Section 3.2).

*Moral Hazard* Providing insurance protection to an individual may lead that person to change behavior in ways that increase the expected loss from what it would have been without coverage. If the insurer cannot predict this behavior and relies on past loss data from uninsured individuals to estimate rates, the resulting premium is likely to be too low to cover losses. *Moral hazard* refers to an increase in the expected loss (probability or amount of loss conditional on an event occurring) caused by insurance-induced changes in the behavior of the policyholder. For example, if an insured person is more careless as a result of purchasing coverage, this illustrates moral hazard. The introduction of specific deductibles, coinsurance or upper limits on coverage can be useful tools to encourage the insureds to engage in less risky behavior, as they know they will have to incur part of the losses from an adverse event. In the case of terrorism, one would not expect moral hazard to play a major role, since there is no reason to expect policyholders to behave in ways that will increase the risk of a terrorist attack after these firms have purchased insurance.

*Correlated Risks* For extreme events, the potential for high correlation between the risks will have an impact on the tail of the distribution. In other words, at a predefined probability  $p_i$ , the region below the EP curve is likely to expand for higher correlated risks covered by insurers. This requires additional capital for the insurer to protect itself against large losses. In the context of terrorism, there was considerable property damage from the 9/11 attacks coupled with losses to other lines of insurance such as workers’ compensation, life and business interruption, thus accounting for the \$32.4 billion of insured damage (see Section 3.1). Even risks that are normally assumed to be independent, such as fire, can be

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<sup>35</sup> For a survey of adverse selection issues, see Dionne, G., Doherty, N. and Fombaron, N. (2000), “Adverse Selection in Insurance Markets”, Chapter 7 in Dionne, G. (Ed.) *Handbook of Insurance*. Boston: Kluwer. There is also a growing literature studying the impact of insurers being more knowledgeable about the risks than the insured individual or firm; see Henriët, D. and Michel-Kerjan, E. (2005), “Risk-Sharing with Asymmetric Information: A Note on a Mustering Approach”, Working Paper, Center for Risk Management and Decision Processes, The Wharton School, Philadelphia.

highly correlated. For example, the Oakland Conflagration Fire of October 20, 1991 damaged or destroyed 3,000 structures for a total insured loss of \$1.7 billion. More recently, the fires in Southern California between October 23 and November 6 of 2003, destroyed over 750,000 acres of land and approximately 4,000 residential properties<sup>36</sup>.

Catastrophic risks often involve spatially correlated losses or the simultaneous occurrence of many losses from a single event. For example, due to their high concentration of homeowners' policies in the Miami/Dade County area of Florida, State Farm and Allstate Insurance paid \$3.6 billion and \$2.3 billion in claims respectively in the wake of Hurricane Andrew in 1992 (out of \$15 billion total insured losses, in 1995 prices). Given this unexpectedly high loss, both companies began to reassess their strategies of setting premiums and providing coverage against wind damage in hurricane-prone areas (Lecomte and Gahagan, 1998)<sup>37</sup>.

## 2.2 Federal and State Catastrophe Programs

We now turn to the important role that the federal and state governments in the United States play in supplementing or replacing private insurance with respect to natural disasters, nuclear accidents and other catastrophic losses. This section provides a brief overview of several of these programs to illustrate the types of public-private partnerships that have been implemented in the past.

### *Flood Insurance*

Insurers have experimented over the years with providing protection against water damage from floods, hurricanes and other storms. After the severe Mississippi Floods of 1927, they concluded that the risk was too great and refused to provide private insurance again. As a result, Congress created the National Flood Insurance Program (NFIP) in 1968, whereby homeowners and businesses could purchase coverage for water damage. Private insurers market flood policies, and the premiums are deposited in a federally operated Flood Insurance Fund, which is then responsible for paying claims. The stipulation for this financial protection is that the local community makes a commitment to regulate the location and design of future floodplain construction to increase safety from flood hazards. The federal government established a series of building and development standards for floodplain construction to serve as minimum requirements for participation in the program.

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<sup>36</sup> West, P. (2004), "Lessons Learned from Southern California's Firestorms Released", *Wildfire Magazine*, January 23.

<sup>37</sup> Lecomte, E. and Gahagan, K. (1998), "Hurricane Insurance Protection in Florida", Chapter 5 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States*. Washington, D.C: J. Henry Press.

The creation of the Community Rating System in 1990 has made linked mitigation measures with the price of insurance in a systematic way (Pasterick, 1998)<sup>38</sup>.

### ***Hurricane Insurance***

The need for hurricane insurance is most pronounced in the state of Florida. Following Hurricane Andrew in 1992, nine property-casualty insurance companies became insolvent, forcing other insurers to cover these losses under Florida's State Guaranty Fund. Property insurance became more difficult to obtain as many insurers reduced their concentrations of insured property in coastal areas. During a special session of the Florida State Legislature in 1993 the Florida Hurricane Catastrophe Fund (FHCF) was created to relieve pressure on insurers to reduce their exposures to hurricane losses. The FHCF, a tax-exempt trust fund administered by the State of Florida, is financed by premiums paid by insurers that write policies on personal and commercial residential properties. The fund reimburses a portion of insurers' losses following major hurricanes (above the insurer's retention level) and enables insurers to remain solvent (Lecomte and Gahagan, 1998)<sup>39</sup>. The four hurricanes that hit Florida in the fall of 2004 (Charley, Frances, Ivan and Jeanne) caused an estimated \$23 billion in insured losses, with only about \$2.6 billion paid out by the Fund. Each hurricane was considered a distinct event, so that retention levels were applied to each storm before insurers could turn to the FHCF.

### ***Earthquake Insurance***

The history of earthquake activity in California convinced legislators that this risk was too great to be left in the hands of private insurers alone. In 1985, a California law required insurers writing homeowners coverage on one to four unit residential buildings to also offer earthquake coverage. Since rates were regulated by the state, insurers felt they were forced to offer coverage against older structures in poor condition, with rates not necessarily reflecting the risk. Following the 1994 Northridge earthquake, huge insured property losses created a surge in demand for coverage. Insurers were concerned that if they satisfied the entire demand, as they were required to do by the 1985 law, they would face an unacceptable level of risk and become insolvent following the next major earthquake. Hence, many firms decided to stop offering coverage or restricted the sale of homeowners' policies in California.

In order to keep earthquake insurance alive in California, in 1996 the State legislature authorized the formation of the California Earthquake Authority (CEA), a state-run insurance company that provides earthquake coverage to homeowners. The innovative feature of this financing plan is the ability to pay for a large earthquake while committing relatively few dollars up front. There is an initial assessment of insurers of \$1 billion to

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<sup>38</sup> Pasterick, E. (1998), "The National Flood Insurance Program," Chapter 6 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States*. Washington, D.C: J. Henry Press.

<sup>39</sup> Lecomte, E. and Gahagan, K. (1998), "Hurricane Insurance Protection in Florida" Chapter 5 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States*. Washington, D.C: J. Henry Press.

start the program and then contingent assessments to the insurance industry and reinsurers following a severe earthquake. Policyholders absorb the first portion of an earthquake through a 15 percent deductible on their policies (Roth, 1998)<sup>40</sup>. However, eight years after the creation of the CEA, the take-up rate for homeowners is about 15 percent, down from 30 percent when the California State Legislature created the CEA (Risk Management Solutions, 2004)<sup>41</sup>. It is questionable how effective this program will be in covering losses should a major earthquake occur in California.

### *Nuclear Accident Insurance*<sup>42</sup>

The Price-Anderson Act, originally enacted by Congress in 1957, limits the liability of the nuclear industry in the event of a nuclear accident in the United States. At the same time, it provides a ready source of funds to compensate potential accident victims that would not ordinarily be available in the absence of this legislation. The Act covers large power reactors, small research and test reactors, fuel reprocessing plants and enrichment facilities for incidents that occur through plant operation as well as transportation and storage of nuclear fuel and radioactive wastes.

Price-Anderson sets up two tiers of insurance. Each utility is required to maintain the maximum amount of coverage available from the private insurance industry - currently \$300 million per site. In the U.S., this coverage is written by the American Nuclear Insurers, a joint underwriting association or “pool” of insurance companies. If claims following an accident exceed that primary layer of insurance, all nuclear operators are obligated to pay up to \$100.59 million for each reactor they operate payable at the rate of \$10 million per reactor, per year. As of February 2005, the U.S. public currently has more than \$10 billion of insurance protection in the event of a nuclear reactor incident. More than \$200 million has been paid in claims and costs of litigation since the Price-Anderson Act went into effect, all of it by the insurance pools. Of this amount, approximately \$71 million has been paid in claims and costs of litigation related to the 1979 accident at Three Mile Island.

In February 2003, Congress extended the law for power reactors licensed by the Nuclear Regulatory Commission (NRC) to the end of 2003.<sup>43</sup> Coverage for facilities operated by the Department of Energy has been extended until the end of 2006 in separate legislative action. Congress is now considering further extension of the law as part of comprehensive energy legislation.

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<sup>40</sup> Roth, R., Jr. (1998), “Earthquake Insurance Protection in California”, Chapter 4 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States*. Washington, D.C: J. Henry Press. .

<sup>41</sup> Risk Management Solutions (2004), “The Northridge, California Earthquake. A 10-Year Retrospective”, May.

<sup>42</sup> For more details on nuclear accident insurance see Nuclear Energy Institute “Price-Anderson Act Provides Effective Nuclear Insurance at No Cost to the Public”, February 2005.

<sup>43</sup> Although the existing law has technically expired, its provisions are “grandfathered” and continue to apply to all existing NRC licensees, that is to say, to power reactor operators with operating licenses issued prior to the expiration date. Personal Correspondence with John Quattrocchi July 21, 2005.

***Federal Aviation Administration 3rd Party Liability Insurance Program***

Since the terrorist attacks of September 11, 2001, the U.S. commercial aviation industry can purchase insurance for third party liability arising out of aviation terrorism. The current mechanism operates as a pure government program, with premiums paid by airlines into the Aviation Insurance Revolving Fund managed by the Federal Aviation Administration (FAA).

As the program carries a liability limit of only \$100 million, losses paid by government sources in the event of an attack will almost surely exceed those available through the current insurance regime. In that case, either the government would need to appropriate additional disaster assistance funds as it did in the aftermath of September 11<sup>th</sup>, or victims would be forced to rely on traditional sources of assistance (Strauss, 2005)<sup>44</sup>.

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<sup>44</sup> Andrew Strauss (2005), "Terrorism Third Party Liability Insurance for Commercial Aviation, Federal Intervention in the Wake of September 11", The Wharton School, Center for Risk Management and Decision Processes, June, Philadelphia.



### **Summary of Chapter 2**

Catastrophe models and exceedance probability (EP) curves are useful decision aids for determining whether extreme events, such as natural disasters, are insurable risks. Given the limited historical data on these low probability events it is necessary to supplement this information with scientific models. One needs to recognize that there is considerable uncertainty in the estimates of the likelihood and consequences of specific events particular for risks such as terrorism. In determining what premium to charge and how much coverage to offer, insurers must also consider problems of adverse selection, moral hazard and correlation between risks.

Insurers focus on survival constraints in determining how much coverage to offer. Their objective is to keep the likelihood that losses exceed a prespecified level from a given risk to be below a threshold probability. The EP curve is a useful tool for examining alternative strategies, such as reinsurance and/or reduction in coverage for meeting this constraint.

The chapter concludes with a discussion of a set of federal and state programs established for aiding insurers faced with the challenges of dealing with natural hazards, nuclear power and third party liability arising out of aviation terrorism insurance. The strengths and limitations of these programs may suggest how to avoid caveats and new ways of providing protection against terrorism.



## CHAPTER 3

### Terrorism as an Extreme Event: Risk Financing Issues<sup>45</sup>

The previous chapter introduced concepts of insurability for extreme events by focusing on natural disasters. We now examine features of terrorism that make the insurability problem somewhat more challenging than for natural disasters and other low probability-high consequence events.

#### 3.1 A New Loss Dimension

Prior to September 11, 2001 terrorism exclusions in commercial property and casualty policies in the U.S. insurance market were extremely rare (outside of ocean marine) because losses from terrorism had historically been small and, to a large degree, uncorrelated. Attacks of a domestic origin were isolated, carried out by groups or individuals with disparate agendas. Thus the country did not face from a concerted domestic terrorism threat, as did countries such as France, Israel, Spain and the UK.

In fact, insurance losses from terrorism were viewed as so improbable that the risk was not explicitly mentioned nor priced in any standard policy and it was never excluded from so-called “all-risk” policies with the exception of some marine cargo, aviation and political risk policies. Even the first attack on the World Trade Center (WTC) in 1993<sup>46</sup> and the Oklahoma City bombing of 1995<sup>47</sup> were not seen as being threatening enough for insurers to consider revising their view of terrorism as a peril worth considering when pricing a commercial insurance policy. Since insurers and reinsurers felt that the likelihood of a major terrorist loss was below their threshold level of concern, they did not pay close attention to their potential losses from terrorism in the United States (Kunreuther and Pauly, in press)<sup>48</sup>.

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<sup>45</sup> This chapter is based on Kunreuther, H. and Michel-Kerjan, E. (2005), “Insuring (Mega)-terrorism: Challenges and Perspectives” in Organization for Economic Cooperation and Development (2005). *Terrorism Insurance in OECD Countries*. Paris: OECD, July 5.

<sup>46</sup> The 1993 bombing of the WTC killed 6 people and caused \$725 million in insured damages. See Swiss Re (2002), *Focus Report: Terrorism—dealing with the new spectre*. Zurich: Swiss Re, February.

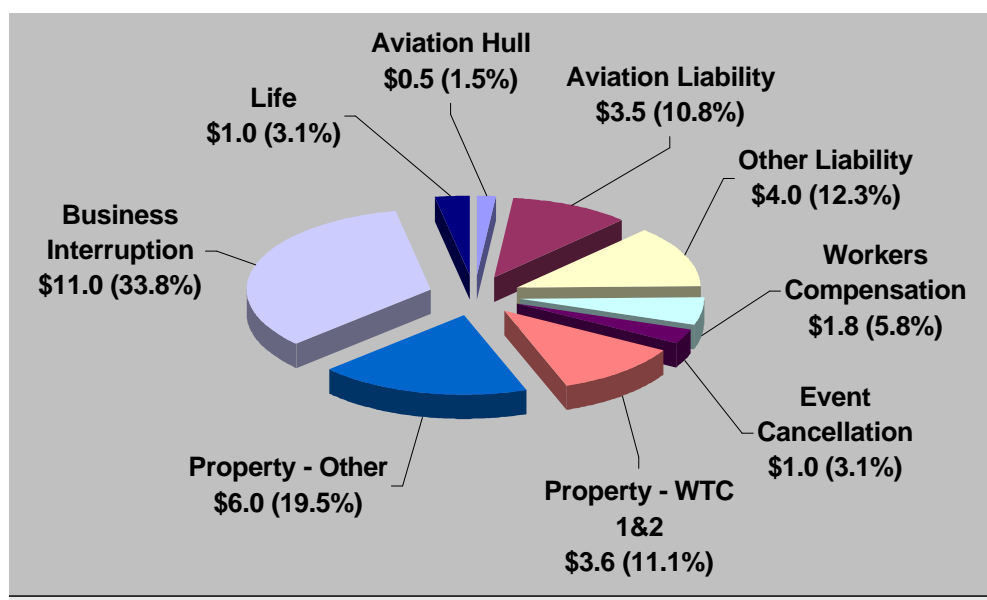
<sup>47</sup> Prior to Sept. 11th, the Oklahoma City bombing of 1995, which killed 168 people, had been the most damaging terrorist attack on domestic soil, but the largest losses were to federal property and employees and were covered by the government.

<sup>48</sup> Kunreuther, H. and Pauly, M. “Terrorism Losses and All-perils Insurance”, *Journal of Insurance Regulation* (in press).

### 9/11 and Other Terrorist Attacks

The terrorist attacks of September 11, 2001 killed over 3,000 people from over 90 countries and injured about 2,250 others. The attacks inflicted damage currently estimated at nearly \$80 billion, about \$32.4 billion of which was covered by about 120 insurers and reinsurers (Hartwig, 2004)<sup>49</sup>. Of the total insured losses, those associated with property damage and business interruption are estimated at \$22.1 billion. Table 3.1 details the 10 most costly terrorist attacks between 1970 and 2001 in terms of insured property losses (including also business interruption and aviation hull losses, but excluding liability and life insurance).

The insured losses from 9/11 illustrate the high degree of risk correlation between different lines of insurance coverage. Indeed, these attacks not only affected commercial property, caused business interruption and aircraft hull damage, but also led to significant claims from other lines of coverage: workers' compensation, life, health, disability and general liability insurance. Figure 3.1 depicts the composition of the \$32.4 billion total insured loss estimates due to these terrorist attacks (as of July 2004).



**Figure 3.1 Composition of 9/11 Insured Loss Estimates (total: \$32.4 billion) as of July 2004, by Line (\$ billion)**

*Sources: Wharton Risk Center with data from Insurance Information Institute*

<sup>49</sup> Hartwig, R. (2004), "The Fate of TRIA: Is Terrorism an Insurance Risk?" Insurance Information Institute, New York, NY. This estimate keeps changing as a result of new claims settlements and court rulings. For example, a federal jury ruled in December 2004 that the 9/11 attacks against the World Trade Center's towers constituted two separate "occurrences" under certain insurance policies, entitling the World Trade Center leaseholder Silverstein Properties to collect \$2.2 billion from nine insurers. This is twice as much as the amount of coverage he carried for a single occurrence from these nine insurers. See Bagli, C., (2004) "Tower's Insurance Must Pay Double," The New York Times, December 7, p.A1.

**Table 3.1 The 10 Most Costly Terrorist Attacks in Terms of Insured Property Losses, 1970-2001**

| Insured property<br>U.S.\$ million, indexed<br>to 2001 ( <u>excluding</u><br>liability and life) | Event  | Injured | Fatalities | Date        | Location                    |
|--|--|---------|------------|-------------|-----------------------------|
| 22,100   | Terror attacks against WTC, Pentagon and Pennsylvania by hijacked airliners            | 2,250   | 3,000      | 11 Sept. 01 | USA (NYC, Wash. DC, PA)     |
| 907  | Bomb explodes near NatWest tower (City)  | 54      | 1          | 24 Apr. 93  | UK (London)                 |
| 744  | Explosion of IRA car bomb near shopping mall   | 228     | 0          | 15 Jun. 96  | UK (Manchester)             |
| 725  | Bomb explodes in garage of World Trade Center  | 1,000   | 6          | 26 Feb. 93  | USA (New York)              |
| 671  | Bomb explodes in financial district  | 91      | 3          | 10 Apr. 92  | UK (London)                 |
| 398  | Rebels destroy 3 airliners, 8 military aircraft and heavily damage 3 civilian aircraft | 15      | 20         | 24 Jul. 01  | Sri Lanka / Colombo Airport |
| 259  | IRA bomb attack in South Key Docklands   | 100     | 2          | 09 Feb. 96  | UK (London)                 |
| 145  | Truck bomb attack on government building in Oklahoma City                              | 467     | 166        | 19 Apr. 95  | USA (Oklahoma City)         |
| 138  | PanAm Boeing 747 crashes due to bomb   | 0       | 270        | 21 Dec. 88  | UK (Lockerbie)              |
| 127  | Hijacked Swissair DC-8, TWA Boeing 707 and BOAC VC-10 dynamited                        | 0       | 0          | 06 Sep.70   | Jordan (Zerqa)              |

Sources: Swiss Re (2002)<sup>50</sup> and Insurance Information Institute

In addition to reimbursements provided by insurers, the Federal Victim Compensation Fund (VCF) was established by Congress in the aftermath of 9/11 and provided nearly \$7 billion in payments to 9/11 civilian and first responder victims' families (CBO, 2005)<sup>51</sup>. The creation of VCF was part of an effort to limit lawsuits against the airlines and other parties. The fund actually requires the beneficiaries to relinquish their rights to sue, thus limiting liability losses that might otherwise have ended up in court and possibly paid by the insurance industry. All but a few 9/11 victims families went through

<sup>50</sup> Swiss Re (2002), "Natural catastrophes and man-made disasters 2001: high flood loss burden". *Sigma* no2/2002, Zurich: Swiss Re, Economic Research and Consulting; Swiss Re (2002), *Focus Report: Terrorism—dealing with the new spectr.*, Zurich: Swiss Re, February.

<sup>51</sup> CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

the VCF for benefits<sup>52</sup>. In addition private philanthropy played a critical role in filling a variety of needs created by the 9/11 tragedy<sup>53</sup>. A comprehensive report by the Foundation Center noted that “in the immediate aftermath of the attacks, private funds were quickly made available by foundations, corporations, and individuals and distributed to a wide range of community organizations that understood how to best reach and serve various affected populations. At last count, voluntary contributions to 9/11 relief and recovery totaled a whopping \$2.8 billion — \$1.1 billion of it from institutional donors like corporations and foundations and the balance from private individuals.” (Foundation Center, 2004)<sup>54</sup>.

### *9/11 in the Context of Insurability Issues*

To more fully understand the losses from 9/11 from an insurability perspective, it is important to compare this event with other types of extreme events that have affected the (re)insurance industry. Table 3.2 presents the 15 largest worldwide insurance losses due to natural catastrophes and man-made disasters from 1970 to 2004. Prior to 9/11 losses, the largest loss experienced by the insurance industry was Hurricane Andrew, which devastated the coasts of Florida in August 1992 and inflicted \$21.5 billion in claims payments (indexed to 2004) (Swiss Re, 2005)<sup>55</sup>. When one adds the \$6-7 billion in payments by U.S. Federal Victim Compensation Fund to victims of 9/11 and their families, the claims from the 9/11 terrorist attacks are almost twice those from Hurricane Andrew (Congressional Budget Office, 2005)<sup>56</sup>.

Taking an even broader perspective, Figure 3.2 depicts the trend in worldwide insurance losses due to major natural catastrophes and man-made disasters from 1970 to the end of 2004 showing how insured losses have increased in recent years. Of the 40 most costly events over this period of time, over half occurred in the past 10 years and 80 percent of them occurred between 1990 and 2004 (in constant prices). In particular, the insured losses from Hurricane Andrew in 1992 and the Northridge earthquake in 1994 led insurers and reinsurers to pay much more attention to the catastrophic potential of natural disasters.

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<sup>52</sup> Awards from the VCF ranged from \$250,000 to \$7.1 million and averaged \$2.08 million. For a very comprehensive and detailed analysis of 9/11 victims’ compensation, see Dixon, L. and Stern, R.K. (2004), *Compensation for Losses of the 9/11 Attacks*. Santa Monica, CA: RAND.

<sup>53</sup> Philanthropic Charitable donations also reached an unprecedented level of nearly 3 billion of dollars for victims of the September 11 attacks; see Renz, L., Cuccaro, E., Marino, L. (2003) *9/11 Relief and Regranting Funds: A Summary Report on Funds Raised and Assistance Provided*. New York, NY: Foundation Center.

<sup>54</sup> The Foundation Center (2004), *September 11: The Philanthropic Response*. The report also includes the list of grants by founder.

<sup>55</sup> Swiss Re (2005), “Natural catastrophes and man-made disaster in 2004: more than 300 000 fatalities, record insured losses”, *Sigma* no 1/2005.

<sup>56</sup> CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

**Table 3.2 The 15 Most Costly Insurance Losses, 1970-2004**

| <i>U.S.\$ Billion<br/>(indexed to 2002)</i> | <i>Event</i>          | <i>Victims<br/>(Dead and<br/>missing)</i> | <i>Year</i> | <i>Country</i>            |
|---|-----------------------|---|-------------|---------------------------|
| <b>32.4<sup>57</sup></b>                    | 9/11 Attacks          | 3,025                                     | 2001        | USA                       |
| <b>21.50</b>                                | Hurricane Andrew      | 43  | 1992        | USA, Bahamas              |
| <b>17.80</b>                                | Northridge Earthquake | 61  | 1994        | USA                       |
| <b>11.00</b>                                | Hurricane Ivan        | 124                                       | 2004        | USA, Caribbean et al      |
| <b>8.00</b>                                 | Hurricane Charley     | 24  | 2004        | USA, Caribbean et al      |
| <b>7.80</b>                                 | Typhoon Mireille      | 51  | 1991        | Japan                     |
| <b>6.7</b>                                  | Winterstorm Daria     | 95  | 1990        | France, UK et al          |
| <b>6.6</b>                                  | Winterstorm Lothar    | 110                                       | 1999        | France, Switzerland et al |
| <b>6.4</b>                                  | Hurricane Hugo        | 71  | 1989        | Puerto Rico, USA et al    |
| <b>5.0</b>                                  | Hurricane Frances     | 38  | 2004        | U.S., Bahamas             |
| <b>5.0</b>                                  | Seauquake and Tsunami | 280 000                                   | 2004        | Indonesia, Thailand et al |
| <b>5.0</b>                                  | Storms and floods     | 22  | 1987        | France, UK et al          |
| <b>4.6</b>                                  | Winterstorm Vivian    | 64  | 1990        | Western/Central Europe    |
| <b>4.6</b>                                  | Typhoon Bart          | 26  | 1999        | Japan                     |
| <b>4.1</b>                                  | Hurricane Georges     | 600                                       | 1998        | USA, Caribbean            |

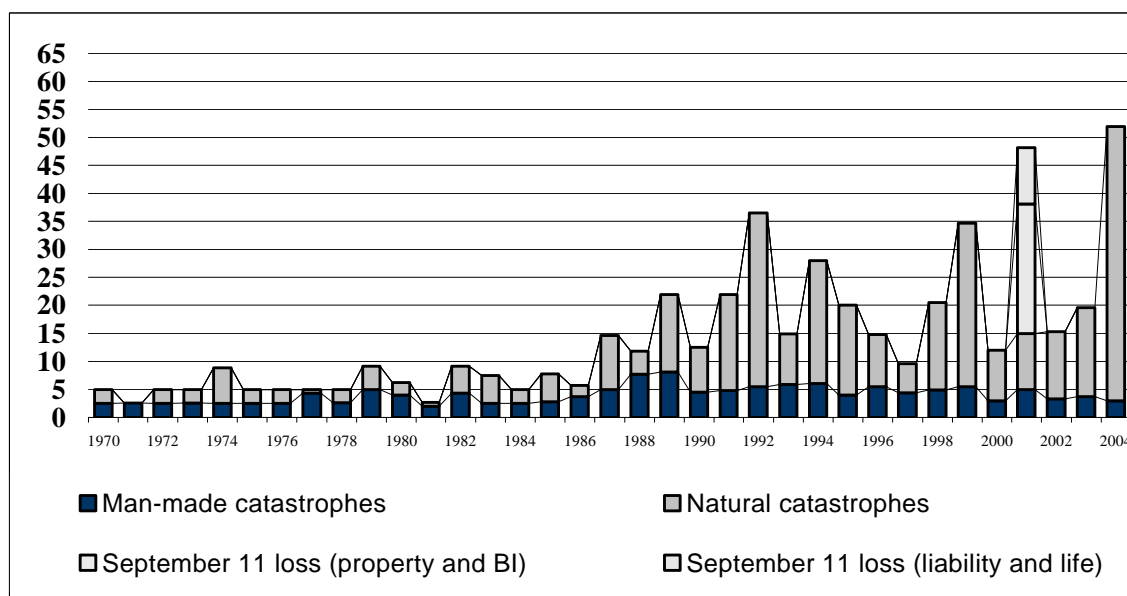
*Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute*

Some of the smaller insurers were forced to declare insolvency due to these events. Those that survived began to rethink what was meant by an insurable risk and the roles of catastrophic models to estimate the likelihood and consequences from specific hazards that might cause damage in specific locations (Grossi and Kunreuther, 2005)<sup>58</sup>. With \$49 billion dollars of insured losses due to natural disasters, the year 2004 constitutes the most costly year ever in the history of the insurance industry (Swiss Re, 2005)<sup>59</sup>.

<sup>57</sup> Includes life and liability insurance losses, but not the \$1.1 billion in additional claims by Silverstein Properties (see above). Sources: Hartwig, R. (2004), "The Fate of TRIA: Is Terrorism an Insurance Risk?" *Insurance Information Institute*, New York, NY.; Bagli, C., (2004) "Tower's Insurance Must Pay Double," *The New York Times*, December 7. p.A1; and CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

<sup>58</sup> Grossi, P and Kunreuther, H. (eds) (2005), *Catastrophe Modeling: A New Approach of Managing Risk*. New York: Springer.

<sup>59</sup> Swiss Re (2005), "Natural catastrophes and man-made disaster in 2004: more than 300 000 fatalities, record insured losses", *Sigma* no 1/2005.



**Figure 3.2 Worldwide Evolution of Catastrophe Insured Losses, 1970-2004**

(Property and business interruption (BI); in U.S.\$ billion indexed to 2004)

Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute

Reinsurers (most of them European) were responsible for a large portion of the claims from 9/11 (Dubois, 2004)<sup>60</sup>. Coming on top of a series of catastrophic natural disasters over the past decade and portfolio losses due to stock market declines, their capital base was severely hit. Furthermore, their appetite for new capital to provide reinsurance against terrorism risk was sharply curtailed. Hence most reinsurers decided to drastically reduce their exposure to terrorism, or even stopped covering this risk. The few who marketed policies charged extremely high rates for very limited protection. This directly affected insurance supply. Most insurers stopped covering terrorism in areas they perceived to be high risk unless they were forced to include it in their policies, as was the case with workers' compensation. When coverage was offered, the prices were likely to increase significantly over what they were prior to 9/11 and coverage limits were reduced.

Take the case of insuring Chicago's O'Hare airport. Prior to 9/11, the airport had \$750 million of terrorism insurance coverage at an annual premium of \$125,000. After the terrorist attacks, insurers only offered the airport \$150 million of coverage at an annual premium of \$6.9 million. The airport purchased this coverage as it could not operate without any coverage (Jaffee and Russell, 2003)<sup>61</sup>. Golden Gate Park in San Francisco, CA was unable to obtain terrorism coverage and its non-terrorism coverage was reduced from \$125

<sup>60</sup> Testimony of Jacques Dubois, Chairman and CEO Swiss Re America on behalf of Swiss Re before the United States Senate on Banking, Housing, and Urban Affairs, May 18, 2004.

<sup>61</sup> Jaffee, D. and Russell, T. (2003). "Market Under Stress: The Case of Extreme Event Insurance" in Arnott, R., Greenwald, B., Kanbur, R. and Nalebuff, B. (eds), *Economics for an Imperfect World: Essays in Honor of Joseph E. Stiglitz*. Cambridge, MA: MIT Press.

million to \$25 million. Yet the premiums for this reduced amount of protection increased from \$500,000 in 2001 to \$1.1 million in 2002 (Smetters, 2004)<sup>62</sup>.

Insurers warned that another event of comparable magnitude to 9/11 could seriously strain the capacity of the industry<sup>63</sup>. Furthermore, they contended that the uncertainties surrounding large-scale terrorism risk were so significant that the risk was uninsurable by the private sector alone. In October 2001, the Insurance Services Office, on behalf of subscribing insurance companies, filed a request in every state for approval of policy forms that would permit insurers the option of excluding terrorism from most commercial insurance coverage with the exception of workers' compensation. By early 2002, 45 states permitted insurance companies to use these exclusions, except for two types of coverage: workers' compensation insurance policies where occupational injuries are covered without regard to the peril that caused the injury and fire policies in states that have a law where losses from fire are covered no matter what the cause<sup>64</sup>. That led to a call for some type of federal intervention (U.S. Congress Joint Economic Committee, 2002)<sup>65</sup>. In other countries, similar reactions were observed. Deprived of reinsurance at an affordable price, most insurers decided to stop covering terrorism risk and turned to the government to fill the gap (Michel-Kerjan and Pedell, 2005; OECD, 2005)<sup>66</sup>. This was viewed as a stopgap measure; there was little or no explicit analysis of what policies might be best in the long run.

### 3.2 Challenges of Insuring Terrorism

Terrorism presents a set of very specific problems regarding its insurability by the private market alone, including the potential for catastrophic losses, the existence of interdependencies and the dynamic uncertainty associated with terrorism. All of these factors increase the amount of capital that insurers must hold to provide terrorism risk insurance coverage. The associated costs of holding that capital increases the premiums

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<sup>62</sup> Smetters, K. (2004), "Insuring Against Terrorism: The Policy Challenge," In Litan, R. and Herring, R. (eds), *Brookings-Wharton Papers on Financial Services*, pp. 139-182.

<sup>63</sup> As stated by the U.S. Government Accountability Office, "ISO found that from 1990 through 2003 industry equity capital increased from \$194.8 billion to \$347 billion on an inflation-adjusted basis. The insurance industry equity capitals (financial resources available to cover catastrophic risk and other types of claims that exceed premium and investment income) commonly are used to assess capacity to cover catastrophic risk. It is difficult [however] to determine whether the growth in insurer equity capital has resulted in material increase in the industry's relative capacity to pay claims. Insurers may also face significant financial exposure in areas prone to catastrophe, which could partially offset the increase in insurer capital over the years." U.S. GAO (2005), *Catastrophe Risk, U.S. and European Approaches to Insure Natural Catastrophe and Terrorism Risks*, Appendix III, GAO-05-199, Washington, D.C., February 28<sup>th</sup>.

<sup>64</sup> See Section 5.3 for more details on the nature of workers' compensation insurance and fire policies as they relate to terrorism losses.

<sup>65</sup> U.S. Congress, Joint Economic Committee (2002), *Economic Perspectives on Terrorism Insurance*. Washington, DC: May 2002.

<sup>66</sup> Michel-Kerjan, E. and Pedell, B. (2005), "Terrorism Risk Coverage in the Post- 9/11 Era: A Comparison of New Public-Private Partnerships in France, Germany and the U.S.," *The Geneva Papers on Risk and Insurance*, 30: 1, pp. 144-170. See also Organization for Economic Cooperation and Development (2005), *Terrorism Insurance in OECD Countries*. Paris: OECD, July 5.



they would need to charge. The fact that government actions are likely to influence both the will and capacity of terrorist groups to attack (foreign policy, counter-terrorism) and on the level of potential losses poses additional challenges.

### ***Potential for Catastrophic Losses from Terrorism***

Following the 9/11 events, insurers have been concerned with the possibility that catastrophic losses from future terrorist attacks may have a severe negative impact on surplus and may possibly lead to insolvency. Empirical evidence provided by experts on terrorism threats supports their concern. There are an increasing number of extremist terrorist groups grounded in religious fundamentalism and fueled by other agendas, many of whom advocate mass casualties and directly target U.S. interests.

Attacks using chemical, biological and radiological (CBR) weapons have the potential to inflict large insured losses, especially on workers' compensation and business interruption lines. The bombing of a chlorine tank in Washington, DC could kill and injure hundreds of thousands of people. Plausible scenarios elaborated by Risk Management Solutions, one of the three leading modeling firms examining catastrophe risks, indicate that large-scale anthrax attacks on New York City could cost between \$30 and \$90 billion in insured losses (Towers Perrin, 2004)<sup>67</sup>.

Nuclear attacks could even have a much more severe impact. Indeed, there is evidence that terrorist groups explored the possibility of obtaining a nuclear device to build "luggage nuclear bombs" and continue to see value in this form of terrorism. Al-Qaeda, for example, clearly expressed interest in acquiring and deploying these weapons of mass destruction (Central Intelligence Agency, 2003; 9/11 National Commission, 2004)<sup>68</sup>. While most extremist terrorist groups will be capable of relatively unsophisticated but still deadly attacks, others will likely seek to acquire or replicate al-Qaeda expertise in order to launch attacks inflicting mass-casualties. This raises special and fundamental problems for insurers covering lines such as workers' compensation.

The 9/11 events, as well as the anthrax attacks in the month thereafter, also demonstrated a new kind of vulnerability: the use of networks as "weapons of mass

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<sup>67</sup> Towers Perrin (2004), "Workers' Compensation Terrorism Reinsurance Pool Feasibility Study", March.

<sup>68</sup> Central Intelligence Agency (2003), "Terrorist CBRN: Materials and Effects (U)", CIA: Directorate of Intelligence, May, CTC 2003-40058; The National Commission on Terrorist Attacks upon the United States (2004), *The 9/11 Commission Report*. New York: Norton.

Answering the Time reporter's question "The U.S. says you are trying to acquire chemical and nuclear weapons" Osama Bin Laden said: "Acquiring weapons for the defense of Muslims is a religious duty. If I have indeed acquired these weapons, then I thank God for enabling me to do so. And if I seek to acquire these weapons, I am carrying out a duty. It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims. [...] Hostility toward America is a religious duty, and we hope to be rewarded for it by God. To call us Enemy No. 1 or 2 does not hurt us. I am confident that Muslims will be able to end the legend of the so-called superpower that is America." 23 December 1998 interview with Time Magazine. Cited in Frontline, 'Osama bin Laden v. the U.S.: Indictments and Statements.' Information available online at:

<http://www.pbs.org/wgbh/pages/frontline/shows/binladen/who/edicts.html>. Downloaded May 1, 2005.



disruption” (Michel-Kerjan, 2003)<sup>69</sup>. Terrorists can use the capacity of a country’s critical networks to have a large-scale impact on the nation. In any given network (e.g., transportation) — every aircraft, every piece of mail, every marine container — can become a potential weapon. The impact of a supply chain disruption on the retail industry could be financially catastrophic should the federal government order a major port to be shut down in the wake of potential or actual threats from contaminated containers.

### *Interdependencies*

The vulnerability of one organization, critical economic sector and/or country depends to some extent not only on its own choice of security investments, but also on the actions of other agents. This concept of *interdependent security* implies that failures of a weak link in a connected system could have devastating impacts on all parts of it, and that as a result there may be suboptimal investment in the individual components (Kunreuther and Heal, 2003; Heal and Kunreuther, 2005)<sup>70</sup>. The existence of such interdependencies provides another challenge in determining how much terrorism coverage to offer and what premium to charge.

Interdependencies do not require proximity. In the case of the 9/11 attacks, security failures at Boston's Logan airport led to crashes at the World Trade Center (WTC), the Pentagon and in rural Pennsylvania. There was nothing that firms located in the WTC could have done on their own to prevent these aircraft from crashing into the twin towers, and any protective efforts they might have undertaken would have been rendered useless by the absence of action at a distant site.

Except for very specific policies (e.g., contingent business income coverage), terrorism insurance normally does not cover losses unless the insured is the direct target of an attack (Godard et al., 2002)<sup>71</sup>. For example, following the terrorist attacks of 9/11 the Federal Aviation Administration (FAA) banned takeoffs of all civilian aircraft regardless of destination. In March 2004, the city of Chicago was denied insurance compensation for business interruption losses that resulted from the FAA’s decision. The specific clause of the insurance contract for business interruption specified that it would cover only losses that were the “direct result of a peril not excluded,” thus imposing a limitation that excludes interdependent effects due to the response to an attack (U.S. District Court, 2004)<sup>72</sup>.

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<sup>69</sup> Michel-Kerjan, E. (2003), “New Vulnerabilities in Critical Infrastructures: A U.S. Perspective”, *Journal of Contingencies and Crisis Management*, 11: 3, pp. 132-141.

<sup>70</sup> Kunreuther, H. and Heal, G. (2003), “Interdependent Security”, *Journal of Risk and Uncertainty*. 26: 2/3, pp. 231-249; Heal, G. and Kunreuther, H. (2005), “IDS Models for Airline Security”, *Journal of Conflict Resolution*, 49: 2, pp 201-217.

<sup>71</sup> Godard, O., Henry, C., Lagadec, P. and Michel-Kerjan, E. (2002), *Treatise on New Risks. Precaution, Crisis Management and Insurance* (in French). Paris: Editions Gallimard, Folio-Actuel, p.620.

<sup>72</sup> U.S. District Court for the Northern District of Illinois, Eastern Division (2004), *City of Chicago v. Factory Mutual Insurance Company*. 02C7023. March 11.

### ***Shifting Attention to Unprotected Targets***

Terrorists may respond to security measures by shifting their attention to more vulnerable targets. Keohane and Zeckhauser (2003)<sup>73</sup> analyze the relationships between the actions of potential victims and the behavior of terrorists. Establishing publicly observable protective measures against a given mode of attack on a specific building should reduce the probability of an attack against it because the marginal benefit of the attack (i.e., the likelihood of success) as perceived by the terrorist group decreases. However, shielding that building makes an attack on an unprotected structure more likely<sup>74</sup>. The overall likelihood of an attack anywhere is likely to fall since the lowest cost or highest net benefit targets would be protected. A key issue here is the question of how flexible terrorist organizations actually are and how constrained they are with respect to human resources and physical capital.

Rather than investing in additional security measures, firms may prefer to move their operations from large cities to less populated areas to reduce the likelihood of an attack. Of course, terrorists may choose these less protected regions as targets if there is heightened security in the urban areas. Terrorists also may change the nature of their attacks if protective measures in place make the likelihood of success of the original option much lower than another course of action (e.g. switching from hijacking to bombing a plane). This substitution effect has to be considered when evaluating the effectiveness of specific policies aimed at curbing terrorism (Sandler, Tschirhart and Cauley, 1983)<sup>75</sup>. Prior to 9/11 CIA director George Tenet suggested this behavior in his prophetic unclassified testimony of February 7, 2001, when he said: "As we have increased security around government and military facilities, terrorists are seeking out "softer" targets that provide opportunities for mass casualties" (CIA, 2001)<sup>76</sup>. Khalid Sheikh Mohammed, the al-Qaeda chief of military operations arrested in March 2003, has since explicitly admitted such a soft target strategy (Woo, 2004)<sup>77</sup>. It is also unclear what impact the threats of terrorism will have on rents in high risk areas. To the extent they decline and there are costs associated with moving operations to other areas, there may be relatively little change in firms' locations because of the terrorism threat.

### ***Dynamic Uncertainty and Time Scale***

Since terrorists are likely to design their strategy as a function of their own resources and their knowledge of the vulnerability of the entity they want to attack, the nature of the

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<sup>73</sup> Keohane, N. and Zeckhauser, R. (2003), "The Ecology of Terror Defense", *Journal of Risk and Uncertainty*, 26: 2/3, pp. 201-229.

<sup>74</sup> One exception would be if terrorist groups attack trophy buildings to prove that they can inflict damage to well-protected structures.

<sup>75</sup> Sandler, T., Tschirhart, J. and Cauley, J. (1983), "A Theoretical Analysis of Transnational Terrorism." *American Political Science Review*, 77: 1, pp.36-54.

<sup>76</sup> Central Intelligence Agency (CIA) (2001), Statement by Director of Central Intelligence George J. Tenet before the Senate Select Committee on Intelligence on the "Worldwide Threat 2001: National Security in a Changing World", CIA, February 7.

<sup>77</sup> Woo, G. (2004), "Parameterizing the Evolving Threat", in Risk Management Solutions, *Managing Terrorism Risk in 2004*.

risk is continuously evolving. The likelihood and consequences of a terrorist attack are determined by a mix of strategies and counterstrategies developed by a range of stakeholders and changing over time. This *dynamic uncertainty* makes the likelihood of future terrorist events extremely difficult to estimate (Michel-Kerjan, 2003)<sup>78</sup>.

More formally, the analyst is confronted with a dynamic game where the actions of the terrorist groups in period  $t$  are dependent on the actions taken by those threatened by the terrorists (i.e. the defenders) in period  $t-1$ . From the terrorists' point of view, they must determine what targets to attack and the commitment of resources to specific activities. Their decisions will be influenced by the types of protective measures undertaken by those at risk. As a point of contrast, actions can be taken to reduce damage from future natural disasters with the knowledge that the probability associated with the hazard will not be affected by the adoption of these protective measures. In other words, the likelihood of an earthquake of a given intensity in a specific location will not change if property owners design more quake-resistant structures.

A factor that is associated with dynamic uncertainty is the *timing of an attack*. Given the eight years that separated the first World Trade Center bombing in 1993 and the large-scale terrorist attacks during the morning of September 11, 2001, one may conclude that terrorist groups program their attacks far in advance and perpetrate them when the public's attention and concern with terrorism have receded.

### ***Information Sharing***

An important feature of terrorism is how knowledge of risk is managed and by whom. The sharing of information on terrorism risk is clearly different than the sharing of information regarding other potentially catastrophic events. Data on terrorist groups' activities and current threats are normally kept secret by federal agencies for national security reasons. For example, the public still has no idea who manufactured and disseminated anthrax in U.S. mailings during the fall of 2001. Without this information, it is difficult for modelers to make projections about the capability and opportunities of terrorists to undertake similar attacks or disruptive actions in the future. Natural hazards and other catastrophic risks have large historical databases and scientific studies that are in the public domain so that insurers, individuals, businesses at risk and public sector agencies all have access to these findings.

From an economic perspective, one justification for government intervention in insurance markets relates to the asymmetry of information between buyers and sellers and the problems this may cause, such as adverse selection (see section 2.1). In the case of terrorism, there is a very peculiar case of *symmetry of non-information* of the risk for both insureds and insurers, where government is the most informed party (Michel-Kerjan, 2003)<sup>79</sup>. Combined with dynamic uncertainty, this presents special challenges for insurers

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<sup>78</sup> Michel-Kerjan, E. (2003), "Large-scale Terrorism: Risk Sharing and Public Policy." *Revue d'Economie Politique*, 113: 5, pp. 625-648.

<sup>79</sup> For this reason, any adverse selection phenomenon would result essentially from an asymmetry of risk perception between insureds and insurers rather than an asymmetry of information about the risk the insured faces *per se* (as this is the case in the traditional perspective of adverse selection). Michel-Kerjan, E. (2003), "Large-scale Terrorism: Risk Sharing and Public Policy." *Revue d'Economie Politique*, 113: 5, pp. 625-648.

who need information in order to establish predictability regarding the likelihood and consequences of a particular risk for at least one year, but preferably over a period of years in order to price their product.

### ***Government Influencing the Risk***

Finally, there are also more fundamental aspects of the threat of terrorism. International terrorism has always been viewed as a matter of national security as well as foreign policy. It is obvious that the government can influence the level of risk of future attacks through appropriate counter-terrorism policies and international cooperation as well as through adequate crisis management to limit consequences should an attack occur. Some decisions made by a government as part of their foreign policy can also affect the will of terrorist groups to attack this country or its interest abroad (Lapan and Sandler, 1988; Lee, 1988; Pillar, 2001)<sup>80</sup>.

Governments can also devote part of their budget to the development of specific measures on national soil to protect the country. The creation of the new U.S. Department of Homeland Security in 2002 confirms the importance of this role in managing terrorism risk. In this sense, terrorism risk is partly under the government's control and will change depending on at least two complementary strategies by the defenders. The first entails protective measures that could be adopted by those at risk. The second consists of actions taken by governments to enhance general security and reduce the probability that attacks will occur. Hence the terrorism risk is a mixed private-public good (Kunreuther and Michel-Kerjan, 2004)<sup>81</sup>.

All these specific characteristics have important implications for anyone attempting to quantify terrorism risk. The next subsection discusses new developments in terrorism risk models and how they can be used to price the risk.

### **3.3 Role of Catastrophe Models**

Just as a new generation of catastrophe models were developed in the aftermath of Hurricane Andrew and the Northridge earthquake, terrorism risk models have emerged in response to 9/11. Terrorism models attempt to address three basic issues regarding the hazard itself: frequency of occurrence, the most likely locations of future terrorist attacks, and attacks' severity in terms of loss. As limited as the data are for natural catastrophes, there is far less information available on terrorist attacks for risk estimation purposes. To the extent that data do exist and are available from government sources, they may not be representative of current threats. Even more important, unlike earthquakes and other

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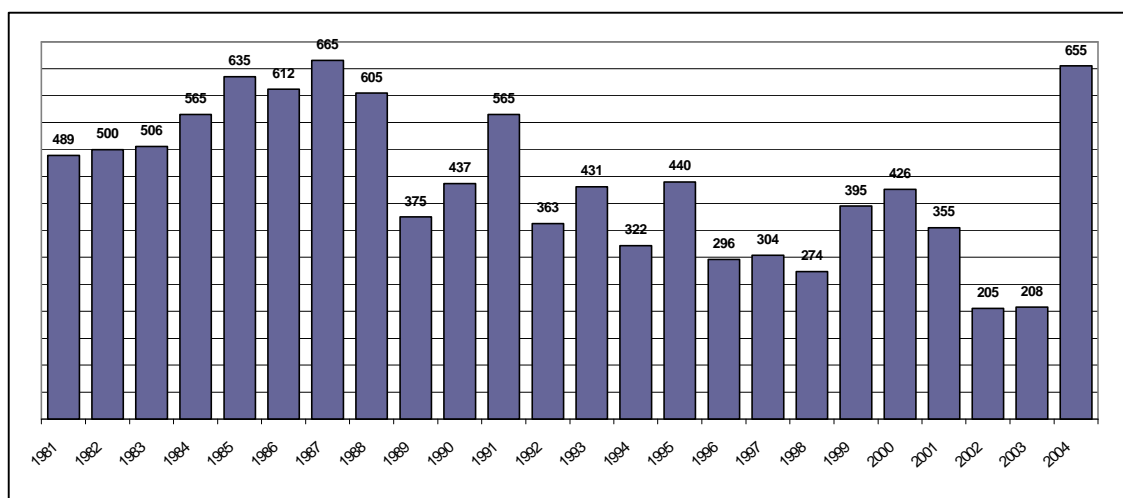
<sup>80</sup> Lapan, H. and Sandler, T. (1988), "To Bargain or Not to Bargain: That is The Question", *American Economic Review*, 78: 2, pp. 16-20; Lee, D. (1988), "Free Riding and Paid Riding in the Fight Against Terrorism" *American Economic Review*, 78: 2, pp. 22-26; Pillar, P. (2001), *Terrorism and U.S. Foreign Policy*. Brookings Institution Press. Washington, DC.

<sup>81</sup> Kunreuther, H. and Michel-Kerjan, E. (2004), "Policy Watch: Challenges for Terrorism Risk Insurance in the United States, *Journal of Economic Perspectives*, 18: 4, Fall, pp. 201-214.

natural disasters, whose occurrences have a physical basis that can be understood by scientists, terrorist attacks are a function of the malicious intent of groups of individuals of varying size and varying agendas, as discussed above. The groups themselves emerge and evolve and their ability to attract resources in terms of both financial and human capital waxes and wanes as the larger political and/or economic climate changes over time. In the absence of historical data to which probability distributions can be fit, the models are by necessity very subjective in nature.

### *Integrating Changes in Foreign Terrorism Risk<sup>82</sup>*

There is evidence that foreign terrorism risk has changed radically over the past two decades<sup>83</sup>. On the one hand, the total number of international terrorist attacks worldwide has been decreasing on average during the 1990s compared with the 1980s, as shown in Figure 3.3 (U.S. Department of State, 2004)<sup>84</sup>.



**Figure 3.3 Total International Terrorist Attacks, 1981-2004**  
Sources: Wharton Risk Center with Data from the U.S. Department of State<sup>85</sup>

On the other hand, there has been the emergence of another type of international threat: extremist religious-based terrorism. Most religiously-motivated terrorist groups advocate mass casualties as they view anyone with a different perspective as a legitimate

<sup>82</sup> Here we focus only on potential “certified” events under TRIA. The threat posed by domestic terrorism has also evolved over the past 20 years. We discuss the potential for large-scale domestic terrorist attacks in Section 10.3.

<sup>83</sup> See for instance Enders, W. and Sandler, T. (2000), “Is Transnational Terrorism Becoming More Threatening?” *Journal of Conflict Resolution*, 44: 3, pp. 307-332; Sandler, T. and Enders, W. (2004), “An Economic Perspective of Transnational Terrorism”, *European Journal of Political Economy*, 20: 2, pp. 301-316; Hoffman, B. (1998), *Inside Terrorism*, New York: Columbia University Press; Chalk, P., Hoffman, B., Reville, R. and Kasupski, A.B. (2005), *Trends in Terrorism*, Santa Monica, CA: RAND.

<sup>84</sup> U.S. Department of State (2004), *Global Patterns in Terrorism*, Office of the Coordinator for Counterterrorism, Appendix G, June 22.

<sup>85</sup> The statistics do not include attacks on American troops in Iraq.

target. That has led over the past years to a decreasing number of attacks but with a few attacks inflicting a considerably higher level of casualties than those perpetrated by leftist-based organizations (Pillar, 2001, Wedgwood, 2002, Stern, 2003)<sup>86</sup>. In fact, when we consider the 15 worst terrorist attacks in terms of the number of casualties (fatalities and injuries combined) (Table 3.3), all of them occurred after 1982 with two-thirds of them occurring between 1995 and 2005.

According to the newly established U.S. Department of State's National Counter-Terrorism Center, "international terrorism continued to pose a significant threat to the United States and its partners in 2004." Indeed, 2004 has been one of the worst year over the past 20 years: 655 acts of international terrorism occurred worldwide during 2004, resulting in 9,000 casualties. There is a dual explanation for this recent evolution. First, there have been a number of small-sized attacks. For example, there were a total of 284 attacks in Kashmir alone; 500 people were killed in all of South Asia. In other words, the attacks were often conducted against one or two people. Second, and by contrast, there were very few attacks in Europe, but there was a very high death toll. This reflects the attacks in places like Madrid, Spain, Beslan, Russia, and London, UK where hundreds of people were killed or injured in single incidents (see Table 3.3).

Moreover, the nature of the target has also evolved over time. Traditionally attacks were aimed at federal targets (government, military, diplomatic). However, a large portion of terrorist attacks worldwide in the last years were perpetrated against businesses. For example, in 2000, 178 out of 206 U.S. targets attacked were businesses (over 80 percent); in 2001, 204 out of 228 (90 percent). While the total number of attacks against U.S. interests dropped in 2003, still 40 percent (34/84) of them were focused against businesses (U.S. Department of State)<sup>87</sup>.

Any forecast of the evolution of international terrorism in the coming years is outside the scope of this report. However, what can be observed in light of recent evidence is that the U.S. has become a prime target, based on evidence from fundamentalist and extremist terrorist groups. While security has increased in government buildings here and abroad, terrorist groups have switched to businesses that represent U.S. values and economic interests or those of its allies. It is likely that private sector entities will remain a major target of these terrorist organizations.

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<sup>86</sup> Pillar, P. (2001), *Terrorism and U.S. Foreign Policy*. Brookings Institution Press. Washington, DC; Wedgwood, R. (2002), "Al Qaeda, Terrorism, and Military Commissions." *American Journal of International Law*. 96: 2, pp. 328-337; Stern, J. (2003), *Terror in the Name of God: Why Religious Militants Kill*. New York: Harper Collins.

<sup>87</sup> U.S. Department of State (2004), *Global Patterns in Terrorism*. Office of the Coordinator for Counterterrorism, Appendix G, June 22. We did not have access to 2004 data.



**Table 3.3 The 15 worst terrorist acts in terms of casualties (fatalities and injuries)<sup>88</sup>**

| <i>Date</i> | <i>Location</i>         | <i>Event</i>  | <i>Fatalities</i> | <i>Injured</i>     |
|-------------|-------------------------|---|-------------------|--------------------|
| 07 Aug 98   | Nairobi, Kenya          | Bomb attacks on U.S. embassy complex                            | 253               | 5,075              |
| 11 Sep 01   | NY, DC and PA, USA      | Terror attacks using aircraft                                   | 3,000             | 2,250              |
| 11 Mar 04   | Madrid, Spain           | Bomb attacks on trains  | 192               | 1,500              |
| 31 Jan 96   | Colombo, Sri Lanka      | Bomb attack on Ceylinco House                                   | 100               | 1,500              |
| 12 Mar 93   | Bombay, India           | Series of 13 bomb attacks                                       | 300               | 1,100              |
| 26 Feb 93   | New York, USA           | Bomb explodes in the World Trade Center                         | 6                 | 1,000              |
| 7 July 05   | London, UK              | Bomb attacks in trains and bus                                  | 57                | >700 <sup>89</sup> |
| 19 Apr 95   | Oklahoma City, USA      | Truck bomb attack on government building                        | 166               | 467                |
| 12 Oct 02   | Bali, Indonesia         | Bomb attack in a night club                                     | 190               | 300                |
| 23 Oct 83   | Beirut, Lebanon         | Bomb attack on U.S. Marine barracks and French paratrooper base | 300               | 100                |
| 03 Sept 04  | Beslan, Russia          | Hostages killed   | 360               | NA                 |
| 21 Dec 88   | Lockerbie, UK           | U.S. PanAm B-747 explodes mid-air                               | 270               | NA                 |
| 18 Jul 94   | Buenos Aires, Argentina | Bomb attack   | 95                | 147                |
| 23 Nov 96   | Comoros, Indian Ocean   | Hijacked Ethiopian Aircraft ditched at sea                      | 127               | NA                 |
| 13 Sep 99   | Moscow, Russia          | Bomb destroys apartment building                                | 118               | NA                 |

This evolution obviously raises the question as to whether one can predict future foreign terrorist attacks on U.S. soil. Recognizing that the experts' risk estimates are based on their own assumptions and may reflect their biases, the challenge is to evaluate these figures carefully in modeling terrorism risk. Terrorism models incorporate the judgment of teams of experts familiar both with limited available historical data and current trends. These experts have operational experience in counter-terrorism at the highest national and international levels, with many specializing in terrorism threat assessment. Because each expert is privy to his own sources of intelligence and has his own security clearances, there is no a single common database upon which all experts can form their judgments. Much of the crucial information is confidential.

### ***Determining Likelihood of Attacks***

To elicit expert opinions on the likelihood of attacks, several different approaches have been utilized. Some modeling firms employ the Delphi Method while others convene a conference of experts to capture and statistically combine various opinions into a useful and cohesive form that can be used to generate probabilities. For complex problems not governed by scientific laws, the judgment and intuition of experts in their field is not only an appropriate ingredient in any model, it is a critical one.

The Delphi Method is a well-known and accepted approach developed by the RAND Corporation at the start of the Cold War. Among its first applications was forecasting technological change in the defense industry. The Delphi Method comprises a series of repeated interrogations, usually administered by questionnaire where the

<sup>88</sup> Multi-Sources: U.S. Department of State (2004), *Global Patterns in Terrorism*. Office of the Coordinator for Counterterrorism, Appendix G, June 22; Swiss Re (2002), *Focus Report: Terrorism—dealing with the new spectre*. Zurich: Swiss Re, February; Miscellaneous sources from the press.

<sup>89</sup> These numbers are still evolving as this report goes to press.

responses are anonymous. Direct interaction between the participants is precluded to eliminate the natural bias to follow the leader. After an initial round of interrogation, individuals are encouraged to reconsider and, when appropriate, to change their views in light of the replies of others in the group that are shared with everyone (Adler and Ziglio, 1996)<sup>90</sup>. While the methodology is highly structured, the final estimates by each participant still only represent opinions, informed by other members of the group.

Using the Delphi Method, experts are asked to weigh in on several aspects of event frequency and intensity: the number of attacks per year, the type of target, the attack mode or weapon type, and finally the specific target of each potential attack. Each of these issues depends in part on the nature of the terrorist organization originating the attack. Critical to the results is the team's operational understanding of the likely terrorist actions in the context of the current state of security countermeasures. Targets and attack methods that were once undefended may now be more vigorously protected by federal homeland security, state and local policy, and private security resources.

An alternative to the Delphi Method is using a conference of experts where participants can exchange views. The agenda can be topics, such as the kind of weapons a specific terrorist group is more likely to use or what areas/countries are more susceptible to attack. When some experts are unable to attend the conference, their judgment can be elicited separately and fed back to others using the Delphi Method.

The lack of historical data makes the use of experts the only way for modelers to determine the likelihood of new attacks. However, experts have their own limitations in forecasting behavior, as each of them has specialized knowledge. Some are much more focused on a given terrorist group and less aware of the dangers from others. Others specialize in a given type of weapon or in a very specific kind of biological or chemical agent. In other words, each expert can be accurate within his or her window of expertise, but the whole group of experts can be wrong about the reality of the global threats — a kind of illusory expertise (Linstone and Turoff, 1975)<sup>91</sup>.

Another pitfall is an *availability bias* whereby a very recent event is taken as a signal that similar events are likely to happen again soon (Tversky and Kahneman 1973)<sup>92</sup>. For instance, if a terrorist attack recently occurred, a natural tendency would be to overestimate the likelihood of another attack in the short run rather than to systematically use past data and knowledge of terrorist strategy to provide an estimate of the likelihood of another attack. Conversely, if a governmental agency arrested leaders of a terrorist group, a natural bias would be to concentrate on that group and overlook other terrorists, resulting in misconceptions of the likelihood of other attacks.

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<sup>90</sup> Adler, M. and Ziglio, E. (eds). (1996), *Gazing Into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health*, London: Kingsley Publishers.

<sup>91</sup> Linstone, H and Turoff, M. (1975), *The Delphi Method. Techniques and Applications*, Addison-Wesley Publishing Company.

<sup>92</sup> Tversky, A. and Kahneman, D. (1973), "Availability: A heuristic for judging frequency and probability", *Cognitive Psychology*, 5, pp. 207-232.



### ***Estimating Damage from Terrorism Attacks***

Modelers have developed damage functions that incorporate historical data from actual events combined with the results of experimental and analytical studies of how different building types respond to various types of attacks. In the case of a terrorist attack using conventional and nuclear weapons, buildings sustain damage as a result of a variety of assaults on their structural integrity and their non-structural components. In the case of non-conventional weapons, the structure of the building is likely to be unaffected but the resulting contamination may render it unusable for long periods and result in extensive cleanup costs. In either case, the damage functions determine loss to building, contents and loss of use. The loss from a societal perspective is greater if there is no excess capacity elsewhere that can be brought into use.

In terrorism modeling, damage is a function of the attack type and building type. The type of attack, whether package, car or truck bomb, can be expressed as a TNT-equivalent. The size of this charge can be thought of as the intensity of the event. Damage to the target building results from the resulting shock wave, the subsequent pressure wave, and fire. The target building may sustain total damage from the point of view of insured loss even if it remains standing. If the building collapses, however, it will increase the number of fatalities. Furthermore, different modes of collapse, such as an overturn versus a pancake collapse, will affect the degree of damage to surrounding buildings and thus the total area affected by the event. The buildings surrounding the target building are also likely to be damaged by the resulting shock and pressure waves and/or by falling or flying debris.

The effects of nuclear weapons on both structures and populations have been subjects of extensive research for decades (Glasstone and Dolan, 1977)<sup>93</sup>. Chemical, biological and radiological (“dirty bomb”) attacks are more problematical. Accidental releases of chemical agents, such as the one that occurred at the Union Carbide chemical plant in Bhopal, India (1984) have been analyzed, as has the 1986 accident at the Chernobyl nuclear power plant. Other events include the 1995 sarin attack in the Tokyo subway and the more recent distribution of anthrax through the mail in autumn 2001 in the U.S. (U.S. Department of State, 2003)<sup>94</sup>. These examples provide data for empirical analysis and research. However, these events have been extremely rare so there are limited historical data.

### ***Estimating Workers’ Compensation Losses***

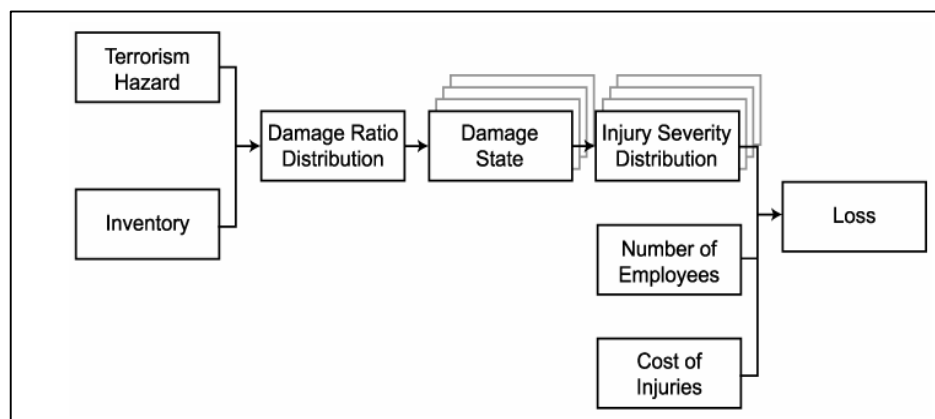
In addition to property damage, terrorism models estimate fatalities under both workers’ compensation and life insurance policies, as well as losses from injuries arising from workers’ compensation, personal accident and other casualty lines. The number of injuries and fatalities, as well as the severity of injuries, is a function of the nature of damage sustained by the structural and non-structural components of buildings and their

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<sup>93</sup> Glasstone, S. and Dolan, P. (eds) (1977), *The Effects of Nuclear Weapons*, Third Edition, Prepared and published by the United States Department of Defense and the United States Department of Energy.

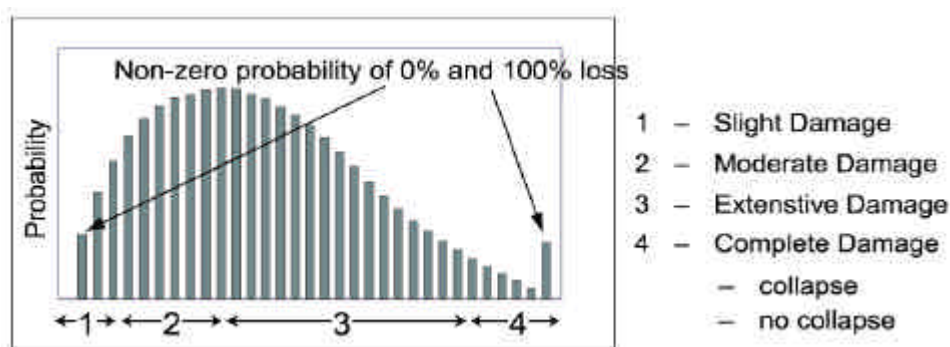
<sup>94</sup> U.S. Department of State (2003), *Patterns in Global Terrorism 2002*, April.

contents. Figure 3.4 illustrates the process for computing workers' compensation loss given that there are no policy limits with respect to the insurance coverage.



**Figure 3.4 Modeling Workers' Compensation Loss**

In estimating workers' compensation loss, models account for variability in damage to individual buildings as well as the time of occurrence so that one can estimate the extent of injuries and fatalities. For each level of severity, a mean damage ratio is calculated along with a probability distribution of damage. Because different structural types will experience different degrees of damage, the damage functions vary according to construction materials, occupancy and time of day. A distribution of damage for each structure type is mapped to different damage states. These may be, for example, slight, moderate, extensive and complete for a specific building, as shown in Figure 3.5.



**Figure 3.5 Building Damage Distribution Mapped to Different Damage States**

At the level of complete damage, the building may or may not have collapsed. Complete damage means that the building is not recoverable. Collapse will typically result in more severe injuries and larger numbers of fatalities than if the building is still standing. Estimates of workers' compensation (and other casualty lines) loss are based not only upon the number of people injured, but also on the severity of the injuries, such as minor, moderate, life threatening and fatality. Distributions of injury severity are then developed for each damage state for each building and occupancy type.

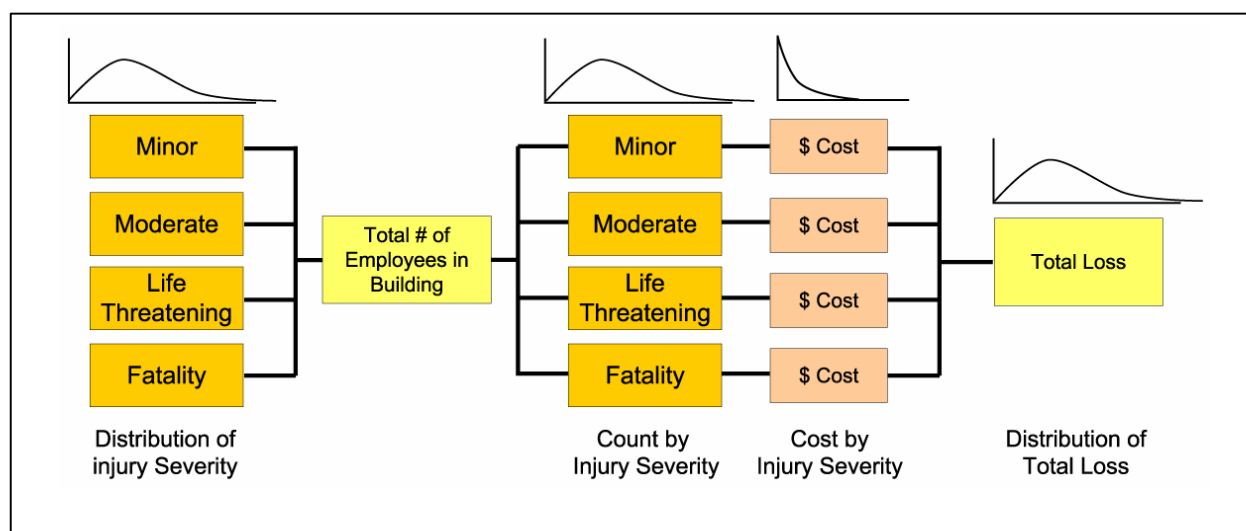
As part of this estimation process, modelers have to consider the variability in state workers' compensation schedules for death and disability. As an illustration, the estimates of the average fatality benefits in seven different states presented in Table 3.4 range from \$113,000 (in Wyoming) to \$759,000 (in the District of Columbia).

**Table 3.4 Variability in Workers' Compensation Payment by State (Average, 2003)**

| State                | Average Fatality Benefits |
|----------------------|---------------------------|
| District of Columbia | \$759,000                 |
| Connecticut          | \$688,000                 |
| Delaware             | \$580,000                 |
| New York             | \$462,000                 |
| Pennsylvania         | \$389,000                 |
| California           | \$346,000                 |
| Illinois             | \$295,000                 |
| Texas                | \$256,000                 |
| Florida              | \$189,000                 |
| Wyoming              | \$113,000                 |

Source: MacDonald (forthcoming)<sup>95</sup>

By combining information on the number of employees in each damaged building and the cost of fatalities and injuries, the model generates the total loss distribution for a particular structure. Losses are calculated based on the number of employees in each injury severity level and on the cost of the injury as shown in Figure 3.6. To calculate losses arising from life insurance and personal accident claims, potential losses are calculated for both residential and commercial buildings using assumptions about the distribution of the population between these two types of structures at the time of the attack.



**Figure 3.6 Calculation of Workers' Compensation Loss for an Individual Building**

<sup>95</sup> Cited in MacDonald, J. (forthcoming), "Terrorism, Homeland Security and Insurance: Are We Asking the Right Questions?", in Auerswald, P., Branscomb, L., La Porte, T. and Michel-Kerjan, E. (eds). *Protecting Critical Infrastructure: Private Efficiency, Public Vulnerability*, New York: Cambridge University Press.

### ***Constructing Exceedance Probability Curves***

Given the challenges in modeling terrorism risk, it is extremely difficult for insurers and other interested parties to construct exceedance probability curves as has been done with respect to natural hazards. Experts utilize a *scenario-based approach* to estimate direct consequences (e.g. physical damage, lives lost) as well as indirect impacts (e.g. business interruption loss) from a range of terrorism-related events. However, in using scenarios, it is recognized that it is not possible to generate a sufficiently rich set of outcomes to represent the full range of possible terrorism threats. Thus, unlike natural hazards, estimating recurrence times and probabilities of scenario-based events is not the approach taken by the majority of modeling companies and insurers.

The focus of attention by insurers has been on the outcomes of deterministic scenarios on potential losses, such as the consequences of an explosion of a 5-to-6-ton truck bomb in an urban area. Insurers and reinsurers pay careful attention to their aggregate exposure to risk in relation to their current policyholder surplus<sup>96</sup>. How the exposure is diversified geographically and across industries also plays a key role. For example, a \$1 billion exposure in a given city should not be viewed as equal to 10 risks of \$100 million in 10 different cities.

Even though there is a reluctance to utilize explicit probabilities in estimating terrorism risks, insurers are concerned about the possibility that their losses will exceed a prespecified level. In this sense they will evaluate the impact of different coverage strategies on their survival constraint (see Equation 2.1 in Section 2.1) and informally use this as one of their guides as to how much terrorism insurance capacity they should provide in different parts of the country<sup>97</sup>.

### ***The Role of Rating Agencies***

Credit ratings by a rating agency are determined by combining quantitative factors and the subjective judgment of experts. Insurers are concerned with their aggregate exposure relative to surplus for different risks because they are aware that this is a factor considered by rating agencies. Credit ratings guide the insurance market's pricing decisions. In principle, all other things being equal, insurers with higher ratings can charge higher premiums to reflect their credit quality. Moreover, insurers that fail to maintain a rating perceived as adequate may find it difficult to attract many commercial customers.<sup>98</sup>

*Reaction of Rating Agencies to 9/11* As noted in Section 3.1, 9/11 has been the most costly event in the history of insurance and reinsurance. It severely affected the financial strength of several insurers and reinsurers, leading rating agencies to act accordingly. Following 9/11, Standard and Poor's (S&P) put the ratings of 22 insurers and reinsurers on

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<sup>96</sup> See definition in Chapter 1.

<sup>97</sup> Although providing terrorism insurance is mandatory under TRIA, an insurer can decide not to cover more than  $n$  businesses in a specific area to limit its aggregate exposure there.

<sup>98</sup> For empirical evidence, see Epermanis, K. and Harrington, S. (in press), "Market Discipline in Property/Casualty Insurance: Evidence from Premium Growth Surrounding Changes in Financial Strength Ratings", *Journal of Money, Credit and Banking*.

“CreditWatch” and then lowered 14 of them (Standard & Poor’s, 2002)<sup>99</sup>. Moody’s echoed this concern in their actions, putting 21 companies “under review” and changing the ratings outlooks of six companies within two weeks of 9/11 (Moody’s, 2001)<sup>100</sup>.

Insurance industry attention has been focused on the effect of the aggregate exposure to terrorism risk on company ratings. In October 2001, S&P discussed the need to develop skills for underwriting these “new man-made risks”, indicating that “If the insurance industry is asked to accept an increasing proportion of terrorism risk, Standard & Poor’s will evaluate this for individual companies in much the same way it analyzes their assumption of other catastrophe risks. Insurers will need to demonstrate that their ultimate loss exposures are limited in a manner appropriate to their capital strength. Such underwriting discipline and loss protection exists at most insurers for naturally occurring catastrophes, but the industry will need to develop these skills to meet new man-made risks to protect its capital base. To the extent that an individual carrier has exposure to terrorism events without the ability to underwrite these risks appropriately, its financial strength rating is likely to suffer.” (Standard & Poor’s, 2001)<sup>101</sup>.

*Difficulties in Rating Terrorism Risk* As noted above, it is difficult to quantify the risks associated with terrorism, notably the probability of an attack on specific assets. The challenge of quantifying this risk exists for insurers and reinsurers, and in turn factors into rating agencies’ analyses of these companies’ risk profiles. From our discussions with rating agencies over the past 6 months, it appears that terrorism risk is only one of many factors rating agencies consider in their analyses of insurance companies, and it cannot be easily quantified.

There are a number of different approaches to analyzing terrorism risk. Standard & Poor’s noted that, “Although the risk probability of terrorism cannot be modeled, insurers can use urban aggregates and zonal distributions to lower geographic and concentration risk through diversification.” (Standard and Poor’s, 2002)<sup>102</sup> While terrorism risk may be difficult to manage, S&P noted in 2002 that their goal is to “...identify those insurers that are better managing the process through lower risk concentrations... Those insurers will likely retain their ratings. The insurance companies that are not effectively managing their exposures could be downgraded.” (Standard & Poor’s, 2002)<sup>103</sup>.

The methodology developed to analyze insurers/reinsurers’ exposure to natural disasters could provide some insight for terrorism. Guy Carpenter notes that, “Primarily as a reaction to the many hurricanes hitting the Southeast last year, A.M. Best has begun to

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<sup>99</sup> Standard & Poor’s (2002). “Terrorism Coverage Remains in Doubt”, released April 15.

<sup>100</sup> Moody’s (2001), “Moody’s Reviews Ratings of Certain Insurers and Reinsurers with Exposure to Recent Terrorist Attacks”, released September 24.

According to the several discussions we have had with rating agencies, these numbers, however, need to be considered with caution because even without 9/11 many insurers would have been downgraded because of huge underwriting losses and loss of policyholder surplus unrelated to 9/11. For many/most insurers there were multiple causes behind the downgrades.

<sup>101</sup> Standard & Poor’s (2001), “Mitigating Terrorism Risks Is Key to Maintaining Insurance Ratings”, released October 23.

<sup>102</sup> Standard & Poor’s (2002), “Terrorism Coverage Remains in Doubt”, released April 15.

<sup>103</sup> Standard & Poor’s (2002), “Terrorism Coverage Remains in Doubt”, released April 15.

intensify its scrutiny of the potential catastrophe loss effects to a company's financial stability. A.M. Best has historically used a net after-tax catastrophe PML [Probably Maximum Loss] of 10% of surplus as a threshold for companies to be rated Excellent (A- and A) and sometimes lower than 10% for those rated Superior (A+ and A++). This 10% rule of thumb was and is still allowed to slide upwards for companies with a high BCAR [Best's Capital Adequacy Ratio] score or the financial flexibility to replace capital on short notice. However, it appears that A.M. Best's analysts are starting to be less lenient than they might have been in the past in granting deviations from the rule. We know of one client that for many years carried a net cat PML well over 20% but was told to reduce it to 10% this year in order to retain its A- rating." (Guy Carpenter, 2005)<sup>104</sup>

One way for rating agencies to attempt to quantify the risk of terrorism is through catastrophe modeling. As pointed out, terrorism risk modeling can highlight areas of risk concentration (a deterministic approach), but is unable to provide accurate estimates of the likelihood of specific attacks. Hence it would be difficult for them to quantify the risk as they do for natural hazards.

In summary, our discussions with leading rating agencies indicate that they do not utilize a unique and pre-defined mathematical process to determine an insurer's degree of vulnerability to terrorism risk. This suggests that for terrorism more than other extreme events, the rating process will be guided by subjective factors rather than through a formal quantitatively-based process.

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<sup>104</sup> Guy Carpenter (2005), "FIT Briefing: An Update from the Financial Integration Team, 'U.S. Regulatory and Rating Agency Update'", March 30.

***Summary of Chapter 3***

Terrorism has features that make it much more challenging to estimate the risks of losses of different magnitudes than for other low probability-high consequence events. In contrast to natural disasters, where the likelihood of an event is determined by natural forces, terrorists are likely to determine what actions to take based on what their adversaries are doing to protect themselves. In other words, one has to analyze terrorism by considering features such as dynamic uncertainty, interdependencies and shifting attention to unprotected targets. In addition, the challenges associated with information sharing due to national security issues, and the nature of international terrorism make it extremely difficult to estimate the risk of a terrorist attack

Recently developed catastrophe models recognize these features and focus their attention on estimating potential damage from a series of different terrorist attack scenarios. Indeed, the modeling firms and those at risk have only limited confidence in their ability to estimate the likelihood of terrorist attacks occurring. Insurers recognize these limitations when determining how to evaluate and price insurance protection against these risks. In the same vein, rating agencies have difficulties in utilizing any formula to factor terrorism risk into their ratings. Perhaps more than for any other catastrophic risk, their rating process for insurers covering terrorism is likely to be subjective.





## CHAPTER 4

### A Framework of Demand and Supply for Terrorism Protection

In order to evaluate alternative terrorism insurance programs, one needs to understand more fully the demand for protection by commercial firms and the supply of coverage by insurers and reinsurers. This chapter examines at a theoretical level the interaction of supply and demand prior to a terrorist attack as well after an event occurs. We label the decision processes of firms and insurers before a terrorist event occurs as *ex ante* behavior and their decision processes following an attack as *ex post* behavior. Both these time dimensions are important in evaluating the performance of alternative programs for terrorism protection. The theoretical analysis of this chapter coupled with the discussion of impediments to a free market for terrorism insurance in Chapter 5 provide a framework for undertaking a detailed set of analyses related to the impact of TRIA on insurer behavior (Chapters 6 and 7) and those demanding coverage (Chapters 8 and 9).

#### 4.1 Ex Ante Behavior

##### *Supply by Insurers*

The supply curve for an insurer is determined by the amount of coverage it is willing to offer at different prices with quantity normally increasing as the price rises. Given its survival constraint (see Section 2.1), the insurer wants to limit its total amount of coverage so its perceived maximum claims from a terrorism attack will not exceed a predetermined value  $L_{max}$ . Hence the supply curve  $S$  for an individual insurer slopes upward as the price of insurance increases, becoming totally inelastic (i.e. vertical) at  $L_{max}$ . In other words, the insurer will not offer *additional* coverage at any price once its total terrorism coverage is at  $L_{max}$ , as shown in Figure 4.1.

If insurers are offered protection against catastrophic losses by additional private reinsurance, new financial instruments (e.g. terrorism catastrophe bonds) or federal reinsurance, then they are likely to supply more coverage at any given price shifting the supply curve downwards to  $S'$  with the supply curve becoming totally inelastic at  $L'_{max} > L_{max}$ . If there is a reduction in coverage for catastrophic risks by reinsurers withdrawing from the market, then the supply curve will shift upwards to  $S''$  which becomes inelastic at  $L''_{max} < L_{max}$ , as depicted in Figure 4.1.

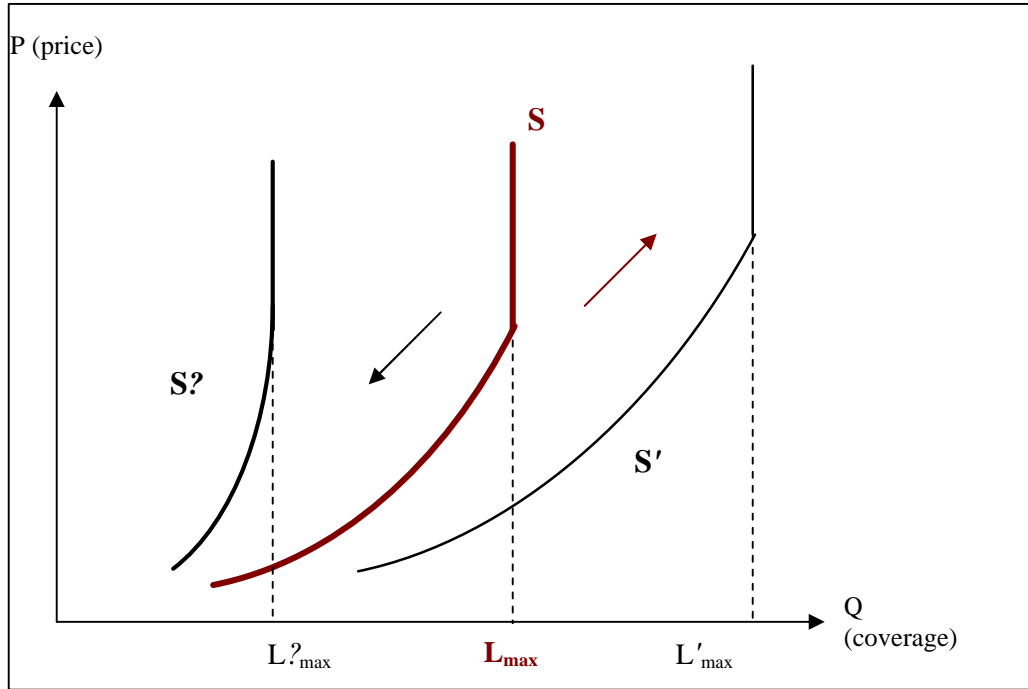


Figure 4.1 Supply of Terrorism Insurance by an Insurer

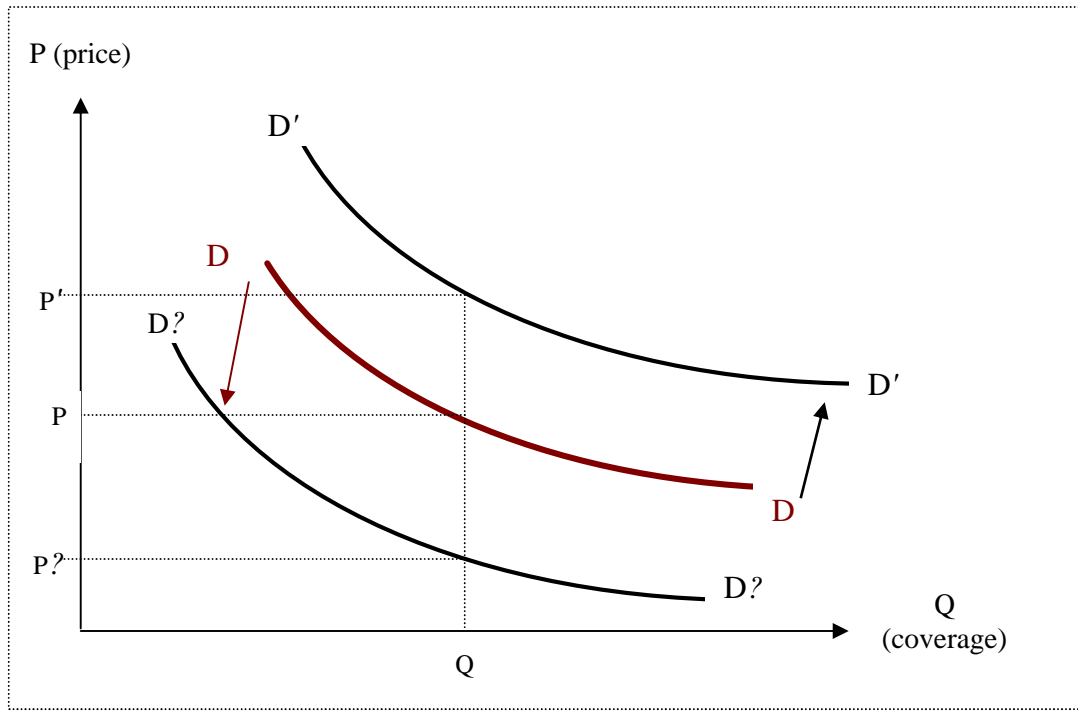
### *Demand by Commercial Firms*

We assume that firms demanding insurance are owners of a building that might be subject to damage by terrorists. The value of the firm's interest in the particular building is  $V^*$ , so the effect of an attack without any insurance would be a reduction of  $V^*$  in the firm's wealth. There may be other firms with interests in the building, such as equity investors or lenders who have made loans secured by the value of the building. The firm whose demand we are modeling may have other equity investments in addition to those in this building.

If the firm estimates the probability over a specific period of time of a terrorist attack that would destroy its building as  $p$ , the expected value of the firm's loss resulting from such an attack is  $pV^*$ . If the firm were risk-neutral, it would be willing to pay a premium  $P = pV^*$  for "full coverage" insurance that will pay  $V^*$  in claims should a terrorist attack destroy the building. Risk-averse firms will be willing to pay a premium  $P = pV^* + r$  where  $r$  denotes the risk premium reflecting the firm's degree of risk aversion. For larger firms or those who diversify their risks across different geographic locations, the value of  $r$  will be lower than for smaller non-diversified firms.

If we now assume that there are many property owners, the market demand curve for insurance will depend upon the distribution of reservation prices by commercial firms (i.e. the maximum premiums that firms are willing to pay for specified amounts of terrorism coverage). These prices depend on the distribution of risk aversion and of the mixes of wealth portfolios across commercial firms. The demand curve  $D$  in Figure 4.2

represents the relationship between the price of coverage ( $P$ ) and the quantity of insurance purchased ( $Q$ ). At a price  $P$  the commercial firm is willing to purchase  $Q$  units of insurance, as shown in Figure 4.2.



**Figure 4.2 Demand for Terrorism Insurance**

We have also drawn two other demand curves  $D'$  and  $D?$  to reflect shifts in the purchase of insurance should there be changes in specific requirements for terrorism protection or a shift in commercial firms' attitudes toward purchasing coverage. To illustrate this point, if a group of firms were required to buy insurance tomorrow and/or had an increased interest in buying coverage at any given price, then the demand curve would shift to  $D'$ , while if there were less interest in coverage or fewer requirements it would shift to  $D?$  as shown in Figure 4.2. Depending on the level of demand, a firm will have to pay different prices for a given amount of coverage  $Q$ .

### ***Equilibrium Price and Quantity of Insurance***

The equilibrium price of insurance and the total amount of coverage provided is determined by the intersection of the relevant supply and demand curves. The shape of each of these curves (i.e. the elasticity of supply and demand), the nature of the concern by firms at risk and the type of terrorism insurance program will jointly affect these values. The supply curve reflects the amounts of coverage that *all* insurers are willing to provide at different premiums, so it will be more elastic (i.e., less steep) than for each individual insurer and will only become vertical at a quantity reflecting the maximum amount of coverage that all insurers are willing to provide based on their survivability constraints as

shown in Figure 4.3 by the quantities  $L_{industry}$  and  $L'_{industry}$  for  $S$  and  $S'$  respectively. If  $D$  and  $S$  are the relevant demand and supply curves, then  $P^*$  is the equilibrium price and  $Q^*$  the equilibrium amount of insurance sold.

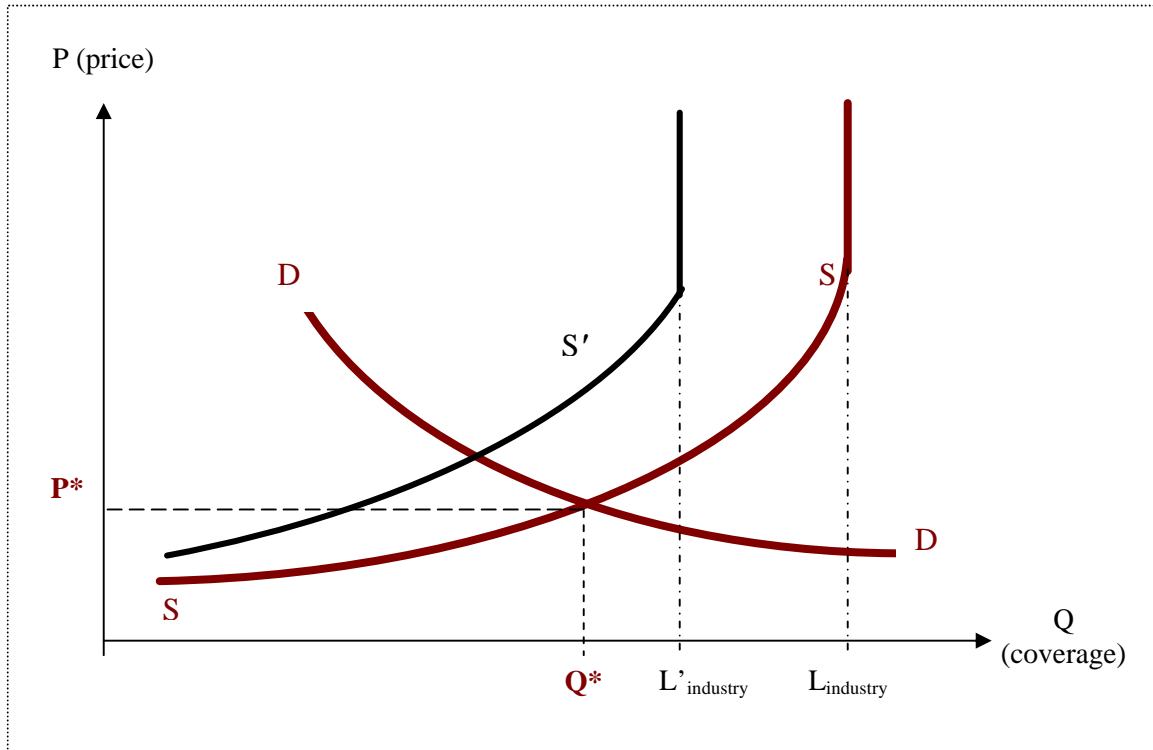


Figure 4.3 *Ex Ante* Supply and Demand for Terrorism Insurance

As depicted in Figure 4.4, an upward shift in demand to  $D'$  will raise both the equilibrium price of insurance to  $P^{**} > P^*$  and the total amount of coverage bought to  $Q^{**} > Q^*$  if the supply curve remains at  $S$ . If the supply curve shifts to the right to  $S'$  so that more coverage is supplied at any given premium, then the equilibrium price will be lower than  $P^{**}$  and quantity demanded will be higher than  $Q^{**}$ . One of the challenges in examining alternative terrorism insurance programs is to understand their impacts on the supply and demand for coverage *ex ante*.

This example assumes that property owners have no alternative source of risk spreading than the purchase of insurance. This need not be the case. In particular, if property owners borrow part of the capital to purchase buildings, banks and other lenders supplying those loans will take the extent of insurance protection into account in deciding what interest rate to charge. If there is full insurance protection, the interest rate will be lower than if property owners are not able to arrange complete coverage. Purchasing incomplete coverage will cause banks to charge higher interest rates to compensate for possible loan default in the event of a loss due to terrorism. That additional interest rate is a cost of spreading the risk of terrorism losses to suppliers of capital as well as to equity investors.

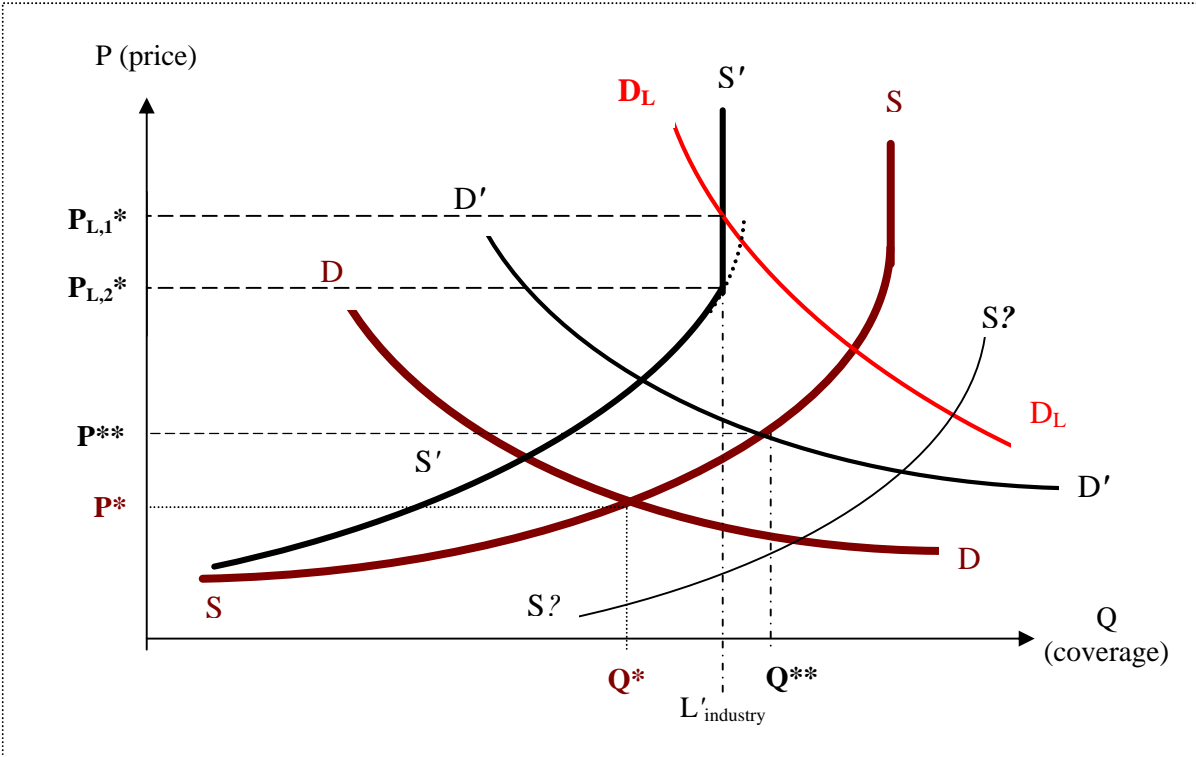


Figure 4.4 *Ex Ante* Supply and Demand for Terrorism Insurance

Because the maximum capacity provided in the market is limited by each insurer's survival constraint, it might be the case that the industry taken as a whole cannot provide more than  $L'_{industry}$  as shown by the supply curve  $S'$ . If there was a large demand for terrorism coverage, as depicted by the demand curve  $D_L$  in Figure 4.4, then the equilibrium price for coverage will be determined by the intersection of this demand curve with the vertical portion of the supply curve ( $S'$ ):  $(L'_{industry}; P_{L,1}^*)$ . If insurers were willing to offer more coverage as the price increased above  $P_{L,2}^*$ , as represented by the dotted portion of  $S'$ , then there would be additional purchasers of insurance at an equilibrium price somewhere between  $P_{L,2}^*$  and  $P_{L,1}^*$ .

## 4.2 Ex Post Behaviors of Firms and Insurers

In examining alternative terrorism insurance programs it is important to determine what is likely to happen after an attack occurs. Of course, the market reaction (both demand and supply) depends on the nature and size of the attack. To illustrate this point, under TRIA the federal government pays 90 percent of an insurer's losses above their applicable deductible and will possibly recoup part of that initial payment by levying *ex post* surcharge against all commercially insured policyholders (see section 1.2 for a more detailed discussion of these provisions). The supply curve  $S_{TRIA}$  in Figure 4.5 reflects this

government subsidy and lowers the price that insurers would have charged policyholders had they been forced to pay private reinsurers for this protection against a catastrophic loss. At some quantity  $L^{TRIA}_{industry}$  the supply curve will become totally inelastic (i.e., vertical). The equilibrium price and quantity supplied under TRIA is given by the intersection of  $D$  and  $S_{TRIA}$ , at  $P^{TRIA*}$  and  $Q^{TRIA*}$ .

If TRIA expires, insurers will not be forced to cover terrorism losses except where required by state mandates such as for workers' compensation and fire following a terrorist attack. Insurers are likely to restrict the amount of terrorism insurance they will provide at any given price (see Chapter 5). Insurers providing terrorism coverage will also lose the federal backstop and become more concerned with their survival constraint. The supply curve now shifts from  $S_{TRIA}$  to  $S_{withoutTRIA}$  and a new equilibrium emerges. There will now be less coverage purchased at higher prices than under TRIA as shown in Figure 4.5.

If a large-scale attack occurs without TRIA in place, insurers may decide that they will further limit the amount of terrorism coverage at any given price, so the supply curve shifts to the left from  $S$  to  $S_{post}$  and there is less coverage available on the market than before the attack. The maximum amount of coverage insurers are willing to offer,  $L^{post}_{industry}$ , will be less than before the terrorist attack due to a decrease in their surplus (capital). How large this shift in supply will be is an open question. If 9/11 is any guide, the shift could be very significant<sup>105</sup>.

At the same time, the demand for coverage is likely to increase in reaction to the next terrorist attack, shifting the demand curve upwards from  $D$  to  $D^{post}$ . As the capacity provided by insurers is limited, the new equilibrium price will then be  $P^{*}_{post}$  with  $Q^{*}_{post}$  coverage sold as shown in Figure 4.5 by the intersection of the *ex post* supply and demand curves.

Although the conceptual framework introduced in this chapter oversimplifies the complexity of these issues, the underlying insights it presents appear to capture important elements of the dynamics of the market for terrorism risk coverage.

<sup>105</sup> If a large terrorist attack occurs with a TRIA-like program in place, the supply curve will not shift significantly as the insurers will be protected by the federal backstop and still have to provide terrorism coverage to commercial firms. The demand curve would shift upwards and there would be a new equilibrium at  $Q^{TRIA*}_{post}$ .

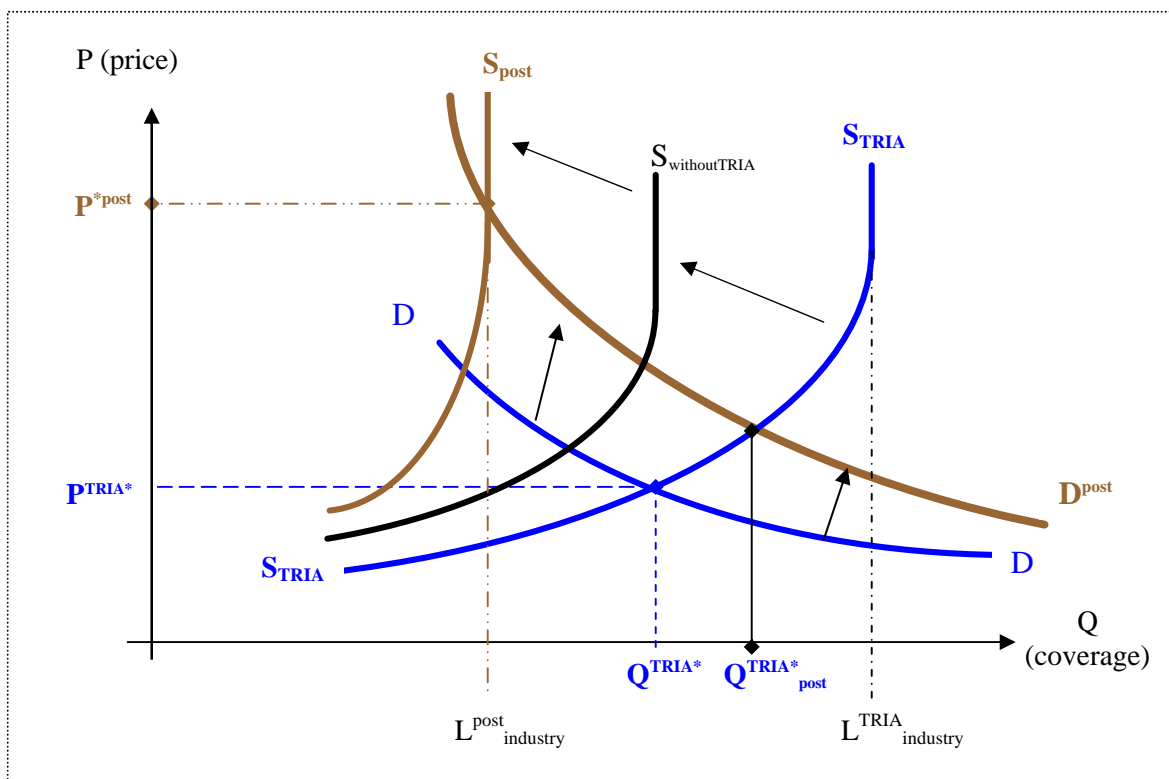


Figure 4.5 Market Reaction to a Terrorist Attack, with or without TRIA





**PART B**

**THE SUPPLY OF TERRORISM RISK  
INSURANCE**



## CHAPTER 5

### Impediments to Free Markets in Terrorism Risk Management

Economic analysis as to whether government intervention in private markets is economically efficient naturally focuses on whether there exists significant market failure compared to a reasonably competitive market, and, if so, whether government intervention to address that failure is likely to produce benefits that outweigh the costs.<sup>106</sup>

Answering these questions is often complex even when it is assumed that governments will seek to intervene efficiently. It is all the more complex in the real world where government intervention represents the outcome of a political process that reflects interest group pressure in addition to concerns with allocating resources in an efficient manner. Perceived market failures may reflect private sector responses to existing government regulation and constraints that undermine rather than enhance economic efficiency. “Free market” solutions may prove illusory. Given existing government constraints that are immune or highly resistant to change, additional public sector intervention may sometimes be the best achievable alternative.

This chapter provides an overview of government constraints on private markets for terrorism risk management. These constraints materially affect the interests of key players and are likely to influence the policy debate. The chapter begins with disaster assistance, which undermines incentives for private sector risk management before losses occur. It then considers federal tax policy, which reduces the private sector’s ability to spread the risk of catastrophic losses from terrorism (and other extreme events). The bulk of the chapter then turns to two major forms of state regulation that significantly affect terrorism insurance markets: (1) mandatory coverage requirements, including compulsory coverage of workers’ compensation claims caused by terrorism, prohibitions of terrorism exclusions, and required coverage of fire losses following terrorism; and (2) prior approval regulation or other government control of rates for property/casualty insurance covering losses caused by terrorism.

#### 5.1 Federal Disaster Assistance

While the magnitude of the problem is difficult to quantify, federal disaster assistance creates a type of Samaritan’s dilemma: providing assistance *ex post* (after hardship) reduces parties’ incentives to manage risk *ex ante* (before hardship occurs).<sup>107</sup>

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<sup>106</sup> See, for example, Breyer, S. (1981), *Regulation and Its Reform*, Cambridge, MA: Harvard University Press.

<sup>107</sup> Kunreuther, H. et al. (1978), *Disaster Insurance Protection: Public Policy Lessons*, New York: Wiley; Kaplow, L. (1991), “Incentives and Government Relief for Risk,” *Journal of Risk and Uncertainty*, 4, pp. 167-175; Harrington, S. (2000), “Rethinking Disaster Policy,” *Regulation*: Spring, pp. 40-46; Browne, M. J. and Hoyt, R.E. (2000), “The Demand for Flood Insurance: Empirical Evidence”, *Journal of Risk and*

To the extent that parties expect to receive government assistance after a loss – a form of free or low cost insurance – they might have less incentive to engage in mitigation or buy insurance before a disaster occurs. Because less insurance is purchased, the government's incentive to provide assistance after a disaster is reinforced or amplified. This problem has been widely discussed in the context of federal assistance following natural catastrophes, such as hurricanes and floods<sup>108</sup>. In the case of terrorism risk, the dulling effects of federal assistance on mitigation may be lower, given the reduced economic incentives for the parties to invest in mitigation due to the negative externalities caused by interdependencies<sup>109</sup>. However, the problem remains.

On the one hand, a government backstop, such as TRIA, dulls incentives for mitigation, such as locating new facilities in regions perceived to have lower risk. On the other hand, because such a program encourages the purchase of insurance, it may reduce the amount of disaster assistance following a major loss, yielding a benefit that would offset part of the cost of taxpayer subsidized insurance. Thus, without TRIA and its requirement that the government pay for losses from terrorist attacks above the insurance industry's aggregate retention from a single event or series of events, it is possible that the government (taxpayers) would pay a significant fraction of that amount for *uninsured* losses from the same event or events.

In principle, a solution to the Samaritan's dilemma is to force parties to purchase private or government insurance before any loss occurs, at rates that provide reasonable incentives for mitigation. In practice, this solution faces formidable obstacles, including (1) resistance to compulsion; (2) political pressure against rates that accurately reflect the risk of loss and might be "unaffordable" to high risk entities, which produces cross-subsidies and reduces incentives for mitigation; and (3) the apparent inability of governments to credibly commit to withholding disaster assistance to parties after a catastrophic loss, whether or not the parties bought insurance *ex ante*. These impediments have been widely discussed for federal flood and crop insurance<sup>110</sup> and may be even more challenging for foreign terrorism risk that constitutes a national security threat.

In addition, some observers argue that the incentive effects of market-determined rates for terrorism coverage to invest in mitigation would likely either be small or raise significant social issues. Problems that reduce incentive effects include the lack of any agreed-upon minimum standards for self-protection among insurers and policyholders<sup>111</sup>,

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*Uncertainty*, 20:3, pp. 291-306.; Ganderton, P.T., Brookshire, D.S., McKee, M., Stewart, S. and Thurston, H. (2000), "Buying Insurance Disaster-Type Risks: Empirical Evidence", *Journal of Risk and Uncertainty*, 20:3, pp. 271-289; Moss, D. (2002), *When All Else Fails: Government as the Ultimate Risk Manager*; Cambridge, MA: Harvard University Press.

<sup>108</sup> In a study published in 2001, Kenneth Froot indicated that "Since the late 70's the Federal government has spent annually an average of \$8 billion (current) on disaster assistance. This is far greater than the average annual loss borne by reinsurers on U.S. catastrophe coverage". See Froot, K. (2001), "The market for catastrophe risk: a clinical examination", *Journal of Financial Economics* 60, pp. 529-571.

<sup>109</sup> For a more detailed discussion of this problem see Kunreuther, H. and Heal, G. (2003), "Interdependent Security." *Journal of Risk and Uncertainty*. 26: 2/3, pp. 231-249.

<sup>110</sup> See Skees, J. (2001), "The Bad Harvest," *Regulation* 24, pp. 16-22.

<sup>111</sup> The Wharton questionnaire distributed to several of the largest insurers is illustrative here. For example, 100% responded negatively to the question "Would the requirement for terrorism mitigation measures change the coverage limit you would offer to your clients should TRIA not be renewed?" One said that "the

the almost unlimited nature of the possible terrorism threats, the possibility of suffering cascading loss from others even if one invests in protection (i.e. negative externalities due to interdependencies), and the lack of access to classified information that would better inform insurance buying and/or self protection decisions. In most cases, the single most effective mitigation technique may be the geographic dispersal of exposures; i.e., reducing the amount of exposed property and lives in any one area.

## 5.2 Corporate Income Taxes

U.S. federal tax policy increases the costs of private sector arrangements for spreading catastrophe risk, thus reducing the supply of insurance and alternative risk spreading vehicles. Insurers cannot establish tax deductible reserves for events that have not occurred. Premiums are taxed up front, leading to high taxes in years where losses from extreme events are relatively low, with limited writeoffs from net loss carryback and carryforward provisions when losses are high. More important, providing insurance against rare but potentially enormous losses actually requires insurers to hold large amounts of equity (non-debt) capital, which is primarily invested in marketable securities. Investors can readily purchase the same types of securities directly or through investment funds, in which case the returns on the securities are subject to personal taxes only (given “pass through” treatment of investment fund returns). When held by an insurer to back the sale of its policies, the returns are taxed twice, at the corporate level and personal level, because insurers cannot hold such capital in tax deferred accounts.

In order for the securities to be used to back policies, the premiums must therefore be high enough to compensate investors for the extra layer of taxes<sup>112</sup>. The total cost can be very large for the amounts of capital that must be invested to back the sale of insurance for rare but potentially extreme events, such as large losses from terrorist attacks. To illustrate, consider the simple case where  $p$  is the probability of an event,  $L$  is the loss if the event occurs,  $S$  is the additional amount of capital (surplus) that insurers (or reinsurers) would desire to hold to insure the event (without increasing their default risk), and  $c$  is the incremental tax cost of holding securities as capital as a proportion of  $S$ . Ignoring all other costs of providing insurance, the premium  $P$  needed for investors to achieve an expected return equal to that achievable with direct investment (or investment through an investment fund with pass through treatment) is simply:

$$P = pL + cS.$$

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type of terrorism event that would have a true financial impact on the company would not be mitigated by these control measures”; another said “the management and upkeep of these so-called mitigation measures would be impossible to maintain”. See Appendix 6.1.

<sup>112</sup> The extra tax hits any corporation, not just insurers, that invests in marketable securities (unless offset by corporate borrowing). Note that the same principle applies to any other incremental cost of holding large amounts of securities as capital in any company. In particular, if there are “agency” costs of holding such capital, defined as any reduction in (risk-adjusted) returns arising from managers pursuing their own interests rather than those of capital providers, then premiums would need to rise to produce the same expected returns after agency costs as investors could achieve through direct investment or investment funds.

The essence of insurance against extreme events is that the  $S$  is large in relation to  $L$ , given limited diversification, and that  $p$  is relatively small. Letting  $s$  denote  $S/L$ , the ratio of the additional surplus to amount of potential loss, then

$$P = pL + csL.$$

The premium loading factor is the ratio of the premium to the expected loss:

$$P/pL = 1 + cs/p.$$

**Table 5.1 Hypothetical Premium Loading Factors for Tax Costs  
Equal to 2 Percent of Surplus**

| Surplus as<br>Proportion of Loss<br>( $s$ ) | Probability of Event ( $p$ ) |       |      |       |
|---|------------------------------|-------|------|-------|
|   | 0.001                        | 0.005 | 0.01 | 0.025 |
| 0.01  | 1.2                          | 1.04  | 1.02 | 1.008 |
| 0.25  | 6                            | 2     | 1.5  | 1.2   |
| 0.5   | 11                           | 3     | 2    | 1.4   |
| 0.75  | 16                           | 4     | 2.5  | 1.6   |
| 1   | 21                           | 5     | 3    | 1.8   |

Table 5.1 shows loading factors, which exceed 1 due to taxes on returns from investing capital to back the sale of policies, for illustrative values of  $s$  and  $p$  with  $c = 0.02$  (corporate taxes on investment returns of 200 basis points).<sup>113</sup> More realistic models and calibration support the conclusion that the effects of U.S. corporate taxation of returns on invested capital can be large (e.g., tax costs equal to 100 percent of expected indemnities or higher) for coverage against extreme losses<sup>114</sup>.

A variety of mechanisms can reduce the costs, including investment in tax-exempt securities (with lower pre-tax yields than comparable taxable securities), some degree of debt financing by insurers or insurance holding companies (where the interest is deductible under the corporate income tax, which in effect allows a pass through to investors on the securities backing the debt), and the purchase by domestic insurers and reinsurers of reinsurance from off-shore entities that are governed by tax rules that impose lower costs<sup>115</sup>. These devices entail their own costs.

Another, albeit quantitatively less important, tax-related impediment to providing insurance against extreme events for U.S. insurers and reinsurers is higher expected costs imposed by having to pay taxes on underwriting income in the (typical) years where severe

<sup>113</sup> Two hundred basis points approximates the tax on bonds with a taxable coupon rate of 6 percent at the corporate tax rate of 35 percent.

<sup>114</sup> Harrington, S. and Niehaus, G. (2003), "Capital, Corporate Income Taxes, and Catastrophe Insurance," *Journal of Financial Intermediation*, 12: (October), pp. 365-389 shows that the effects of the taxation of investment income on capital dwarf those of limitations on loss carryback and carryforward provisions. Also see Harrington, S. and Biehaus, G. (2001) "Government Insurance, Tax Policy, and the Availability and Affordability of Catastrophe Insurance," *Journal of Insurance Regulation* 19 (Summer): 591-612.

<sup>115</sup> The relevant tax regimes in other major jurisdictions are summarized in the February 2005 GAO report *Catastrophe Risk, U.S. and European Approaches to Insure Natural Catastrophe and Terrorism Risks*, Report to the Chairman, Committee on Financial Services, House of Representatives.

events do not occur. This presents a problem because insurers and reinsurers have limited ability to deduct all losses immediately in the years when their losses are high and taxable income is negative.

More broadly, corporate tax policy also increases the costs of alternative risk spreading arrangements, at least indirectly. It generally is recognized that mechanisms such as catastrophe bonds cannot be cost effective unless the investment income on securities held to back the bonds is not taxed at the entity level. Achieving that tax status typically requires the costly creation of special purpose vehicles in tax-favored jurisdictions.

### **5.3 State Requirements and Rate Regulation**

Existing state requirements and regulation significantly affect the demand and supply of terrorism insurance in a variety of ways that reduce the private sector's ability to manage terrorism risk. These restrictions' effects on private markets for terrorism insurance could become much more pronounced if TRIA expires.

#### ***Workers' Compensation***

Workers' compensation coverage is mandatory for a large majority of employers in all states other than Texas where it is optional. Employers must either purchase insurance or qualify to self-insure. State workers' compensation laws represent an historical compromise. Benefits must be paid to employees for injuries arising "out of and during the course of" employment, regardless of whether the employer and/or employee was negligent. Workers' compensation benefits are the exclusive remedy open to employees: they cannot sue under tort law for injuries falling within workers' compensation law. The laws provide additional incentives for workplace safety in some cases where workers' desires for safety and the threat of tort liability in the absence of workers' compensation would be inadequate to encourage optimal safety. Finally, by requiring employers to either insure or meet eligibility rules to self-insure, the laws reduce the number of work-related injuries for which employees might have little or no medical or disability income coverage.

Workers' compensation laws do not permit employers or insurers to exclude coverage for worker injuries caused by terrorism, including those caused by acts involving nuclear, biological and chemical agents. Unless that is changed, insurers must cover such losses, and employers must either buy protection or bear the risk as a qualified self-insurer (which generally would require reinsurance of large losses), with or without TRIA<sup>116</sup>. The implications of mandatory coverage can be highlighted by considering three cases in which: (1) terrorism risk is generally insurable with adequate capacity at market-

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<sup>116</sup> As discussed in Section 9.3 of this report, another employer option under TRIA is to self-insure part of the loss through a domestic captive and receive coverage under the TRIA backstop. However, most state captive laws do not permit captives to offer direct workers' compensation coverage.

determined rates, (2) terrorism risk is uninsurable or capacity constrained and (3) binding regulatory constraints on terrorism insurance rates affect supply.

*Insurable Risk with Adequate Capacity and Market-Determined Rates* Consider first the hypothetical case where state regulation of rates in the voluntary workers' compensation market is never binding, so that insurers are free to offer coverage at rates perceived as adequate. If the risk of loss from terrorism for a particular employer or group of employers remains insurable by insurers with adequate capacity, increases in the risk of loss will cause rates and capacity to rise as needed, at least following a period of adjustment. Employers will either pay the higher rates, or seek to qualify as self-insurers and face additional incentives for mitigation<sup>117</sup>. Employers will be worse off due to the increase in risk, at least in the short run. In the longer-run, the attendant increase in the cost of labor will reduce employment and/or wages. To the extent that businesses self-insure, insurers lose value due to a loss of quasi-rents on prior investment in client relationships, infrastructure, expertise and reputation.

Under these conditions, the primary effect of TRIA is straightforward: by lowering the price of workers' compensation insurance in relation to the risk of loss from terrorism, TRIA's implicit subsidy reduces the burden of the increase in terrorism risk to employers, labor and insurers for commercial enterprises that conduct business in "risky" locations or sectors. Workers' compensation insurance is purchased by more employers at lower premiums than would otherwise be the case. If commercial insurance, on average, is more likely to respond to large losses than self-insurance (i.e., if insurers are less likely to default than employers if losses are large), there is some increase in security from the subsidy as well.

*Uninsurable Risk or Capacity Constraints* If insurers perceive the risk of loss from terrorism as being completely uninsurable, or beyond the "available" capacity for some accounts, they can decline to offer coverage voluntarily to any given employer. They may minimize their total loss by continuing to write some coverage at higher rates, at least temporarily, because declines in insurers' renewal business will cause the loss of any quasi-rents on prior investments in developing their books of business.

Employers who cannot obtain coverage may be able, if eligible or capable of becoming eligible, to self-insure. However, even where the employer otherwise qualifies as a self-insurer, it is usually required to purchase an excess workers' compensation policy to cover losses in excess of the self insured retention, which, like primary policies, will not include policy limits. Such coverage may also not be available. As a result, many or most employers will purchase coverage in the state residual market (see below) for workers' compensation insurance, at higher rates and with less flexibility than could previously be achieved in the voluntary market. The residual market could be a state fund (used in about

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<sup>117</sup> It is also possible that the workers' compensation insurance residual market (or state fund) could become the least cost option for some employers, which would tend to produce the types of cross-subsidies discussed further below.



a quarter of the states). The increased costs will harm employers in the short-run and reduce wages and/or employment in the longer-run.

When more employers obtain coverage in the residual market, the residual market mechanism will face the risk of large deficits in the event of a major terrorist attack. Depending on the specific funding mechanism, voluntary workers' compensation insurers and/or state taxpayers would ultimately have to bear the risk<sup>118</sup>. In the majority of states where voluntary workers' compensation insurers are assessed for residual market deficits or assigned residual market policyholders in proportion to their voluntary workers' compensation premiums, insurers will increase rates even further for employers that they insure voluntarily, thus producing cross-subsidies from the voluntary to the residual market associated with the risk of loss from terrorism. The higher voluntary rates to cover the expected cost of residual market deficits will in turn encourage additional employers to self-insure, which in turn further reduce the assessment base for residual market deficits.

The results of this scenario include:

- 1) A possibly large reduction in workers' compensation insurer values.
- 2) Higher costs to employers, primarily in higher risk locations or sectors, with the incidence falling primarily on employees.
- 3) Large workers' compensation insurance residual markets, with the risks of deficits from losses caused by terrorism borne largely by employers, labor and taxpayers.
- 4) Some degree of cross-subsidies through residual market mechanisms from employers with lower risk of loss from terrorism to those with higher risk of loss.

Again, TRIA reduces such effects. However, for the case where the risk is uninsurable for some employers under TRIA (i.e., employers are unwilling or unable to pay amounts that would be necessary to induce supply by insurers), insurers, employers and employees could all be better off if they were permitted to negotiate exclusions of losses from terrorist attacks in workers' compensation insurance. They cannot do that today because TRIA does not preempt state coverage requirements. Such exclusions would increase the risk that taxpayers or other parties would face, but it would reduce the extent to which the risk is channeled through workers' compensation residual markets, state funds and premiums charged to low risk employers.

*Binding Regulatory Constraints on Rates* State regulation of workers' compensation rates remains prevalent. TRIA provided that insurers' initial rate filings were not subject to prior regulatory approval (i.e., approval by state regulators before the rates could be used) and therefore could be implemented immediately, but that they were subject to subsequent review based on applicable state requirements. Thus, TRIA changed the timing of regulatory review, but not the applicability of such review.

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<sup>118</sup> Taxpayers will bear much of the risk in the five states with monopolistic state workers' compensation insurers.

The specific language from Section 106(a)(2)(B) is:

*(B) during the period beginning on the date of enactment of this Act and ending on December 31<sup>st</sup>, 2003, rates and forms for terrorism risk insurance covered by this title and filed with any State shall not be subject to prior approval or a waiting period under any law of a State that would otherwise be applicable, except that nothing in this title affects the ability of any State to invalidate a rate as excessive, inadequate, or unfairly discriminatory, and, with respect to forms, where a State has prior approval authority, it shall apply to allow subsequent review of such forms...*

In late 2002 and early 2003, the National Council on Compensation Insurance (NCCI) filed advisory loss cost estimates for certified terrorism coverage under workers' compensation insurance in the 36 jurisdictions where it serves as the licensed rating agency, and where insurers can usually adopt the NCCI loss costs and file their own expense and profit margins, or file their own loss costs and margins<sup>119</sup>. Non-NCCI rate filing organizations made filings in the remaining states. All states subsequently adopted filings for terrorism loadings in workers' compensation premiums. Florida initially rejected the NCCI filing as excessive, but later approved the filing after additional support was submitted by the NCCI. The District of Columbia held that the NCCI's initial filing was excessive and approved a lower loading for terrorism risk. The approved loading was lower than that approved in some states with lower perceived risk of loss from terrorism. The Tennessee Department of Commerce rejected an insurer's independent filing that would have produced higher rates than the NCCI filing<sup>120</sup>.

Even if NCCI or independent filings are accepted or approved by regulators, workers' compensation rate classification systems do not permit tailoring of terrorism premium loadings for the location of the employer within a given state or the job classes of employees (i.e., they do not allow different terrorism loadings for different territories and for different job classifications). As a result, employers in higher risk regions in a state or with higher risk job classifications, such as employments that may be particularly subject to concentration risk, are governed by the same filed rates as lower risk regions or occupations, thus limiting the ability of insurers to price coverage explicitly in relation to those characteristics. A likely effect, absent sufficient flexibility available from some other aspect of the rating system, is that some higher risk employers may find it difficult to obtain coverage at filed rates, increasing residual market size and producing some degree of cross-subsidy among employers.

Depending on the state, there are a number of mechanisms that provide flexibility and may in some cases relax otherwise binding regulatory constraints on rates. Many states have authorized Large Risk Alternative Rating Plan Options for employers that meet specified size thresholds for workers' compensation premiums (e.g., over \$250,000 or \$1

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<sup>119</sup> A loss cost is defined by the NCCI (and the ISO) as that portion of a rate that does not include provision for expenses (other than loss adjustment expenses) or profit. It may be used by companies as a starting point to set insurance rates, after reflection of company-specific expenses and profit. Once an advisory loss cost has been approved by a state, an NCCI or ISO participating insurance company can usually adopt it without having to undertake its own often lengthy and expensive rate filing process; Kunreuther, H., Michel-Kerjan, E. and Porter, B. (2005), "Extending Catastrophe Modeling to Terrorism", Chapter 10 in Grossi, P. and Kunreuther, H. (eds) *Catastrophe Modeling: A New Approach for Managing Risk*, New York: Springer.

<sup>120</sup> American Insurance Association (2005), "How the Free Market Fails for Terrorism Insurance", April.

million in annual premiums). With these retrospectively rated plans, insurers and employers are allowed to negotiate rates fully. Large deductible plans, in which deductibles per accident may range as high as \$1 million, also may provide pricing flexibility. In some states, insurers may be able to adjust the rate upward or downward to reflect the underwriter's assessment of the risk of a given firm under "schedule rating" plans.

### ***Commercial Property and Fire Following***

Prior to the September 11<sup>th</sup> attacks, commercial property policies commonly excluded losses arising out of nuclear, biological or chemical agents. Prior to the effective date of TRIA at the end of 2002, all but five states – California, Florida, Georgia, New York and Texas – approved exclusions of losses caused by terrorism. All states except Florida, New York and Georgia have now approved Insurance Service Office optional endorsements excluding terrorism losses from commercial property policies if TRIA is not renewed, or if it is modified to increase insurers' risk or share of losses from terrorism events. One option essentially permits a total exclusion of losses from terrorism. A second option excludes losses resulting from acts involving nuclear, biological or chemical agents. A third endorsement provides coverage of terrorism losses not otherwise excluded up to a coverage sublimit<sup>121</sup>.

As of 9/11, 29 states had Standard Fire Policy laws that generally prevented property insurance policies from excluding losses caused by fire that follows an otherwise excluded peril (such as an earthquake, or a terrorist attack)<sup>122</sup>. Such laws generally only require that the insurer pay the "actual cash value" of the fire loss, rather than replacement cost, and they generally do not apply to business interruption losses. About half of the then existing "fire following" statutes did not apply to the non-admitted or "surplus lines" market, where property owners who experience difficulty in obtaining insurance in the conventional market from an insurer fully licensed and subject to rate and policy form regulation in a state may be able to obtain coverage from a "non-admitted" insurer that is not subject to rate and form regulation. The restrictions also did not apply in some states that had exempted property insurance policies sold to "large commercial insureds" from rate and form regulations during the late 1990s and early 2000s<sup>123</sup>. According to the NAMIC<sup>124</sup>, as of April 2005, twelve of the 29 states have since modified their statutes to exclude fire following requirements for acts of terrorism (see Figure 5.1). A number of others are considering such a change<sup>125</sup>.

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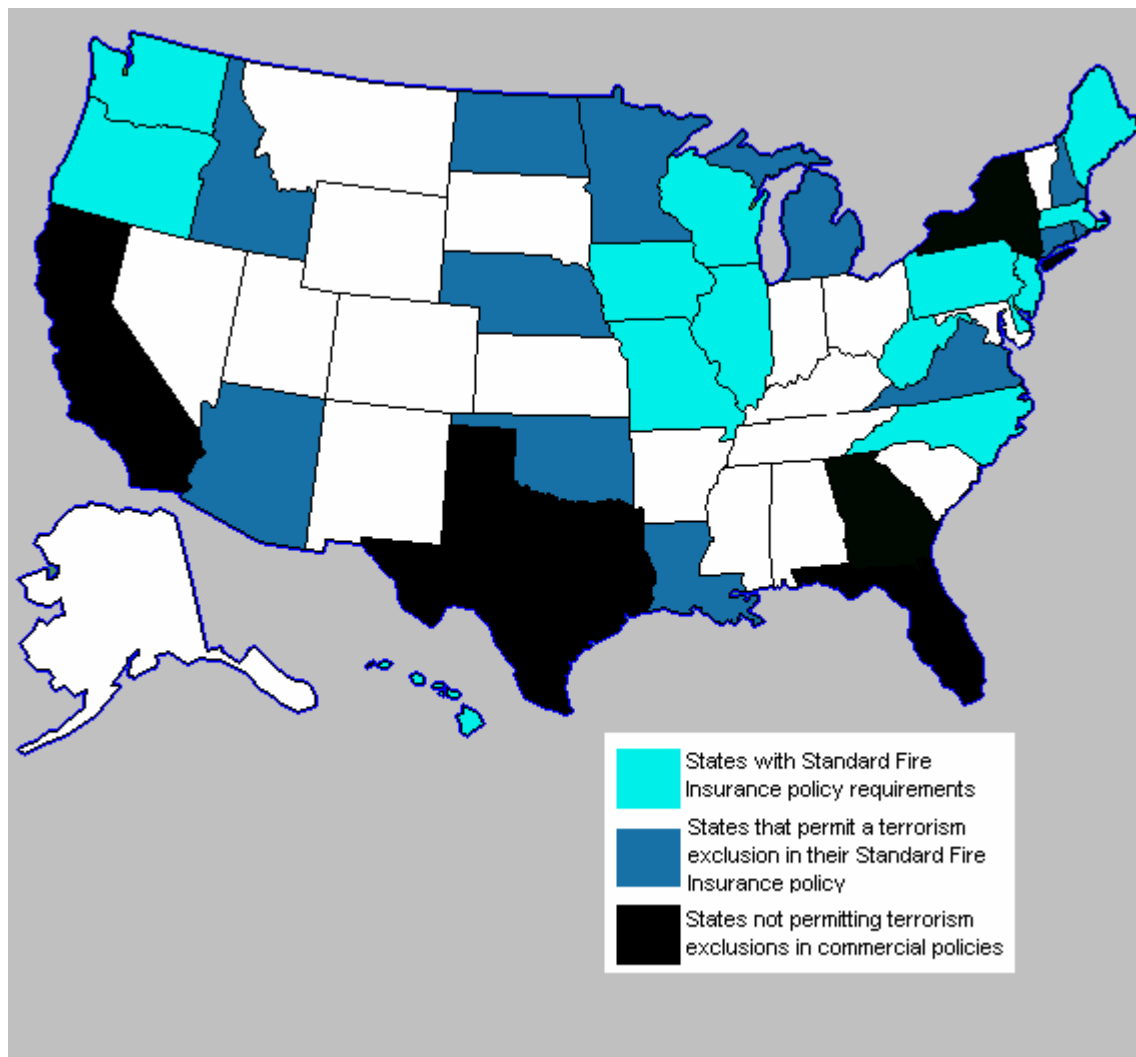
<sup>121</sup> See Insurance Services Office (2004), "ISO Files Conditional Terrorism Insurance Policy Endorsements," Press Release, May 3, and Marsh (2005), *Marketwatch: Terrorism Insurance 2005*.

<sup>122</sup> Marsh (2005), *Marketwatch: Terrorism Insurance 2005*.

<sup>123</sup> About half the states have such exemptions with varying eligibility thresholds

<sup>124</sup> National Association of Mutual Insurance Companies (NAMIC) (2005), "Compliance Grid, Standard Fire Insurance Policy", April 29.

<sup>125</sup> The actual number of states with Standard Fire Policy requirements varies among sources. See Marsh (2005), *Marketwatch: Terrorism Insurance 2005*; Aon (2004), *Terrorism Risk Management and Risk Transfer Market Overview*, December, and NAMIC Online, State Advocate, "Issue Update: Two More States Act on Standard Fire Policy Issue."



**Figure 5.1 Terrorism and Fire Following in 50 States<sup>126</sup>**

*Sources: Wharton Risk Center, based on data from the Marsh 2005 report and miscellaneous sources*

Viewed broadly, prohibitions on terrorism exclusions in commercial property policies, whether total or for fire losses following terrorism, have similar effects as mandatory coverage of terrorism losses for workers' compensation. There are, however, three important differences. First, workers' compensation insurance policies provide coverage for state-mandated workers' compensation benefits. Most states require unlimited coverage of medical expenses for any injured worker. Moreover, insurers cannot limit the total amount of coverage that they provide for death and disability by including aggregate limits for losses to multiple employees. Second, apart from fire following restrictions, property policy forms generally exclude nuclear, biological and chemical-

<sup>126</sup> Florida does not permit terrorism exclusions in its commercial policies, but does not have a Standard Fire Insurance Policy.

related losses from any sort of event (whether terrorism oriented or not), so that insurers and owners can manage those risks without compulsion. The common exclusion of this coverage significantly reduces insurers' exposure to catastrophic loss compared with workers' compensation. Third, the states have not established residual markets for commercial property insurance for large properties, which alters the regulatory dynamic associated with possibly binding regulatory constraints on property insurance rates<sup>127</sup>.

In a hypothetical world of complete freedom to negotiate price and coverage, increased risk of large losses from terrorist attacks will produce higher property insurance premiums and thus reduce the amounts of coverage purchased. Some properties or projects may be uninsurable: the premium that owners are willing or able to pay is less than what insurers would be willing to charge or, in the short-run, there may be no coverage available at any price. The increased costs of risk will then be borne by property owners. Some projects may not be undertaken given the higher costs. Employment may decline or grow less quickly in certain regions. Insurers and brokers may lose some accounts, perhaps many.

If property owners are required to carry terrorism coverage to satisfy loan covenants, they will have to pay for the coverage, or renegotiate the covenants. In the latter cases, some of the losses from the new environment will fall on lenders. If lenders for new projects make terrorism coverage a *quid pro quo* for financing, then fewer new projects will likely be financed. Alternatively, negotiations may end up having lenders assume more risk of default in the event of a terrorist attack, which could allow or encourage additional spreading of terrorism risk among investors in securities that may be issued to back commercial real estate loans.

Binding regulatory constraints on commercial property insurance rates, i.e., that prevent rates from achieving market clearing levels, will reduce the availability of property insurance in the admitted market. It will tend to increase the amount of coverage purchased in the non-admitted or "surplus line" market, thus bypassing the rate constraints, at some increase in the costs of arranging coverage and possibly some reduction in quality and financial security. Rather than lose their entire investment in developing a relationship with particular clients, many insurers will continue to offer them coverage in the short run, despite rate inadequacy, perhaps undermining the insurers' financial strength. As a result, some of the impact of rate constraints will fall on insurers and perhaps their policyholders. Relatively more of the reduction in total economic value that flows from the new environment – the increased risk of large losses from terrorism – will be shifted to insurers and to their shareholders from commercial property owners, developers and lenders. Those gaining from regulatory rate constraints therefore are certain property owners, developers and lenders, with insurers being the primary losers.

How likely is significant regulatory rate suppression for property insurance for medium to large commercial entities? Insurance rates for commercial property insurance historically have not been subject to much political pressure, especially rates for medium to large-sized properties. Following 9/11 that changed in some states. To the extent that

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<sup>127</sup> Many states do have FAIR (Fair Access to Insurance Requirement) plans that serve as residual markets for residential and small business property.

the risk of loss is greatest in large urban areas, property insurance rate regulation could tempt politically minded regulators to hold rates down in these regions at the possible expense of disruptions in supply and higher rates elsewhere, especially if out-of-state insurers writing in a given state bear part of the cost. According to the American Insurance Association, regulators in New York, Washington, D.C., Florida, Georgia, Louisiana and North Carolina have depressed rates by “negotiating” proposed rates for commercial property coverage downward, or by requiring unachievable justifications of proposed rates<sup>128</sup>.

At the end of 2002, the Insurance Services Office (ISO) used the estimates provided by AIR Worldwide (one of its subsidiaries) to file advisory loss costs with the insurance commissioner for each state. ISO defined three tiers for the country, placing certain areas within Chicago, New York City, San Francisco and Washington, DC, in the highest tier, with assigned loss costs of approximately \$0.10 per \$100 of property value. A second tier consisted of Boston, Houston, Los Angeles, Philadelphia and Seattle, as well as other portions of the highest rated cities; the rest of the country fell into the third tier. In pre-filing discussions with regulators, ISO’s advisory loss costs were challenged by some regulators who felt that such premiums would lead businesses to relocate to other areas.

Negotiations ensued and compromises were made. ISO filed loss costs for first-tier cities based on zip code, which differentiated between the higher risk of downtown city centers and the lower risk of properties on the outskirts. But nowhere did the filed loss costs exceed \$0.03 per \$100 of property value in the first tier; and the second and third tiers settled at \$0.018 and \$0.001, respectively, per \$100 of property value. Thus, while the new levels no longer adequately reflected the risk in the eyes of the modelers, they became more palatable to other stakeholders. The Departments of Insurance in all 50 states eventually approved these ISO advisory loss costs that covered the years 2003, 2004 and 2005 (Kunreuther, Michel-Kerjan and Porter, 2003)<sup>129</sup>. A more detailed discussion of ISO’s role in recommending prices for terrorism coverage appears in Appendix 5A.

To the extent that regulation has led to binding constraints in the admitted market, some property owners have likely experienced more difficulty in arranging coverage, more properties have likely been placed with non-admitted insurers, and admitted insurers may have held on to some business at rates perceived as inadequate. To the extent that commercial property rates are politically salient, expiration of TRIA and the upward pressure on rates could amplify those effects significantly. The “free market” solution – allow rates for terrorism coverage to be determined by competition – is fundamentally sound. But if that cannot or does not happen, at least in the major states, increased intensity of rate regulation following an expiration of TRIA would impose real costs.

<sup>128</sup> American Insurance Association (2005), “How the Free Market Fails for Terrorism Insurance”, April.

<sup>129</sup> Kunreuther, H., Michel-Kerjan, E. and Porter, B. (2003), “Assessing, Managing and Financing Extreme Events: Dealing with Terrorism”, National Bureau of Economic Research, Cambridge, MA, December.



### **Summary of Chapter 5**

Government constraints materially affect the ability of private parties to manage terrorism risk. These constraints are unlikely to change substantially in conjunction with an expiration of TRIA. Disaster assistance undermines incentives for private sector risk management before losses occur and would be likely to produce greater payments following any future attacks if TRIA expires. Federal tax policy reduces the private sector's ability to spread the risk of catastrophic losses from terrorism (and other extreme events) through insurance. The effects will be worse without a TRIA-like program.

Mandatory coverage requirements for workers' compensation and fire following a terrorist attack, prior approval regulation and/or other government control of rates for property/casualty insurance covering losses caused by terrorism further constrains private sector contracting. Such regulations could significantly amplify disruptions in terrorism insurance markets following an expiration of TRIA.





## APPENDIX 5A

### ISO's Filing Update for Certified Terrorism Pricing<sup>130</sup>

During the fall of 2004 the Insurance Services Office (ISO) filed to update its previously approved commercial property loss costs for certified acts of terrorism. Those earlier loss costs had been filed in 2002 in response to the passage of TRIA, and they relied on AIR Worldwide Corporation's (AIR) Terrorism Loss Estimation Model. ISO's latest loss cost filings incorporated the results of an update to AIR's terrorism model that included detailed modeling of the Nuclear, Biological and Chemical threat. The most significant changes in ISO's 2004 loss cost filing were:

1. Estimation of Nuclear, Biological and Chemical (NBC) loss costs on a refined geographical basis. The AIR model has the capability of providing such output at a geocoded resolution.
2. Overall reduction in estimated average annual losses due to certified acts of terrorism by about 20 percent, reflecting current threat assessment and results of AIR's detailed NBC model.
3. In and around major metropolitan areas there has been a compression of the loss costs. Due to the revised treatment of the NBC exposure, the indicated loss costs in the downtown areas are lower than in the prior version of the model and loss costs in the counties surrounding the metropolitan center have increased. This is due to the footprints of large NBC attacks.

Reflecting these changes, ISO filed to revise its advisory loss costs under TRIA, and to introduce loss costs should TRIA end. Since the initial (2002) filing of ISO's loss costs in the highest hazard areas resulted in significant regulatory compromise, ISO's updated filing for 2005 still represented an increase in loss costs for those areas, notwithstanding the fact that the overall model was indicating a reduction in average annual loss.

In addition, due principally to the revised treatment of the NBC exposure in the AIR model, the three tier structure contained in the initial filing was discontinued for this second round. A number of counties surrounding metropolitan areas previously rated at the minimum \$0.001 now had higher loss costs due to the larger geographic footprint presented by the NBC exposure.

TRIA imposes higher deductibles on companies with each successive Program Year, and this is reflected in the ISO loss costs. Further, with the scheduled expiration of TRIA, it was necessary to file loss costs that no longer assumed the reinsurance benefit provided by the program. Therefore ISO's updated filing contained "post-TRIA" loss costs which are higher than 2005 loss costs to reflect the removal of the federal backstop under TRIA. As this report is being written, discussions between ISO and insurance commissioners are still underway in several states.

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<sup>130</sup> We appreciate discussions with AIR and ISO on this issue as well as John Reynolds of ISO's input regarding updating the ISO Filing.



## CHAPTER 6

### **Terrorism Loss Sharing Under With or Without TRIA: An Empirical Analysis**

We now turn to a series of analyses on the impact of TRIA on loss sharing between those directly targeted by a terrorist attack, their insurers and other interested parties such as commercial policyholders and U.S. taxpayers. We concentrate our analyses on the following three aspects:

- The impact of the deductible feature of TRIA on how much of the losses from a terrorist attack insurers will bear. We show that the larger the ratio of an Insurer's Deductible/Policyholders' Surplus<sup>131</sup> ( $D/S$ ), the more exposed an insurer is to losses from any given terrorist attack. We determine how the  $D/S$  ratio for the top 451 insurers operating in the country<sup>132</sup> has changed over the three years of TRIA's operation (2003-2005). In Appendix 6B we compute the  $D/S$  ratios for 2006 and 2007 for the top 30 insurers under two different TRIA-renewal scenarios: (a) the deductible remains at 15 percent of insurers' TRIA-line direct earned premiums for the previous year (the 2005 ratio under TRIA) and (b) it increases to 17.5 percent in 2006 and up to 20 percent in 2007, as considered by Congressional bills introduced in 2004. We then compare  $D/S$  over the 5-year period 2003-2007 for each insurer.
- The impact of different simulated terrorist attacks on the losses experienced by the victims, insurers, policyholders and taxpayers and the likely differences in large urban areas. We differentiate workers' compensation from other TRIA-covered lines. While we have the data to undertake such analyses for large cities throughout the country, here we provide the results for three states: Texas (Houston and Dallas), California (Los Angeles and San Francisco) and New York (New York City). The chapter also examines the impact of different take-up rates of terrorism insurance by commercial firms on the final share of losses between interested parties.
- The distribution of losses between victims, insurers, commercial policyholders and taxpayers under three terrorism insurance programs: (a) TRIA today, (b) TRIA ends and is not replaced by any public-private risk-sharing mechanism, and (c) TRIA is made permanent.

The analyses undertaken in this chapter are based on data provided by A.M. Best and Risk Management Solutions, and informed by extended discussions over the past year

<sup>131</sup> See Section 2.1 for a definition of policyholders' surplus.

<sup>132</sup> Ranked by 2004 TRIA-line direct earned premium (DEP); i.e. the measure used to calculate insurers' 2005 deductible under TRIA. These insurers all had a total TRIA-line direct earned premium equal to or above \$10 million in 2004.

with key interested parties concerned with terrorism insurance and by responses to a questionnaire designed by the Wharton Risk Center and distributed to insurers by the American Insurance Association (AIA) and the Property Casualty Insurers Association of America (PCIAA)<sup>133</sup>. Appendix 6A contains the questions asked insurers and a summary of their responses.

## 6.1 Insurer Deductible/Surplus (*D/S*) Ratios

Given the obligation of insurers to offer terrorism insurance to all their commercial policyholders under TRIA, the amount of loss that an insurer will eventually bear is based on its deductible. As described in Section 1.2, the insurer's deductible under TRIA is determined as a percentage of its total direct earned premiums (DEP) during the preceding year for TRIA lines. For each of the top 451 insurers A.M. Best provided us with the premiums written in TRIA commercial lines<sup>134</sup>, so we can determine what their current deductible (*D*) is under TRIA. Although we do not know the insurers' exact terrorism exposure<sup>135</sup>, we will assume that they are providing this TRIA-based coverage to a large proportion of their policyholders in the urban areas we consider here. Our interest is in determining how vulnerable insurers are to the possibility of suffering a large loss relative to their surplus. Those insurers with large deductibles (*D*) relative to their surplus (*S*) are the ones most at risk if they are providing terrorism coverage to most of their policyholders.

Insurers writing policies in an urban area know that there is some chance that the loss from a terrorist attack could reach or exceed their deductible (*D*). We first focus our analyses of the impact of TRIA on insurers on the 30 largest companies based on direct earned premiums in TRIA lines for 2004. These companies wrote premiums that comprised 70% of the total insurance market<sup>136</sup>. Figure 6.1 depicts the number of insurers (y-axis) whose *D/S* exceeds pre-specified values of *x* percent (x-axis).

This analysis is based on the TRIA deductibles of 7 percent (2003), 10 percent (2004) and 15 percent (2005) of the direct earned premiums (DEP) for TRIA line policies during the previous year. The data show clearly that there has been a major shift over the past 3 years as the TRIA deductible percentage has increased. For example, as shown in Figure 6.1, only 5 insurers had a *D/S* ratio exceeding 10 percent in 2003 while more than half were in this category in 2005. Of the top 30 insurers, 8 of them have a *D/S* ratio exceeding 20 percent in 2005, while only 1 was in this range in 2003.

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<sup>133</sup> We thank Debra Ballen of AIA and Greg Heidrich of PCIAA for their helpful suggestions in constructing the questionnaire and distributing it to their members.

<sup>134</sup> The original sample was made of all insurers with a TRIA-line total earned premium higher than \$10 million in 2002, 2003 and 2004. Because the number of these insurers varied from one year to the next (establishment of new companies, mergers, bankruptcies, etc.), we selected a consistent sample of 451 insurers over the three years 2002-2004 that we used to determine the evolution of the *D/S* ratio under TRIA 2003-2005.

<sup>135</sup> This information would obviously be highly valuable but is not yet publicly available.

<sup>136</sup> The top 30 insurers' TRIA line direct earned premiums in 2004 were about \$147 billion of dollars out of the \$210 billion provided by the top 451 insurers of our sample in that same year.

Appendix 6B explains in more detail how the  $D/S$  ratios were calculated. Table 6B.1 depicts the actual values for the years 2003-2005 in tabular form for each of the 30 insurers with the largest TRIA-line DEP in 2004.

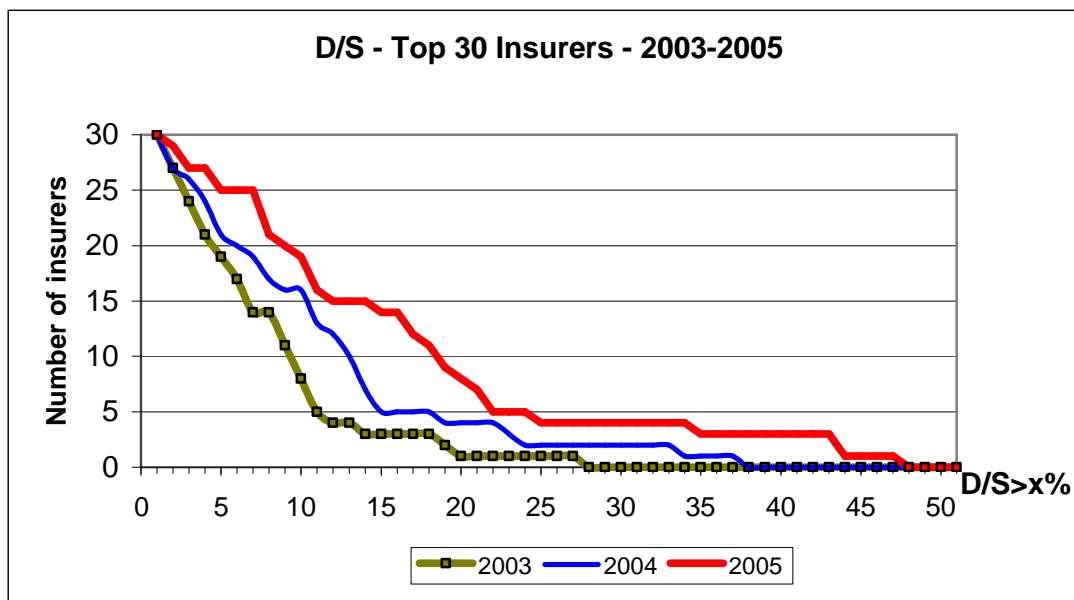


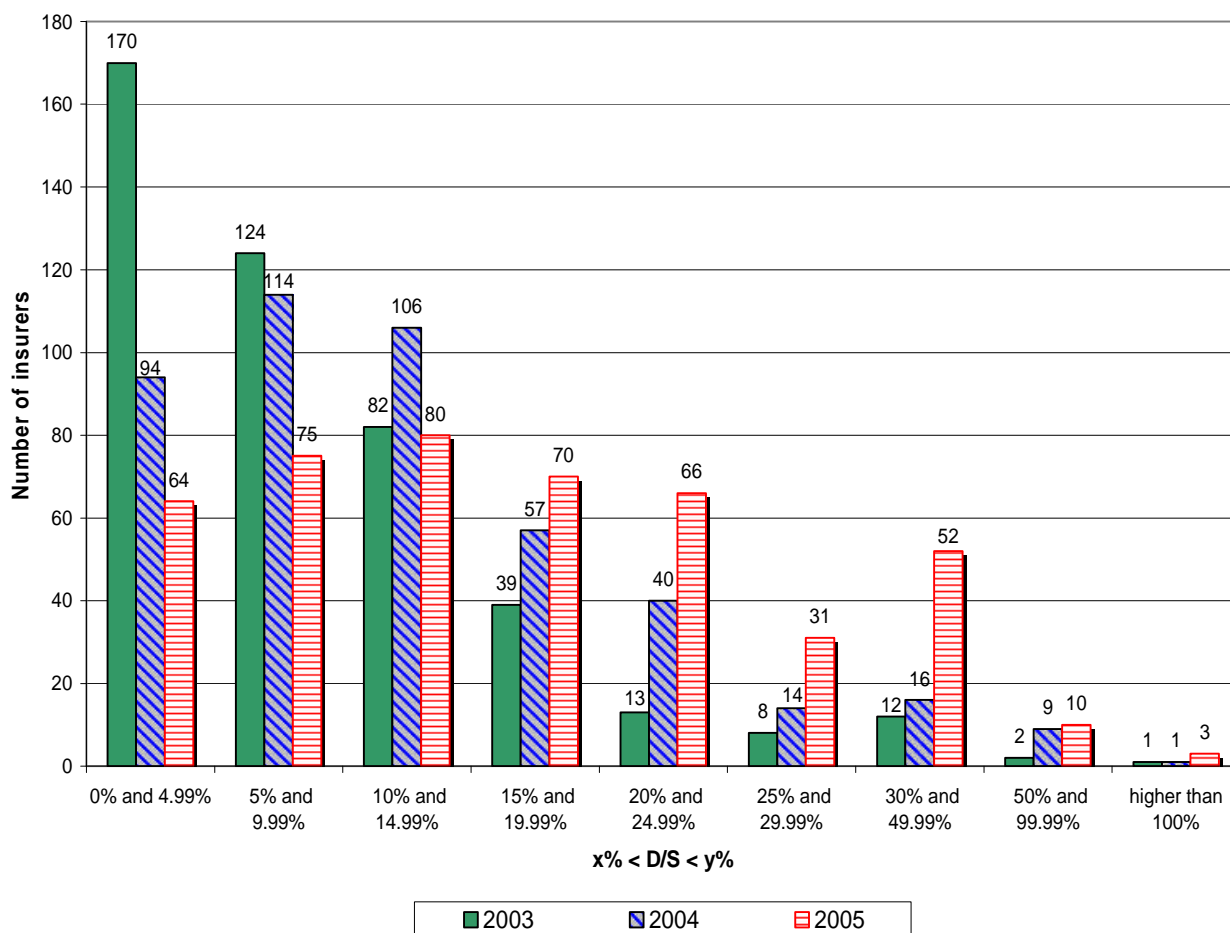
Figure 6.1 Number of the Top 30 Insurers which  $D/S$  Exceeds  $x\%$

In Appendix 6B we also analyze the impact on  $D/S$  for the 30 largest insurers for two alternatives should TRIA be renewed. Table 6B.2 provides these ratios for the case where the deductible remains equal to 15 percent of DEP in 2006 and 2007. In that case, given the proportional increase in both surplus and deductible due to the expected increase in DEP during these two years for most insurers over this time period, the  $D/S$  ratios remain stable or even decrease. Table 6B.3 depicts the  $D/S$  ratios under the proposed deductibles for TRIA for 2006 and 2007 based on Congressional bills introduced in 2004:  $D = 17.5$  percent of DEP in 2006 and 20 percent of DEP in 2007. For this scenario, the increase in surplus does not compensate for the increase in  $D$ , so that all insurers'  $D/S$  ratios increase, some quite significantly. Now 18 of the top 30 insurers would have a TRIA deductible higher than 10 percent of their surplus in 2007; for 13 of them  $D$  would be higher than 20 percent.

Figure 6.2 below depicts the evolution of the  $D/S$  graphically for our sample of 451 insurers for these same three years: 2003, 2004 and 2005. For the sake of simplicity, we provide a broad overview of the results rather than focus on individual insurers. That is, for each year, we plot the number of insurers whose  $D/S$  ratio lies between different percentage ranges in increments of 5 percent (i.e. [0%; 4.99%]; [5%; 9.99%], etc).

Note that 294 insurance companies providing terrorism insurance in the U.S. had a  $D/S$  ratio lower than 10 percent in 2003, compared to 139 insurers in 2005. If we consider higher  $D/S$  ratios, more than half of the firms have a  $D/S$  ratio greater than 15 percent in

2005 compared with less than 1/6 of the insurers in 2003. In 2003, only 36 insurers had a *D/S* ratio above 20 percent. There were 80 such insurers in 2004. In 2005, 162 insurers (more than 35 percent of the sample) have a *D/S* ratio greater than 20 percent.



**Figure 6.2 Change in D/S Ratio for the Top 451 Insurers under TRIA (2003-2005)**  
*Source: Wharton Risk Center using data from A.M. Best*

## 6.2 Constructing Attack and Loss-Sharing Scenarios

Due to the difficulty in estimating the likelihood of a terrorist attack, insurers utilize scenarios to determine their maximum exposure to a range of possible attacks that vary by location and mode of attack. When asked the question “Does your company consider scenarios in its catastrophe/exposure management process?”, 92 of the insurers who responded to the Wharton survey responded “Yes”. One company responded to the above question by noting:

*“Our company uses deterministic terrorism attack scenarios, and the associated Probable Maximum Loss (PML) estimates of these scenarios, to establish and manage exposure concentrations within major metropolitan areas and/or surrounding landmark properties.”*

However, few insurers consider the likelihood of these scenarios occurring in determining their exposure as illustrated by the following responses to the question: “Do you take estimates of the likelihood of the various known scenarios into account when making underwriting decisions?”:

*“Not really. There is little historical data to predict future events.”*

*“Likelihood is very unpredictable for terrorist acts.”*

*“Our company does not believe that estimates of the frequency of terrorism attacks are credible at a country, regional or specific property level.”*

Given insurers’ interest in determining their exposure using deterministic scenarios and to more fully understand the nature of the economic and human losses from a terrorist attack on business property, we have constructed a set of scenarios to analyze the impact of financial losses between the non-insured victims, the insurers and the taxpayers under TRIA today. We also utilize these scenarios to analyze the impact on the distribution of losses if TRIA were not renewed so that the private market (i.e. insurers, property owners and/or employers) would be responsible for all the losses.

As already discussed, there are no easy answers to these loss allocation questions, as they will be determined by the nature and location of the terrorist attacks and the number of insurers providing coverage. For example, if the attack is a relatively small one on a single building and large insurers with high deductibles cover the target building, then there will be little, if any, federal government involvement in loss payments. However, if a few smaller companies with low TRIA deductibles cover the target building, then the federal government will pay a significant portion of their losses and then will then partially or fully recoup these payments from all policyholders purchasing commercial insurance.

Data from the Wharton questionnaire distributed to insurers as well as discussions with interested parties indicate that most insurers focus on damage from 2-to-10-ton truck bombs in determining the losses they will suffer from a terrorist attack<sup>137</sup>. One reason for this focus is that A.M. Best uses this type of scenario in analyzing the impact of a terrorist attack on the balance sheet of insurers. Hence we have used data provided by Risk Management Solutions (RMS) to the Wharton Risk Center on the impact of a 5-ton truck bomb exploding in each of the 447 largest commercial high-rise buildings in the country on property damage and workers’ compensation losses.<sup>138</sup> There are other scenarios that could be used to evaluate losses from a terrorist attack. For example, using RMS data

<sup>137</sup> More specifically, 90% of the Wharton questionnaire indicated that they were using that type of scenario in evaluating their exposure: 7 of the 10 insurers responding to the questionnaire indicated that they used 5-ton bomb scenario and 2 insurers indicated they were using a 2-ton truck bomb scenario.

<sup>138</sup> We are grateful to Andrew Coburn from Risk Management Solutions who provided us with these data.

Appendix 6C compares the resulting damage on these same 447 buildings from aircraft attacks versus a 5-ton truck bomb<sup>139</sup>.

### Scenario Methodology

Figure 6.3 describes the methodology for allocating losses from a specific scenario to the potential victims as well as the insurers and federal government immediately after a terrorist attack. The loss allocation process can be divided into several steps.

*Step 1.* Identify the nature of the terrorist attack (e.g., “certified” or non-certified event)

*Step 2.* Determine losses covered by insurance

*Step 3.* Determine what proportion of losses is assumed by each of the affected parties

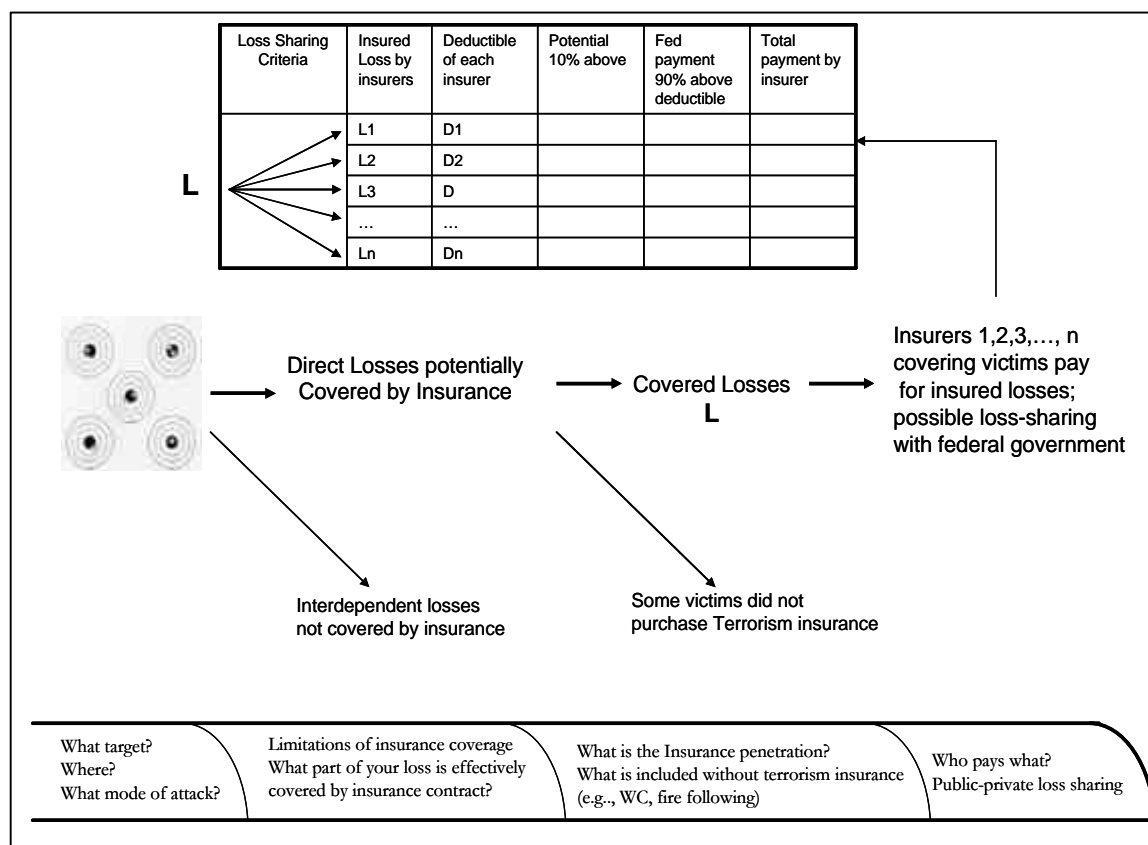


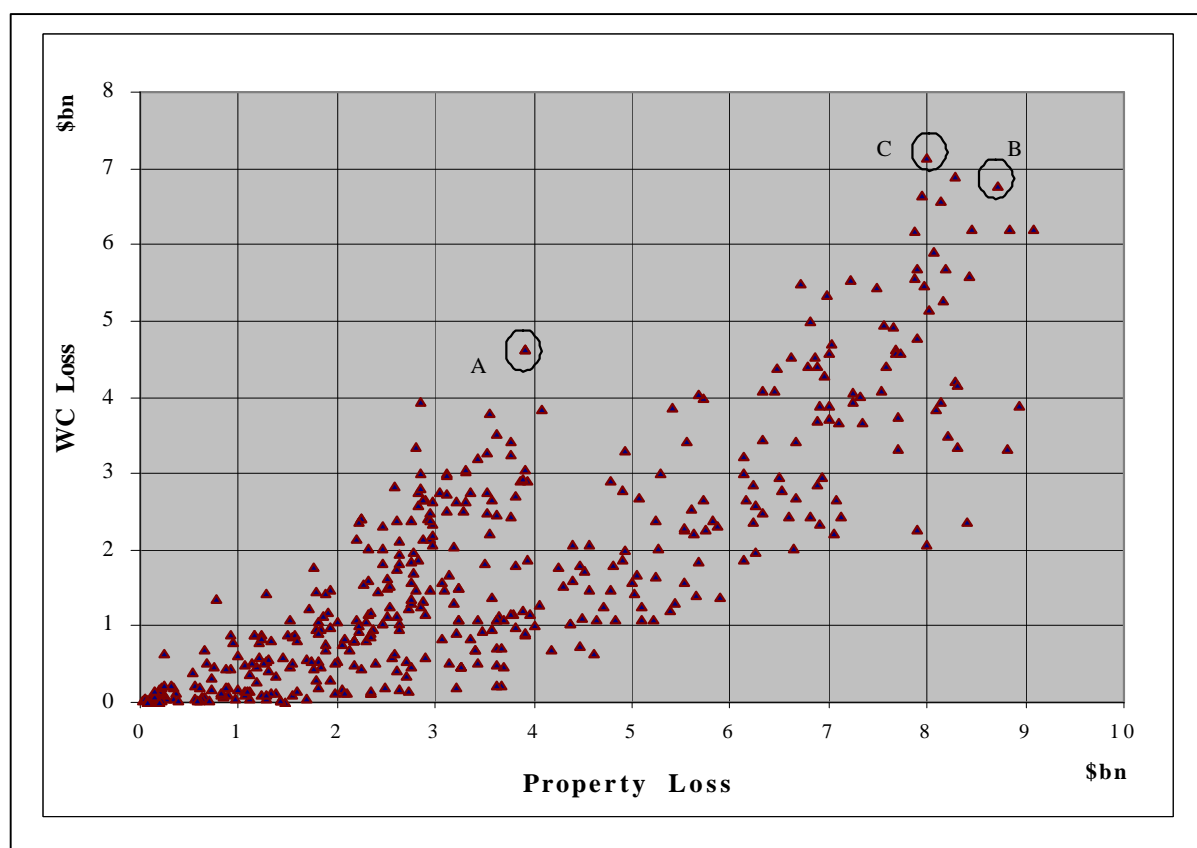
Figure 6.3 Loss Allocation Process

Figure 6.4 provides the distribution of loss for each of 447 commercial high-rise buildings on two major insurance lines covered by TRIA: property (including business interruption) and workers’ compensation. The explosion of a 5-ton truck bomb would

<sup>139</sup> The RAND Corporation has undertaken a detailed study on the impact of aircraft attacks on high rises in the United States. RAND shared these data with the Wharton Risk Center. We appreciate helpful conversations with Stephen Carroll and Tom LaTourette from RAND on how to interpret these data.



inflict disastrous damage to the specific building that terrorists want to target, but also to other adjacent structures. The impact on property would then mainly depend on the nature of the building and the number of employees who are working there<sup>140</sup>. For example, a 5-ton truck bomb on Building A would inflict \$4.7 billion in losses on workers' compensation and \$3.9 billion in property loss. An attack on Building B in a different city could inflict \$6.8 billion in workers' compensation (WC) losses and \$8.7 billion in property loss as shown in Figure 6.4. The maximum combination of property and WC losses is estimated to be between \$15-16 billion for a single event, as shown by Buildings B or C.



**Figure 6.4 Property Losses and Workers' Compensation Losses from 5-Ton Bomb Attacks to 447 High Rise Buildings in the United States**

*Sources: Wharton Risk Center using data from Risk Management Solutions*

<sup>140</sup> The attack was assumed to occur at a time when most employees would be in the building (10 am on a Wednesday).

### ***Developing Alternative Scenarios***

Insurers are concerned with losses in high-risk major metropolitan areas. In response to the question as to what factors are important when offering terrorism insurance, 8 out of the 10 insurers responded that location played a significant role<sup>141</sup>. We thus concentrate our analysis on cities in three states considered to be vulnerable to terrorist attacks and where there is likely to be considerable damage to property and injuries to employees: New York (NY), Los Angeles and San Francisco (CA) and Houston and Dallas (TX). A terrorist attack perpetrated on U.S. soil by foreign terrorist groups is likely to take the form of simultaneous attacks against different targets, as illustrated by 9/11 and the terrorist attacks in Madrid, Spain on March 11, 2004 and in London, England during July 2005. Hence we will analyze the impact on insurers and taxpayers of a set of different scenarios with 5-ton truck bombs where the losses would vary between \$500 million (minor attack against one building) and \$100 billion (simultaneous attacks).

### **6.3 Impact of Location, Attack Size and Insurance Take-up Rate under TRIA**

How would losses from foreign terrorist attacks on U.S. soil be distributed across the relevant affected parties? This chapter examines this question in some detail under different risk-sharing scenarios that vary with respect to location, magnitude of damage and terrorism risk insurance take-up rate.

#### ***Assumptions***

We have utilized *market shares* of insurers to allocate losses from a terrorist attack between the 451 largest insurers that comprise 97 percent of the market with respect to 2004 TRIA-line direct earned premiums (DEP)<sup>142</sup>. Property insurance lines have been separated from workers' compensation lines. In the case of property coverage we have utilized premiums written for commercial coverage on a nationwide basis. With respect to workers' compensation (WC) coverage we had access to insurers' market shares in the relevant states and so have allocated losses using these data. It is worth noting that in each of the three states on which we focus our analysis, there are major competitive WC insurers: New York State Insurance Fund, State Compensation Insurance Fund of California and Texas Mutual Insurance Company. The State Compensation Insurance Fund of California covers half of WC lines in CA while the major insurers in New York and Texas cover 40 percent and 20 percent respectively of the total WC coverage in their states.

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<sup>141</sup> One insurer indicated that location played a modest role. Another insurer noted that location played no role in its decision to offer terrorism insurance, presumably because it was providing coverage to a diversified set of policyholders in various parts of the country.

<sup>142</sup> Since data are not available on individual insurers' terrorism exposure, market share appears to be the most reasonable proxy for analyzing loss sharing across the affected parties.

### *A Comparative Analysis for 2005 under TRIA*

We first undertake a comparative analysis of loss distribution between the affected parties as one varies location, level of loss and take-up rate under a scenario where the terrorist attacks take place in 2005 with TRIA in place. Insurers will pay their entire loss up to their TRIA deductible  $D$  (15 percent of the TRIA-lines direct earned premium in 2004) and then an additional 10 percent above  $D$ <sup>143</sup> with the federal government paying the other 90 percent<sup>144</sup>. Under TRIA the federal government would levy a surcharge against all policyholders purchasing commercial insurance to recoup part of its payment within the total insurers' payments and the insurance industry retention (\$15 billion in 2005) ("mandatory recoupment").

*Impact of Location* Table 6.1 examines the impact of two 5-ton truck bomb attacks in one of the major cities in each of the three states under the assumption that the total property loss is \$15 billion and workers' compensation (WC) loss is \$10 billion in each of the locations we study (New York City for New York, Los Angeles or San Francisco for California, and Houston or Dallas for Texas); i.e a total \$25 billion loss. We also assume that half of the property damage to commercial enterprises in the buildings are covered by either terrorism insurance or fire following a terrorist attack, and that all the WC losses are covered by insurance (see Sections 5.3 and 5.4 for a detailed discussion of workers' compensation and fire following). This results in a \$17.5 billion insured loss out of the \$25 billion total loss. A sensitivity analysis relative to the insurance take-up rate is undertaken later in this subsection.

For this scenario the insurers and policyholders will absorb \$15 billion of the \$17.5 billion insured loss in each of the three cities. However, the distribution of payments between insurers and all policyholders differ across metropolitan areas (due to different WC market share). In both New York and California there are 2 or 3 large insurers providing a very large portion of WC coverage for the entire state, so that they will have a much higher loss relative to their TRIA deductible than WC insurers in Texas where there is less concentration of coverage in one company. Hence, the federal government will initially pay more in New York and California (the 90 percent portion above the deductible of the few key WC insurers), and then recoup part of that payment against all policyholders. In all three cities the federal government covers \$2.5 billion of the loss, which is shared by all U.S. taxpayers<sup>145</sup>.

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<sup>143</sup> We are assuming that insurers have not purchased reinsurance. Had they done so then the amount of their loss would be somewhat reduced.

<sup>144</sup> We assume a zero deductible for the policyholder on their terrorism insurance policy. This assumption simplifies the analysis but does not affect the qualitative results.

<sup>145</sup> Treasury has the authority to collect the \$2.5 billion through surcharges should it elect to do so, but here we only allow a recoupment for losses between the insurer's payments and the \$15 billion market retention in 2005.

**Table 6.1 \$25 billion Losses Due to Two 5-ton Truck Bombs  
50% Insurance for Property Coverage; 100% Insurance for WC**

| <u>City Comparison</u> | Non <sup>146</sup> -insured | Loss Sharing  |                    |                                  |                          |
|------------------------|-----------------------------|---------------|--------------------|----------------------------------|--------------------------|
|                        |                             | Total insured | Insurers' Payments | All Policyholders <sup>147</sup> | Final Fed. Gov Taxpayers |
| New York, NY           | \$7.5bn                     | \$17.5bn      | \$13.27bn          | \$1.73bn                         | \$2.5bn                  |
| % total insured        |                             |               | 76%                | 10%                              | 14%                      |
| Los Angeles, CA        | \$7.5bn                     | \$17.5bn      | \$13.1bn           | \$1.9bn                          | \$2.5bn                  |
| % total insured        |                             |               | 75%                | 11%                              | 14%                      |
| Houston, TX            | \$7.5bn                     | \$17.5bn      | \$14.5bn           | \$0.5bn                          | \$2.5bn                  |
| % total insured        |                             |               | 83%                | 3%                               | 14%                      |

Source: Wharton Risk Center

*Impact of Size of Loss* Table 6.2 shows how changing the size of the loss from \$0.5 billion to \$100 billion affects the distribution of payments in one specific metropolitan area (New York, NY) using the same assumptions as above regarding coverage: half of the property damage to commercial enterprises in the buildings are covered by either terrorism insurance or by fire following a terrorist attack, and all the WC losses are covered by insurance.

The figures reveal that if losses from terrorist attacks do not exceed \$15 billion the insurance companies and policyholders will bear all of the losses. We considered two cases where the total loss is \$40 billion. In Case 1 property loss is \$28 billion and WC is \$12 billion. In Case 2 the dollar figures are reversed: property loss is \$12 billion and WC is \$28 billion. Even if the total loss is the same, the loss sharing differs considerably between these two cases. While taxpayers would end up paying \$5.4 billion in Case 1, they would pay \$15.3 billion in Case 2. The difference is due to both the level of insured loss and the distribution of loss among insurers who have different deductibles under TRIA. In other words, a \$1 billion loss due to property damage is shared differently than a \$1 billion loss of WC because the insurers will be different.

Should the terrorist attacks lead to losses of \$100 billion, then the U.S. taxpayers will bear 54.5 percent of the total insured losses. A question we will return to in Chapter 10 of this report is whether there are alternatives to TRIA for financing these taxpayer losses.

<sup>146</sup> Retained by policyholders who suffered the losses but were not covered against terrorism.

<sup>147</sup> The federal government recoups the 90% portion of the insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005 (see Section 1.2 on TRIA design).

**Table 6.2 Impact of Varying Losses from 5-ton Truck Bomb Attacks on New York City  
50% Insurance for Property Coverage; 100% Insurance for WC**

| <u>Scenarios</u>  | Non <sup>148</sup> -<br>insured | Loss Sharing     |                       |                                     |                             |
|---|---------------------------------|------------------|-----------------------|-------------------------------------|-----------------------------|
|   |                                 | Total<br>insured | Insurers'<br>Payments | All<br>Policyholders <sup>149</sup> | Final Fed. Gov<br>Taxpayers |
| <b>Total: \$0.5bn</b><br>Property: \$0.25bn<br>WC: \$0.25bn | <b>\$125mi</b>                  | <b>\$375mi</b>   | <b>\$375mi</b>        | <b>\$0</b>                          | <b>\$0</b>                  |
| % total insured   |                                 |                  | 100%                  | 0%                                  | 0%                          |
| <b>Total: \$5bn</b><br>Property: \$2.5bn<br>WC: \$2.5bn     | <b>\$1.25bn</b>                 | <b>\$3.75bn</b>  | <b>\$2.97bn</b>       | <b>\$780mi</b>                      | <b>0\$</b>                  |
| % total insured   |                                 |                  | 79.2%                 | 20.8%                               | 0%                          |
| <b>Total: \$15bn</b><br>Property: \$9bn<br>WC: \$6bn        | <b>\$4.5bn</b>                  | <b>\$10.5bn</b>  | <b>\$8.23bn</b>       | <b>\$2.27bn</b>                     | <b>\$0</b>                  |
| % total insured   |                                 |                  | 78.3%                 | 21.7%                               | 0%                          |
| <b>Total: \$25bn</b><br>Property: \$15bn<br>WC: \$10bn      | <b>\$7.5bn</b>                  | <b>\$17.5bn</b>  | <b>\$13.27bn</b>      | <b>\$1.73bn</b>                     | <b>\$2.5bn</b>              |
| % total insured   |                                 |                  | 75.9%                 | 9.9%                                | 14.2%                       |
| <b>Total: \$40bn</b><br>Property: \$28bn<br>WC: \$12bn      | <b>\$14bn</b>                   | <b>\$26bn</b>    | <b>\$20.6bn</b>       | <b>\$0</b>                          | <b>\$5.4bn</b>              |
| % total insured   |                                 |                  | 79.2%                 | 0%                                  | 20.8%                       |
| <b>Total: \$40bn</b><br>Property: \$12bn<br>WC: \$28bn      | <b>\$6bn</b>                    | <b>\$34bn</b>    | <b>\$18.7bn</b>       | <b>\$0</b>                          | <b>\$15.3bn</b>             |
| % total insured   |                                 |                  | 55%                   | 0%                                  | 45%                         |
| <b>Total: \$100bn</b><br>Property: \$50bn<br>WC: \$50bn     | <b>\$25bn</b>                   | <b>\$75bn</b>    | <b>\$34.1bn</b>       | <b>\$0</b>                          | <b>40.9bn<sup>150</sup></b> |
| % total insured   |                                 |                  | 45.5%                 | 0%                                  | 54.5%                       |

Source: Wharton Risk Center

*Impact of Insurance Coverage* Turning now to the impact of the percentage insured on the distribution of payments, we again focus on New York City where a terrorist attack causes total property losses of \$15 billion and WC losses of \$10 billion. All employees are

<sup>148</sup> Retained by policyholders who suffered the losses but were not covered against terrorism.

<sup>149</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

<sup>150</sup> Including \$18.3 billion that would represent the 90% federal payment above the New York Insurance Fund's TRIA deductible.

protected against WC losses; the percentage of commercial enterprises insured against property damage is now varied from 0% to 100%.

Table 6.3 shows that insurers and policyholders will absorb all of the losses if 25 percent or less of the commercial enterprises purchase property insurance. Even when 50 percent or more of those at risk are insured against terrorism losses, 80 percent or more of the property and WC losses from the terrorist attack are covered by the insurance industry.

**Table 6.3 Impact of Varying Percentage Insured Against Property Losses in New York City  
\$25 Billion Losses Due to Two 5-ton Truck Bombs; 100% Insurance for WC**

| Take-up rate<br>for Property<br>Coverage | Non-<br>insured <sup>151</sup> | Loss Sharing     |                       |                                     |                             |
|--|--------------------------------|------------------|-----------------------|-------------------------------------|-----------------------------|
|  |                                | Total<br>insured | Insurers'<br>Payments | All<br>Policyholders <sup>152</sup> | Final Fed. Gov<br>Taxpayers |
| 0%                                       | \$15bn                         | \$10bn           | \$5.9bn               | \$4.1bn                             | \$0                         |
|  |                                | % total insured  | 59.9%                 | 40.1%                               | 0%                          |
| 25%                                      | \$11.25bn                      | \$13.75bn        | \$9.6bn               | \$4.15bn                            | \$0                         |
|  |                                | % total insured  | 70%                   | 30%                                 | 0%                          |
| 50%                                      | \$7.5bn                        | \$17.5bn         | \$13.27bn             | \$1.73bn                            | \$2.5bn                     |
|  |                                | % total insured  | 75.9%                 | 9.9%                                | 14.2%                       |
| 75%                                      | \$3.75bn                       | \$21.25bn        | \$17bn                | \$0                                 | \$4.25bn                    |
|  |                                | % total insured  | 80%                   | 0%                                  | 20%                         |
| 100%                                     | \$0                            | \$25bn           | \$20.6bn              | \$0                                 | \$4.4bn                     |
|  |                                | % total insured  | 81.5%                 | 0%                                  | 17.5%                       |

Source: Wharton Risk Center

*Summary of Findings* The above analyses provide the following insight into the distribution of losses under TRIA should a terrorist attack occur in 2005: The U.S. taxpayers will cover a relatively small proportion of the losses if half of the property losses are covered by insurance unless there is a terrorist attack that produces extreme losses of \$100 billion or more (see Table 6.2).

Even if all property is protected by insurance, the U.S. taxpayers will absorb only 17.5 percent of the total loss under TRIA from a terrorist attack inflicting a \$25 billion loss in New York City (See Table 6.3). This is due to the high deductible associated with TRIA today. It is interesting to note that Congressional bills introduced in 2004 have specified higher deductibles in 2006 (D=17.5%) and 2007 (D=20%). (See the Prospective Analysis in Appendix 6B.)

<sup>151</sup> Retained by policyholders who suffered the losses but were not covered against terrorism.

<sup>152</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

The results of analyses similar to the one presented here for New York City can be found in Appendix 6D for Texas and California. Although we have the data to undertake similar analyses for a large number of states, we have focused on these three states to highlight the impact of a terrorist attack on urban areas considered to be highly vulnerable.

#### 6.4 Who Bears the Loss if TRIA is Not Extended?

What would be the severity of the losses to insurers if they continued to provide the same amount of terrorism coverage for property and workers' compensation as they are currently doing, TRIA were not renewed, and insurers would be responsible for the entire loss from both foreign and domestic terrorist attacks? If insurers maintained their current book of business, some would have loss/surplus ratios exceeding 1 following a 5-ton truck bombing, implying that they would become insolvent.

Here again, we assume a 50 percent take-up rate for non WC lines and full coverage for WC. Figure 6.5 compares the impact on the insurers' loss/surplus ( $L/S$ ) ratio for aggregate losses of \$25 billion, \$40 billion and \$100 billion from 5-ton truck bombs in NYC under current operation of TRIA or if it were not extended. To simplify the analysis, we focus our study below on the top 30 insurers<sup>153</sup>. They provide two-thirds of property insurance market capacity and about 85 percent of the WC capacity in New York.

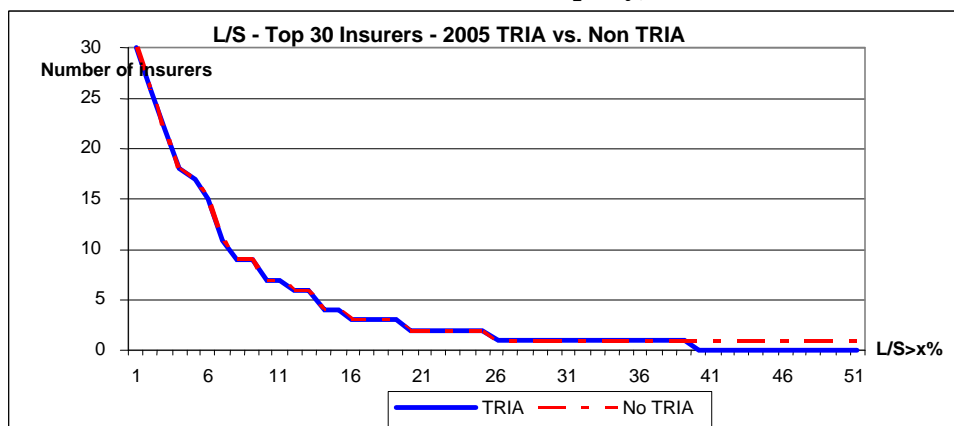
For each insurer, we calculate what its claims would be under the three different cases (total losses of \$25 billion, \$40 billion and \$100 billion) and then determine its share of the loss relative to that of the federal government and all policyholders under TRIA. If TRIA is not extended then the insurers would bear 100 percent of the loss unless it utilized private reinsurance and/or catastrophe bonds to cover catastrophic losses. We then determine its ratio  $L/S$  in these two cases. The three graphs comprising Figure 6.5 depict the number of insurers (y-axis) whose  $L/S$  ratio exceeds pre-specified values of  $x$  percent (x-axis).

With the exception of the scenario in which there is a loss of \$100 billion, the impact on the loss/surplus ratio for most of these top 30 insurers will not significantly change whether or not TRIA is extended because of the high TRIA deductible currently in effect (most of the top 30 insurers' payments are well below their 15 percent deductible). When losses are at \$100 billion, many of the insurers will have a much higher  $L/S$  ratio when TRIA is not renewed than under the current program. In fact, over half of the largest insurers will have  $L/S$  ratios greater than 25 percent and two insurers would become insolvent (i.e.,  $L/S > 1$ )<sup>154</sup>. This underscores the concern that many insurers have on being protected against catastrophic losses.

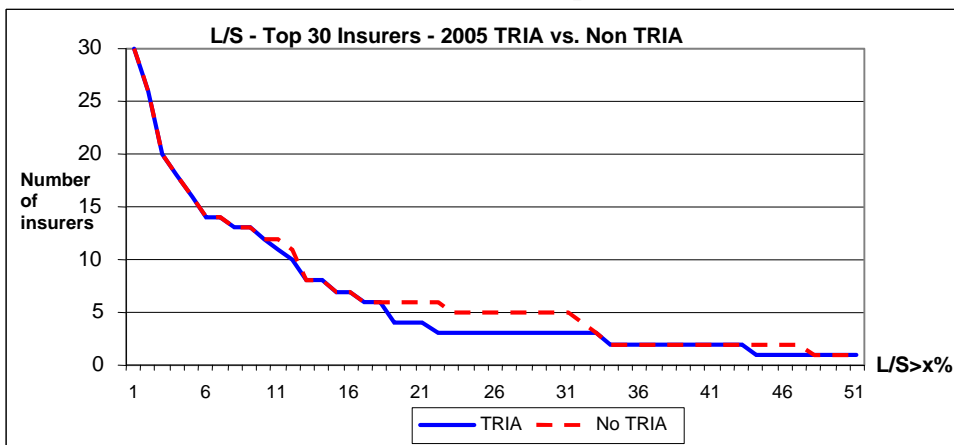
<sup>153</sup> The New York Insurance Fund is included as one of the top 30 insurers in New York State. We did not include the California State Compensation Insurance Fund as one of these companies.

<sup>154</sup> Under this \$100 billion loss scenario with a \$50 billion loss in WC, even if TRIA were in place the New York State Insurance Fund would become insolvent.

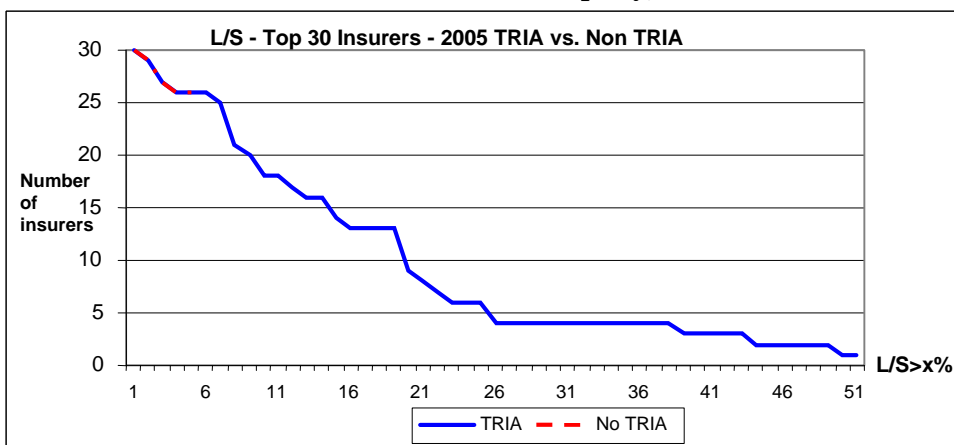
**Scenario 1: \$25bn (15bn Property, 10bn WC)**



**Scenario 2: \$40bn (12bn Property, 28bn WC)**



**Scenario 3: \$100bn (\$50bn Property, \$50bn WC)**



**Figure 6.5 Impact on Loss/Surplus Ratios under TRIA and if TRIA is Not Continued**  
Losses from 5-ton Truck Bomb Attacks on New York City Vary from \$25 to \$100 billion  
50% Insurance for Property Coverage; 100% Insurance for WC  
*Source: Wharton Risk Center*



Of course, if a single insurer were severely hit so that it suffered a loss above its TRIA deductible, then the federal government would have covered 90 percent of this portion of the loss under TRIA. In this sense, the insurer's  $L/S$  would be lower under TRIA than if the Act were not renewed. That is actually the case for insurers whose principal (or exclusive) line of business is workers' compensation. Their  $L/S$  ratios will increase significantly if TRIA is not renewed. In fact without TRIA in place, the New York State Insurance Fund would become insolvent even if terrorist losses from WC were \$10 billion (i.e. for the scenario where total losses are \$25 billion). Writing only WC, its surplus is limited. Being the largest provider of WC coverage in New York State it would incur the bulk of the WC loss should a terrorist attack occur in New York City.

These analyses show that insurers who are exclusively covering workers' compensation would be in a highly vulnerable situation should there not be a risk-sharing arrangement with the federal government in place. A closer look at the data from the scenarios of terrorist attacks in New York City when TRIA was in place reveals that most of the 90 percent quota-share above the deductible would be paid by the federal government to a few large workers' compensation insurers in the state. A similar pattern emerges from the urban areas we studied in California (and to some extent in Texas) presented in Appendix 6D.

## 6.5 Who Bears the Loss if TRIA Were Made Permanent?

We now turn to the question as to how insurers will react should TRIA be made permanent in its current form. Will insurers' exposure to terrorism losses change from what it currently is under TRIA and, if so, what would be the impact on loss sharing between the affected parties following a large-scale terrorist attack on U.S. soil?

### *Determining Aggregate Exposure of Insurers*

To examine this question, assume that TRIA officially becomes a permanent program in its current form with the insurer's deductible at 15 percent of their TRIA-line direct earned premium from the previous year. All insurers know that they will have to pay for all losses they incur below this deductible ( $D$ ) and 10 percent of the loss above  $D$ , the remaining 90 percent eventually paid by other parties (taxpayers, policyholders). Consider now an insurer with a very low deductible/surplus ratios. There would be a rationale for this insurer to take advantage of the small percentage it will have to absorb if its loss exceeds the TRIA deductible ( $D$ ). Such insurers would have an incentive to write a large amount of coverage in an urban area, knowing that if they experienced a very large loss ( $L$ ) they would only have to pay 10 percent of the amount above  $D$ . In other words, if  $L > D$  their total payment would be only  $D + .1(L-D)$  rather than  $L$ .

To examine the impact of a permanent TRIA program on the amount of terrorism coverage written by insurers, we assume that each insurer is concerned with maintaining an

aggregate exposure to a deterministic scenario at 10 percent of its surplus ( $S$ )<sup>155</sup>. Let  $E$  be the *ultimate exposure* of the insurer; i.e., what it will pay after sharing part of the loss with other parties. Let  $E^*$  represent the *aggregate exposure* that an insurer is willing to risk if it is responsible for ten percent of the loss above  $D=15\%$  (i.e. the current arrangement under TRIA in 2005) and it wants to set a value of  $E/S = D + .1(E^*-D) = 10\%$ . We define an  $E^*$  *strategy* as the decision by an insurer to increase significantly the amount of coverage it provides in order to take advantage of the 90 percent risk-sharing arrangement with the government, and at the same time to collect a significant amount of terrorism insurance premiums.

As before, we focus on the locations where there is more likely to be a large terrorism loss. To make the data analysis manageable, we have limited our sample of insurers to those who already provide the largest terrorism coverage in urban areas and are likely to be interested in expanding their coverage in these large cities should TRIA be made permanent. Hence we exclude those insurers who are writing terrorism coverage almost exclusively for small businesses. That is not to say that they do not cover a large number of policyholders, but rather that their policies are diversified across the U.S. with relatively little coverage written in highly vulnerable urban areas, such as New York City, Houston or Los Angeles<sup>156</sup>. As a result it is not clear such insurers would even consider an  $E^*$  strategy should TRIA be made permanent.

We focused on the top 30 insurers based on TRIA-line direct earned premiums in 2004 and then eliminated the 7 companies who are small business and personal lines writers. This group of 23 large insurers actually accounts for about two-thirds of the TRIA-lines direct earned premiums. For the sake of simplicity, we then make the assumption that these 23 insurers cover 100 percent of the insured losses in the city we consider. We then analyze how losses would be shared under the current TRIA program and compare this with a design of a “permanent TRIA.”

For each insurer, we can determine its aggregate terrorism coverage in urban areas. For insurers with a  $D/S > 10\%$ , insurers limit their exposure to 10 percent of their surplus ( $E^*=E$ ). Those with  $D/S < 10\%$  could offer much more coverage than under the current TRIA program, particular those with very small  $D/S$  due to a large surplus ( $E^*>E$ ). Figure 6.6 depicts the impact of fixing a threshold of  $E/S=10\%$  on an insurer’s decision on how much terrorism coverage to offer for those with  $D/S>10\%$  (Insurer (a); left part of the graph) and those with  $D/S < 10\%$  (Insurer (b); right part of the graph). In both cases, there are two bars. The solid gray one on the left indicates the  $D/S$  ratio of the insurer in 2005, the one made up of oblique lines on the right indicates exposure based on the constraint that  $E/S=10\%$ .

The aggregate exposure for each of these two types of insurers is depicted in Figure 6.7. Insurer (a) will limit coverage to 10 percent of its surplus and will be responsible for

<sup>155</sup> This assumption represents a very prudent behavior. As shown in Table 6B.1 in Appendix, 17 of the top 30 insurers already have a  $D/S$  ratio equal or higher than 10% in 2005.

<sup>156</sup> Many of these insurers automatically include terrorism coverage in their customers’ policies and charge very little for this protection, often providing it free. They do so because they do not feel they will suffer a very large loss from future attacks and because it is too costly to manage collecting these small premiums on a national basis.

all its losses from a terrorist attack if  $L = E$  since  $E$  is below  $D$ . An insurer with considerable business in non-TRIA lines so that its surplus is high but its deductible is quite low will take advantage of the structure of TRIA's program should it be made permanent by increasing its aggregate exposure considerably from the current level, up to  $E^*$  (Insurer (b) here). Insurer (b) will only pay 10 percent of any loss above its deductible ( $D$ ) with the other 90 percent paid by taxpayers and possibly all policyholders under the federal government's recoupment arrangement under TRIA (the surface comprised of horizontal lines in Figure 6.7).

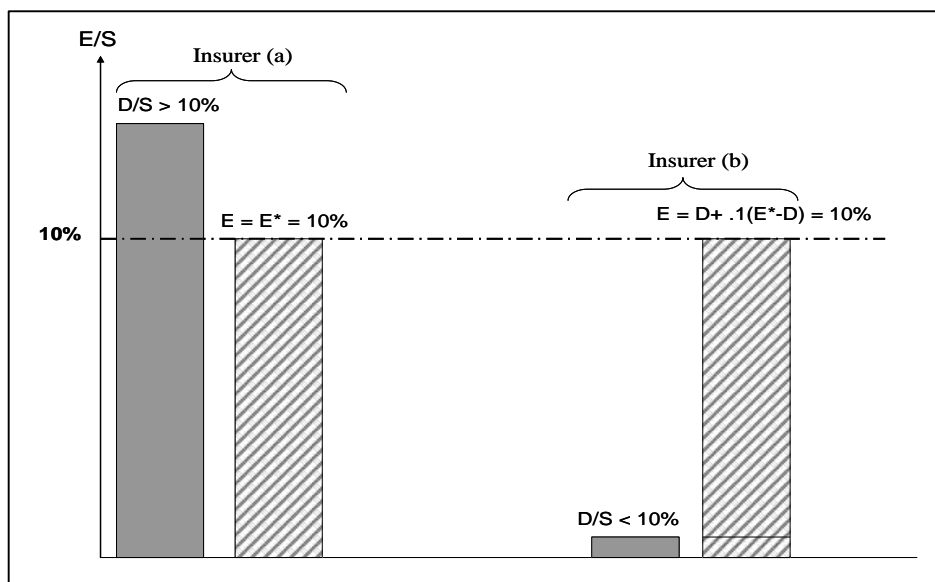


Figure 6.6 Insurer's Exposure Limited to 10% of Its Surplus

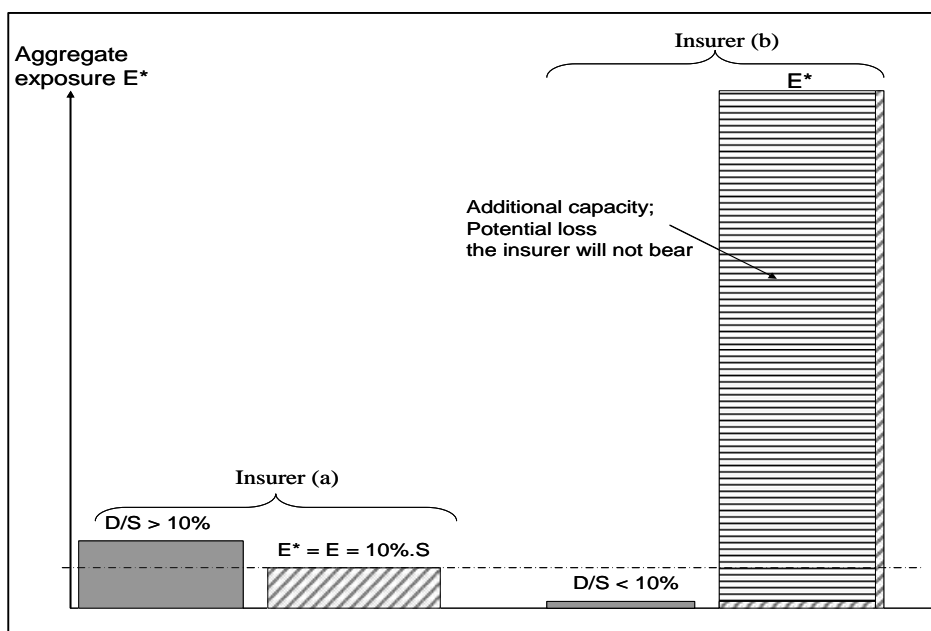


Figure 6.7 Aggregate Exposure for Insurer (a) and Insurer (b)

An important difference from the previous analyses is that market share is now based on each insurer's  $E^*$ . We assume here that  $E^*$  is comprised of both property and WC coverage. As a result the market shares of insurers providing terrorism coverage would be quite different if TRIA were made permanent. In particular, it is likely that the New York State Insurance Fund would not be the major provider of WC coverage, as its surplus is much lower than other large insurers so they are constrained in how much terrorism insurance they will want to write. The assumptions and details of the calculations for determining  $E^*$  for each insurer are provided in Appendix 6E.

Using  $E^*$  one can then determine how the coverage from a terrorist attack would be spread across insurers. Since insurers with low  $D/S$  ratios are willing to write considerably more property coverage at relatively low prices in metropolitan areas should TRIA be made permanent<sup>157</sup>, all commercial enterprises will expect to be insured against property losses (we assume a 100 percent take-up rate)<sup>158</sup>.

*Allocation of Losses Across Affected Stakeholders* Based on the above assumptions, Table 6.4 compares who pays for the losses under TRIA today and should TRIA be made permanent for two scenarios in New York City: a \$25 billion and \$100 billion terrorist attack using 5-ton truck bombs. In each scenario, the 100 percent take-up rate when TRIA is made permanent results in a shift of non-insured losses (\$7.5 billion and \$25 billion, respectively) to either all the policyholders or the general taxpayer. On first glance it seems counterintuitive that insurers will pay less for terrorism losses when their take-up rate is 100 percent rather than 50 percent. The reason is that insurers with low  $D/S$  ratios will increase their exposure very significantly as shown in Figure 6.7. Following a terrorist attack, these few insurers will be initially responsible for the largest part of the losses. Under TRIA today these losses would have been spread over a much larger number of insurers, who collectively would have absorbed more of the loss since it would fall below their values of  $D$ . In other words, under a permanent TRIA program these few insurers will end paying a very limited portion of their exposure (they actually pay  $E$  not  $E^*$ ) with the federal government covering 90 percent of the loss above their  $D$  levels. As for the other analyses we have assumed that the federal government will pay for any losses above the \$15 billion industry market retention without recoupment of any of their expenditures under the TRIA federal backstop provision.

Consider the insurance scenario with a \$25 billion loss. Since the total loss will increase from \$17.5 billion (with a 50 percent take-up rate) to \$25 billion (with a 100 percent take-up rate) the general taxpayer's share of the loss will increase from \$2.5 billion to \$10 billion; i.e. a 400 percent increase from the current TRIA program. The difference between the \$15 billion insurance industry retention and insurers' payments of \$13.3 billion will be charged against all policyholders who will experience a 288 percent increase

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<sup>157</sup> We discuss the rationale for insurers' limiting their aggregate exposures at the end of the chapter.

<sup>158</sup> It is unclear how terrorism insurance will be priced under this scenario. Insurers with low  $D/S$  ratios competing for business in urban areas will have an economic incentive to reduce their price as they expand their coverage, since they know that will be only responsible for 10% of any loss over  $D$ ; something an insurer with much limited surplus cannot do. As a result of that, a few insurers only are likely to be the major providers of coverage.

in payments. The difference in market shares induced by a few insurers playing an  $E^*$  strategy results in a 37 percent decrease in insurance industry payments, even if all losses caused by the attacks are now covered.

**Table 6.4 Distribution of Losses under TRIA Today and if TRIA is Made Permanent**  
(\$25 billion Loss in New York City)

| SCENARIOS   | Insured Loss Sharing |                 |                    |                                  |                          |
|---|----------------------|-----------------|--------------------|----------------------------------|--------------------------|
|   | Non-insured          | Total insured   | Insurers' Payments | All Policyholders <sup>159</sup> | Final Fed. Gov Taxpayers |
| <b>TRIA Today – 50% take-up rate on Property Insurance – 23 insurers</b>      |                      |                 |                    |                                  |                          |
| <b>Total: \$25bn</b><br>Property: \$15bn<br>WC: \$10bn                        | <b>\$7.5bn</b>       | <b>\$17.5bn</b> | <b>\$13.3bn</b>    | <b>\$1.7bn</b>                   | <b>\$2.5bn</b>           |
| <i>Insured loss sharing</i>   |                      |                 | 76%                | 9.8%                             | 14.2%                    |
| <b>TRIA Extended Indefinitely – 100% take-up rate – 23 insurers</b>           |                      |                 |                    |                                  |                          |
| <b>Total: \$25bn</b><br>Property: \$15bn<br>WC: \$10bn                        | <b>\$0</b>           | <b>\$25bn</b>   | <b>\$8.4bn</b>     | <b>\$6.6bn</b>                   | <b>\$10bn</b>            |
| <i>Insured loss sharing</i>   |                      |                 | 46%                | 14%                              | 40%                      |
| <b>D in final payments</b>  |                      |                 | <b>-37%</b>        | <b>+288%</b>                     | <b>+400%</b>             |
| <b>TRIA Today – 50% take-up rate (TRIA-line premium market) – 23 insurers</b> |                      |                 |                    |                                  |                          |
| <b>Total: \$100bn</b><br>Property: \$50bn<br>WC: \$50bn                       | <b>\$25bn</b>        | <b>\$75bn</b>   | <b>\$24bn</b>      | <b>\$0</b>                       | <b>51bn</b>              |
| <i>Insured loss sharing</i>   |                      |                 | 32%                | 0%                               | 68%                      |
| <b>TRIA Extended Indefinitely – 100% take-up rate– 23 insurers</b>            |                      |                 |                    |                                  |                          |
| <b>Total: \$100bn</b><br>Property: \$50bn<br>WC: \$50bn                       | <b>\$0</b>           | <b>\$100bn</b>  | <b>\$20.7bn</b>    | <b>\$0</b>                       | <b>\$79.3bn</b>          |
| <i>Insured loss sharing</i>   |                      |                 | 20.7%              | 0%                               | 79.3%                    |
| <b>D in final payments</b>  |                      |                 | <b>-14%</b>        | <b>0%</b>                        | <b>+55%</b>              |

Source: Wharton Risk Center

Consider now the more extreme case of a \$100 billion loss. Here also, when some insurers decide to significantly increase their aggregate exposure after learning that TRIA is renewed indefinitely, the insurance industry would pay considerably less in claims even though the take-up rate on property coverage is assumed to be 100 percent. More

<sup>159</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

specifically, due to their higher exposures when TRIA is extended indefinitely, the insurers will receive a larger subsidy from the federal government than they would under TRIA today. Furthermore the insurance industry loss with either a 50 percent or 100 percent take-up rate is greater than the \$15 billion market retention rate. We are assuming that the general taxpayer covers the loss above this amount so there will be no recoupment of the subsidy by the federal government and commercial policyholders will not be taxed at all. The larger total insured loss due to the increased coverage amount is passed on to the U.S. taxpayers who now absorb \$79.3 billion in loss payments compared to \$51 billion under TRIA today.

If one wants to design a program that encourages insurers to write coverage, then a permanent TRIA program will be successful in this regard due to the very large subsidy the government provides to any insurer whose losses exceed  $D$ . The very large insurers with low  $D/S$  will provide most of the coverage and pay very little after a terrorist attack compared to their aggregate exposure. They would keep all their premiums and transfer the loss to all commercial policyholders and taxpayers. Obviously there is an inequity in this system, since the policyholders of those insurers who do not suffer any loss are responsible for the same amount of repayment to the government in the form of a surcharge as those policyholders in companies who suffered large losses and were subsidized by the government.

### ***Rationale for Limiting Aggregate Exposure***

There are several reasons why insurers may not be willing to assume the large aggregate exposure implied by an  $E^*$  Strategy that need to be considered. First, a larger  $E^*$  increases the likelihood that an insurer will experience medium to large losses below its TRIA deductible  $D$  the more structures insurers cover in high-risk areas. In this sense insurers may decide to limit their aggregate exposure by estimating the likelihoods of different terrorist attack scenarios occurring and then constructing an exceedance probability curve such as the one depicted in Section 2.1. Insurers may then reduce their aggregate exposure by utilizing their survival constraint in a manner similar to the processes they follow for other catastrophic risks.

Second, when an insurer provides coverage against terrorism it also provides insurance against all other events that could cause damage or losses to their property and/or claims from their WC coverage. An insurer's decision on whether to write more terrorism coverage thus needs to consider its aggregate exposure from a much broader set of risks (e.g. fire, theft, job injury).

Insurers may be concerned that Congress will amend a permanent TRIA program should legislators observe the type of strategizing described above. Suppose insurers who expanded their coverage by focusing on  $E^*$  were to be held responsible for 50 percent of their losses above their TRIA deductible  $D$ . These insurers will very likely want to cancel some of their commercial policies for fear of incurring large claim costs after a terrorist attack. One reason why these insurers have not followed an  $E^*$  Strategy today is their concern that TRIA will not be renewed in its current form.



## Summary of Chapter 6

This chapter provides a series of empirical analyses that aim to illuminate the question of loss sharing under the current operation of TRIA, no TRIA program and a permanent TRIA program.

The first analysis computes the ratio of an insurer's deductible ( $D$ ) over surplus ( $S$ ) for the top 451 insurers in the U.S. over the three-year operation of TRIA. In 2003, only 36 insurers had a  $D/S$  ratio above 20 percent. There were 80 such insurers in 2004 and 162 such insurers in 2005 (including 8 of the top 30). The chapter and Appendix 6B also provide a set of simulations under different scenarios for renewal of TRIA through 2007 with different values of  $D$  from those currently in place.

In the second set of analyses, we focus on the distribution of losses to victims, insurers, commercially insured policyholders and the general taxpayer from a 5-ton truck bomb terrorist attack using real data for more than 400 high rises located in vulnerable metropolitan areas in three states: Texas (Dallas and Houston), California (Los Angeles and San Francisco) and New York (New York City). The results show that private insurers are likely to bear the largest portion of the loss for a \$500 million to \$25 billion attacks, mainly because of the 15 percent deductible under TRIA in 2005. Only if the damage is extremely high (e.g. \$100 billion) will the taxpayers bear a significant portion of the insured loss (over 50 percent).

The analyses also reveal that the distinction between workers' compensation lines and other TRIA lines is important as a large portion of the WC coverage is provided by only a few key insurers in California and New York State. Since workers' compensation providers will not be able to exclude terrorism from their policies if TRIA is not in place, some insurers in these states are likely to be declared insolvent after a large terrorist attack.

If TRIA is *not* extended and insurers maintain the same amount of terrorism coverage as they do today, then the amount that insurers will pay out to policyholders will not change because of the high TRIA deductible unless the insured losses are very large. The major exception is for insurers who provide extensive workers' compensation coverage, where even relatively small losses could cause significant reductions in their surplus (or even insolvency) if TRIA were not renewed.

If TRIA is renewed *indefinitely* and insurers decide to provide terrorism coverage up to a maximum exposure of 10 percent of their surplus, then those with very low deductible/surplus ratios may want to write considerably more terrorism coverage than they currently do. Should that happen, the market share distribution is likely to be significantly modified. This creates inequities, as these insurers would receive large amount of premiums and transfer most of their risk to all policyholders and taxpayers at no cost. We discuss the inherent limitations of pursuing such a strategy and why it appears not to have been used by insurers under the current TRIA program.





## APPENDIX 6A

### Responses to the Wharton Risk Center Questionnaire to Insurers

During the spring of 2005, the Wharton Risk Center, in collaboration with the American Insurance Association and Property Casualty Insurers Association of America, sent out questionnaires to 40 of their member companies to better understand their positions vis-à-vis terrorism risk.

Below, we provide answers to a selected sample of questions of this insurer questionnaire. We received 12 responses, 7 of which were from the top 10 insurers in the country that provide 50 percent of the TRIA line market.

#### Current Coverage with TRIA in Place

**Under TRIA, how important are each of the following factors when you offer coverage which includes terrorism insurance for *property losses* [including business interruption (BI)]?**<sup>160</sup> (as percentage of responders)

|   | Not at all | Very little | Modest | Significant |
|---|------------|-------------|--------|-------------|
| a. Location of risk                               | 10%        | 0%          | 10%    | 80%         |
| b. Assessment of likelihood of an attack          | 10%        | 30%         | 20%    | 40%         |
| c. Assessment of severity of an attack            | 10%        | 10%         | 20%    | 60%         |
| d. Your company's capital/capacity                | 10%        | 0%          | 20%    | 70%         |
| e. Price that can be realized                     | 10%        | 70%         | 10%    | 10%         |
| f. Availability of affordable private reinsurance | 30%        | 20%         | 30%    | 20%         |
| g. Proximity to other insured locations           | 10%        | 0%          | 20%    | 70%         |

**Under TRIA, how important are each of the following factors when you offer *workers' compensation* insurance which mandates coverage for terrorism?**

The percentages are approximately the same as in the above table.

<sup>160</sup> Ten insurers answered this question.

### Role of Scenarios

**Does your company consider scenarios in its catastrophe exposure management process?**<sup>161</sup>

Yes: **91%** No: **9%**

**If Yes, how does it use these scenarios?**

Below are some of the responses obtained from survey participants:

*“Deterministic model is used which allows loss estimates from various scenarios. Accumulations are managed against a single scenario.”*

*“We have considered a very wide variety of man made and natural CAT scenarios; inclusive of terrorism, hurricanes, earthquakes, global warming, chemical etc, not only from a Property impact, but liability exposure as well. We assume both a man made and natural CAT to occur in same time period.”*

*“We used a modeling firm information to determine what the largest probable scenarios were based on the terrorists’ resources and motive and chance for success. We did not focus on return periods.”*

*“Our company uses deterministic terrorism attack scenarios, and the associated Probable Maximum Loss (PML) estimates of these scenarios, to establish and manage exposure concentrations within major metropolitan areas and/or surrounding landmark properties.”*

*“We assess risk on two levels. 1) Individual risks, we protect the impact of a 2 Ton Truck Bomb attack. 2) On an aggregate level, we look at aggregate impact of various attack models, employing our own aggregation system and that of an outside modeling agency.”*

**Do you take estimates of the likelihood of the various known scenarios into account when making underwriting decisions? If so, in what ways?**

Below are some of the responses obtained from survey participants:

*“Terrorism estimates are viewed as one PML.”*

*“Exposure characteristics of accounts that may make it more prone to a certain type of attack (e.g., refinery, high rise, etc) are considerations for risk selection and pricing.”*

*“Our company does not believe that estimates of the frequency of terrorism attacks are credible at a country, regional or specific property level. Therefore, underwriters are only able to assess the relative risk of various properties to terrorism based on a subjective evaluation of the “attractiveness” of the property as a target and the defenses employed at*

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<sup>161</sup> Eleven insurers answered this question.

*the property to mitigate the risk of terrorism. These assessments are based largely on public perception and Federal government pronouncements on terrorist intents.”*

*“Not really. There is little historical data to predict future events.”*

*“Likelihood is very unpredictable for terrorist acts.”*

**Does your company consider the scenario of a 5-6 ton truck bomb that is detonated by terrorists in determining its exposure (or other size, specify)?<sup>162</sup>**

Yes: **70%** (5-ton truck bomb) and 20% (2-ton truck bomb)

No: **10%**

Overall 90 percent of responders use a truck bomb as a scenario to evaluate their potential exposure.

**What do you believe is the likelihood of a 5-6 ton truck bomb detonated by terrorists that will affect your company losses for each of the following time periods: the next 12 months? the next 5 years? the next 10 years? Respond by indicating your best estimate of the likelihood ratio.**

Below we indicate the range of probability we obtain among the responders<sup>163</sup>:

12 months: [**3%; 40%**]    5 years: [**7%; 80%**]    10 years: [**10%; 100%**]

These responses indicate that there is a large disparity in probability evaluation, with often a 10-fold difference between responders.

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<sup>162</sup> Ten insurers answered this question.

<sup>163</sup> Over half of responders did not answer this question and/or specifically indicated that terrorism cannot be predicted with any degree of confidence.

### Future Arrangement without TRIA

**If TRIA is not renewed, how important would each of the following factors be to your company in influencing your willingness to offer *property coverage* [including business interruption (BI)]?**<sup>164</sup> (as percentage of responders)

|   | Not at all | Very little | Modest | Significant |
|---|------------|-------------|--------|-------------|
| a. Location of risk                               | 0%         | 0%          | 10%    | 90%         |
| b. Assessment of likelihood of an attack          | 0%         | 40%         | 30%    | 30%         |
| c. Assessment of severity of an attack            | 0%         | 20%         | 20%    | 60%         |
| d. Your company's capital/capacity                | 0%         | 0%          | 10%    | 90%         |
| e. Price that can be realized,                    | 0%         | 60%         | 20%    | 20%         |
| f. Availability of affordable private reinsurance | 10%        | 0%          | 40%    | 50%         |
| g. Proximity to other insured locations           | 0%         | 0%          | 0%     | 100%        |
| h. Ability to apply sub-limit                     | 0%         | 0%          | 10%    | 90%         |
| i. Ability to exclude fire following              | 0%         | 0%          | 10%    | 90%         |

**If TRIA is not renewed, how important would each of the following factors be to your company in influencing your willingness to offer *workers' compensation coverage*?**<sup>165</sup> (as percentage of responders)

|   | Not at all | Very little | Modest | Significant |
|---|------------|-------------|--------|-------------|
| a. Location of risk                               | 0%         | 0%          | 25%    | 75%         |
| b. Assessment of likelihood of an attack          | 12.5%      | 50%         | 12.5%  | 25%         |
| c. Assessment of severity of an attack            | 0%         | 0%          | 37.5%  | 62.5%       |
| d. Your company's capital/capacity                | 0%         | 0%          | 12.5%  | 87.5%       |
| e. Price that can be realized,                    | 12.5%      | 12.5%       | 37.5%  | 37.5%       |
| f. Availability of affordable private reinsurance | 12.5%      | 0%          | 62.5%  | 25%         |
| g. Proximity to other insured locations           | 0%         | 0%          | 12.5%  | 87.5%       |
| h. Ability to exclude terrorism                   | 12.5%      | 0%          | 0%     | 87.5%       |

**How much reinsurance would your company want to purchase if TRIA is not renewed?**<sup>166</sup>

More than you currently purchase? **90%**  
The same amount that you currently purchase? **10%**  
Less than you currently purchase? **0%**

<sup>164</sup> Ten insurers answered this question.

<sup>165</sup> Eight insurers answered this question.

<sup>166</sup> Ten insurers answered this question.

**Without a government backstop like TRIA, are there any private sector solutions that can provide the necessary capacity to encourage your company to offer terrorism insurance?**

Below are some of the responses obtained from survey participants:

*“Affordable reinsurance coverage.”*

*“None that we are aware of.”*

*“Non-available that we see. Appropriate/affordable reinsurance capacity will be lacking.”*

*Possibly, but not likely. The capacity issues will limit the availability of reinsurance and the cost would be high. Private pooling possible, but would need Federal backing”*

*“It is hard to image a solution that would result in a terrorism premium that policyholders are willing to pay that matches the cost of risk transfer from insurers to reinsurers or non-insurers. The free markets, e.g. reinsurance and capital markets, largely view the risk as unattractive and uninsurable. Capacity will remain available in accordance with sound risk management principles driven largely by accumulation management techniques. Once that threshold (i.e., of sound risk management is exceeded) no further capacity will be made available. There is simply no reasonable option to address the NBCR exposure of any magnitude.”*

*“Unsure, CAT bonds, swaps and reciprocal agreements and/or pool structures have not been defined enough to date to determine impact to individual carrier solvency. We would have interest in mandated national pools.”*

### **Mitigation**<sup>167</sup>

**Are there certain terrorism mitigation measures (for example, blast-proof windows, access barriers, security x-ray stations, protective building ventilation measures) you believe should be required by some or all firms as a condition for insurance? Please be specific.**

Below are some of the responses obtained from survey participants:

*“The measures noted would help mitigate access and individual type of terrorist/vandalism perils, but not enough to mitigate any type of “certified” loss event.”*

*“No – due to the unpredictability of where an attack could take place and by what cause (NBC or bomb or aircraft) it would be unreasonable to assume all insureds can effectively guard against another attack at a cost that is feasible to each insured. With biological and chemical attacks the property damage may be limited. Liability is unpredictable. Of those listed, access barriers appear to be the most feasible and cost justifiable, relatively speaking.”*

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<sup>167</sup> For a discussion of mitigation of terrorism losses, see Section 8.1 of the report.

*“No. Most modes of terrorist attack cannot be meaningfully mitigated by an individual policyholder.”*

*“No. Availability of insurance is largely driven by concentration of values / workers. The largest insurance incentive is to those risks that are not in close proximity to other risks and which themselves do not represent a concentration of value/workers. Mitigation based on geographic diffusion should not be driven through the insurance industry. Rather, urban and suburban planning is a larger social issue for which the insurance industry will not consider all stakeholders or non-economic values.”*

**Would the requirement for terrorism mitigation measures change the coverage limit you would offer to your clients should TRIA not be renewed?<sup>168</sup>**

- ☐ Yes: **0%**
- ☐ No: **100%**

This answer is unanimously negative. When we asked why this was the case, among the responses were:

*“The type of terrorism event that would have a true financial impact on the company would not be mitigated by these control measures”*

*“Would not change likely targets, and most modes of terrorist attack cannot be meaningfully mitigated by individual policyholders”*

*“Management and upkeep of above impossible to maintain”*

**Would you be in favor of the federal government requiring certain terrorism mitigation measures to be adopted with certified third parties inspecting the facilities to determine whether these measures were adopted?<sup>169</sup>**

- ☐ Yes: **9%**

Please indicate why

*“To the extent that the federal government has ascertained that there exist effective and cost-accessible mitigation techniques that it desires to mandate, then it is appropriate for the federal government do so.”*

- ☐ No: **91%**

Here again responses are mostly negative, but the responses differ also from one participant to another. When we asked why this was the case, among all responses were:

*“Voluntary certification right, but not mandatory.”*

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<sup>168</sup> All 12 insurers answered this question.

<sup>169</sup> Eleven insurers answered this question.

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*“Most likely not. There may be the perceived value that the presence of these programs would equate to a reduction in the amount of terrorism premiums required to cover potential losses. We would disagree.”*

*“Cost and time, not cost effective and a waste of time and effort.”*

*“Unrealistic, cost prohibitive, impossible to monitor.”*

*“We do our own property inspections.”*

\* \* \* \* \*





## APPENDIX 6B

### Deductible over Surplus Ratios: 2003 to 2005, and Prospective Analyses 2006-2007

Using data provided by A.M. Best, we undertook an analysis of the top 463 companies<sup>170</sup> ranked by their 2004 TRIA lines direct earned premiums (larger than \$10 million). For each insurer, we had the following data:

- Total direct earned premiums all lines;
- Total direct earned premiums (DEP) for TRIA lines;
- Policyholder surplus (*S*).

We determined the deductible over surplus (*D/S*) ratio for the three years of TRIA operation: 2003, 2004 and 2005. Table 6B.1 provides the data for determining the *D/S* ratio for 2005 when *D*=15% and also shows these ratios for 2004 and 2003 when *D*=10% and 7% respectively for the top 30 insurers [ranked by total TRIA direct earned premiums (DEP) in 2004]. Note that in 2003, only three insurers in the top 30 had *D/S*= 15% while this number increased to 14 insurers in 2005.

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<sup>170</sup> The original sample of insurers with a 2004 total TRIA-line direct earned premium above \$10 million was made of 466 insurers; but partial data were missing for 3 of them. As discussed, among these 463 insurers, our 2004 selected sample is made of the 451 insurers that also appear in the 2002 and 2003 data sets.

**Table 6B.1 D/S Ratio for the 30 Largest Insurers under TRIA (2003-2005) (in \$ million)**

| Name                       | 2004 - DEP<br>All Lines | 2004 DEP<br>TRIA Lines | 2004<br>PHS    | Deductible<br>2005<br>(15%DEP 04) | D/S<br>2005   | D/S<br>2004   | D/S<br>2003   |
|----------------------------|-------------------------|------------------------|----------------|-----------------------------------|---------------|---------------|---------------|
| AIG                        | 33,114                  | 23,715                 | 80,607 *       | 3,557                             | 4%            | 3%            | 2%            |
| St. Paul Travelers         | 22,679                  | 16,776                 | 14,406         | 2,516                             | 17%           | 12%           | 8%            |
| Zurich/Farmers             | 27,263                  | 14,380                 | 9,259          | 2,157                             | 23%           | 18%           | 13%           |
| Liberty Mutual             | 15,613                  | 9,555                  | 8,735          | 1,433                             | 16%           | 12%           | 9%            |
| CA State Comp Ins Fund     | 8,185                   | 8,185                  | 2,863          | 1,228                             | 43%           | 37%           | 27%           |
| CNA Insurance              | 11,014                  | 8,021                  | 7,003          | 1,203                             | 17%           | 13%           | 8%            |
| Chubb                      | 9,697                   | 7,194                  | 7,765          | 1,079                             | 14%           | 11%           | 9%            |
| Hartford Insurance         | 11,027                  | 7,189                  | 11,053         | 1,078                             | 10%           | 7%            | 5%            |
| ACE INA                    | 6,766                   | 5,437                  | 2,446          | 816                               | 33%           | 22%           | 18%           |
| Nationwide                 | 14,167                  | 4,168                  | 9,140          | 625                               | 7%            | 4%            | 3%            |
| <b>TOP 10:</b>             |                         |                        |                |                                   |               |               |               |
| - Total                    | 159,526                 | 104,621                | 153,276        | 15,693                            | Mean<br>ratio | Mean<br>ratio | Mean<br>ratio |
| - Average                  | 15,953                  | 10,462                 | 15,327         | 1,569                             | 18%           | 14%           | 7%            |
| State Farm                 | 47,920                  | 4,051                  | 46,520         | 608                               | 1%            | 1%            | 1%            |
| Allianz of America         | 4,779                   | 3,482                  | 3,480          | 522                               | 15%           | 10%           | 9%            |
| W. R. Berkley              | 3,347                   | 3,256                  | 2,424          | 489                               | 20%           | 14%           | 11%           |
| Great American P&C         | 3,635                   | 2,738                  | 2,106          | 411                               | 20%           | 13%           | 10%           |
| FM Global                  | 2,583                   | 2,582                  | 3,533          | 387                               | 11%           | 10%           | 8%            |
| XL America                 | 2,891                   | 2,412                  | 1,775          | 362                               | 20%           | 14%           | 10%           |
| Cincinnati Insurance       | 3,065                   | 2,285                  | 4,191          | 343                               | 8%            | 8%            | 6%            |
| Berkshire Hathaway         | 11,033                  | 2,180                  | 48,651         | 327                               | 1%            | 0%            | 0%            |
| Auto-Owners                | 4,199                   | 2,133                  | 3,520          | 320                               | 9%            | 6%            | 4%            |
| Safeco                     | 5,497                   | 2,132                  | 3,443          | 320                               | 9%            | 7%            | 5%            |
| Progressive Insurance      | 13,484                  | 1,897                  | 4,638          | 285                               | 6%            | 3%            | 2%            |
| Old Republic General       | 2,491                   | 1,850                  | 1,834          | 277                               | 15%           | 10%           | 6%            |
| HDI U.S. Group             | 2,415                   | 1,741                  | 565            | 261                               | 46%           | 33%           | 19%           |
| Allstate Insurance         | 23,983                  | 1,617                  | 16,802         | 243                               | 1%            | 1%            | 1%            |
| Fairfax Financial (USA)    | 1,820                   | 1,549                  | 3,268          | 233                               | 7%            | 5%            | 6%            |
| Markel Corporation         | 1,766                   | 1,477                  | 1,214          | 221                               | 18%           | 13%           | 10%           |
| Arch Capital Group U.S.    | 1,638                   | 1,458                  | 520            | 219                               | 42%           | 23%           | 3%            |
| GE Global                  | 2,422                   | 1,457                  | 6,913          | 219                               | 3%            | 2%            | 2%            |
| White Mountains            | 2,642                   | 1,244                  | 2,835          | 187                               | 7%            | 4%            | 4%            |
| Erie Insurance Group       | 3,847                   | 1,231                  | 2,953          | 185                               | 6%            | 4%            | 3%            |
| <b>TOP 30</b>              |                         |                        |                |                                   |               |               |               |
| - Total                    | 304,984                 | 147,393                | 314,463        | 22,109                            | Mean<br>ratio | Mean<br>ratio | Mean<br>ratio |
| - Average                  | 10,166                  | 4,913                  | 10,482         | 737                               | 15%           | 11%           | 6%            |
| <b>TOP 463 Insurers</b>    | <b>440,527</b>          | <b>210,561</b>         | <b>425,379</b> | <b>31,585</b>                     |               |               |               |
| <b>TOP 10 Insurers (%)</b> | <b>36%</b>              | <b>50%</b>             | <b>36%</b>     | <b>50%</b>                        |               |               |               |
| <b>TOP 30 Insurers (%)</b> | <b>69%</b>              | <b>70%</b>             | <b>70%</b>     | <b>70%</b>                        |               |               |               |

\* This represents shareholders' equity rather than policyholders' surplus, which we believe is more appropriate here

\*In principle, foreign insurance groups could benefit from additional incoming capital from their headquarters should they be severely hit by a terrorist attack on the U.S. soil. However, without any written commitment *ex ante* –as most of them do not have in place to date to our knowledge—we consider surplus (PHS) of these companies as they are established on a U.S. basis only (e.g., Zurich USA).

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### **Prospective Analysis: Impact of TRIA Extended to 2007 on *D/S* ratios**

Below we show how the extension of TRIA would impact on the *D/S* ratio for the top 30 insurers in the U.S. for 2006 and 2007. We analyze the following two scenarios<sup>171</sup>:

- Scenario 1: TRIA is extended and the 15% deductible remains
- Scenario 2: TRIA is extended and the deductible is increased to 17.5% of TRIA-line direct earned premiums (DEP) in 2006, and 20% in 2007.

#### ***Methodology***

The study is undertaken for the top 30 insurers. In order to determine *D/S* (2006) and *D/S* (2007) for each company under these two scenarios, we need to know what would be their TRIA lines DEP and their surplus in 2005 and 2006 respectively. We base our analysis on the annual percentage change in these two numbers over the three-year period (2002-2004) for each of the thirty companies. We then extrapolate these figures for the next two years to estimate direct earned premiums (DEP) for TRIA lines and surplus (*S*) for 2005 and 2006. Tables 6B.2 and 6B.3 present the result of this analysis for each of the above scenarios. Should the deductibles increase to 20% in 2007, 6 of the 10 largest insurers would have a *D/S* ratio that would be 20% or greater.

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<sup>171</sup> These two scenarios correspond to bills introduced in 2004 to renew TRIA. A bill introduced by the Senate in February 2005 (S.467) and another one reintroduced by the House of Representatives in March 2005 (H.R. 1153) suggest a three-year extension of TRIA with an increase of the deductible from 15 percent in 2006 up to 20 percent in 2007 and 2008. The two analyses provided here should help determine the impact of such changes on the insurer *D/S* ratio.

**Table 6B.2 D/S Ratios for 30 Largest Insurers for Scenario 1:**  
**D=15% DEP in 2006 and 2007 (all amounts in \$ million)**

| Name                    | Projected 2006<br>TRIA Line DEP | Projected<br>surplus 2006 * | Projected.<br>Deductible 07 | D/S<br>2007<br>(15%) | D/S<br>2006<br>(15%) | D/S<br>2005<br>(15%) | D/S<br>2004<br>(10%) | D/S<br>2003<br>(7%) |
|-------------------------|---------------------------------|-----------------------------|-----------------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
| AIG                     | 32,663                          | 110,524                     | 4,899                       | 4%                   | 4%                   | 4%                   | 3%                   | 2%                  |
| St. Paul Travelers      | 20,069                          | 16,907                      | 3,010                       | 18%                  | 18%                  | 17%                  | 12%                  | 8%                  |
| Zurich/Farmers          | 18,170                          | 13,647                      | 2,725                       | 20%                  | 22%                  | 23%                  | 18%                  | 13%                 |
| Liberty Mutual          | 13,101                          | 13,307                      | 1,965                       | 15%                  | 16%                  | 16%                  | 12%                  | 9%                  |
| CA State Comp Ins Fund  | 9,024                           | 3,156                       | 1,354                       | 43%                  | 43%                  | 43%                  | 37%                  | 27%                 |
| CNA Insurance           | 9,024                           | 7,436                       | 1,353                       | 18%                  | 18%                  | 17%                  | 13%                  | 8%                  |
| Chubb                   | 9,365                           | 13,608                      | 1,405                       | 10%                  | 12%                  | 14%                  | 11%                  | 9%                  |
| Hartford Insurance      | 9,901                           | 18,006                      | 1,485                       | 8%                   | 9%                   | 10%                  | 7%                   | 5%                  |
| ACE INA                 | 7,766                           | 3,963                       | 1,165                       | 29%                  | 31%                  | 33%                  | 22%                  | 18%                 |
| Nationwide              | 5,376                           | 12,159                      | 806                         | 7%                   | 7%                   | 7%                   | 4%                   | 3%                  |
| <b>TOP 10:</b>          |                                 |                             |                             |                      |                      |                      |                      |                     |
| - Total                 | 134,459                         | 212,713                     | 20,167                      | Mean<br>ratio        | Mean<br>ratio        | Mean<br>ratio        | Mean<br>ratio        | Mean<br>ratio       |
| - Average               | 13,446                          | 21,271                      | 2,01                        | 17%                  | 18%                  | 18%                  | 14%                  | 7%                  |
| State Farm              | 4,898                           | 68,565                      | 735                         | 1%                   | 1%                   | 1%                   | 1%                   | 1%                  |
| Allianz of America      | 3,524                           | 4,626                       | 527                         | 11%                  | 13%                  | 15%                  | 10%                  | 9%                  |
| W. R. Berkley           | 5,510                           | 4,639                       | 826                         | 18%                  | 19%                  | 20%                  | 14%                  | 11%                 |
| Great American P&C      | 3,592                           | 3,109                       | 539                         | 17%                  | 18%                  | 20%                  | 13%                  | 10%                 |
| FM Global               | 3,006                           | 6,500                       | 451                         | 7%                   | 9%                   | 11%                  | 10%                  | 8%                  |
| XL America              | 3,560                           | 2,824                       | 534                         | 19%                  | 20%                  | 20%                  | 14%                  | 10%                 |
| Cincinnati Insurance    | 2,600                           | 7,622                       | 390                         | 5%                   | 6%                   | 8%                   | 8%                   | 6%                  |
| Berkshire Hathaway      | 2,941                           | 84,182                      | 441                         | 1%                   | 1%                   | 1%                   | 0%                   | 0%                  |
| Auto-Owners             | 3,032                           | 4,346                       | 455                         | 10%                  | 10%                  | 9%                   | 6%                   | 4%                  |
| Safeco                  | 2,560                           | 4,699                       | 384                         | 8%                   | 9%                   | 9%                   | 7%                   | 5%                  |
| Progressive Insurance   | 3,059                           | 6,508                       | 459                         | 7%                   | 7%                   | 6%                   | 3%                   | 2%                  |
| Old Republic General    | 2,501                           | 2,215                       | 375                         | 17%                  | 16%                  | 15%                  | 10%                  | 6%                  |
| HDI U.S. Group          | 1,957                           | 561                         | 294                         | 52%                  | 49%                  | 46%                  | 33%                  | 19%                 |
| Allstate Insurance      | 1,942                           | 20,531                      | 291                         | 1%                   | 1%                   | 1%                   | 1%                   | 1%                  |
| Fairfax Financial (USA) | 1,299                           | 4,832                       | 195                         | 4%                   | 5%                   | 7%                   | 5%                   | 6%                  |
| Markel Corporation      | 1,990                           | 1,967                       | 298                         | 15%                  | 17%                  | 18%                  | 13%                  | 10%                 |
| Arch Capital Group U.S. | 3,323                           | 663                         | 499                         | 75%                  | 56%                  | 42%                  | 23%                  | 3%                  |
| GE Global               | 1,478                           | 8,467                       | 221                         | 3%                   | 3%                   | 3%                   | 2%                   | 2%                  |
| White Mountains         | 996                             | 3,181                       | 149                         | 5%                   | 6%                   | 7%                   | 4%                   | 4%                  |
| Erie Insurance Group    | 1,724                           | 3,967                       | 258                         | 7%                   | 6%                   | 6%                   | 4%                   | 3%                  |
| <b>TOP 30</b>           |                                 |                             |                             |                      |                      |                      |                      |                     |
| - Total                 | 189,951                         | 456,717                     | 28,488                      | Mean ratios          |                      |                      |                      |                     |
| - Average               | 6,332                           | 15,224                      | 950                         | 15%                  | 15%                  | 15%                  | 11%                  | 6%                  |

\* This represents shareholders' equity rather than policyholders' surplus, which we believe is more appropriate here.

**Table 6B.3 D/S Ratios for 30 Largest Insurers for Scenario 2:**  
**D=17.5% DEP in 2006 and 20% DEP in 2007** (all amounts in \$ million)

| Name                    | Projected 2006<br>TRIA Line DEP | Projected 2006<br>surplus | Projected.<br>Deductible 07 | D/S<br>2007<br>(20%) | D/S<br>2006<br>(17.5%) | D/S<br>2005<br>(15%) | D/S<br>2004<br>(10%) | D/S<br>2003<br>(7%) |
|-------------------------|---------------------------------|---------------------------|-----------------------------|----------------------|------------------------|----------------------|----------------------|---------------------|
| AIG                     | 32,663                          | 110,524*                  | 6,533                       | 6%                   | 5%                     | 4%                   | 3%                   | 2%                  |
| St. Paul Travelers      | 20,069                          | 16,907                    | 4,014                       | 24%                  | 21%                    | 17%                  | 12%                  | 8%                  |
| Zurich/Farmers          | 18,170                          | 13,647                    | 3,634                       | 27%                  | 25%                    | 23%                  | 18%                  | 13%                 |
| Liberty Mutual          | 13,101                          | 13,307                    | 2,620                       | 20%                  | 18%                    | 16%                  | 12%                  | 9%                  |
| CA State Comp Ins Fund  | 9,024                           | 3,156                     | 1,805                       | 57%                  | 50%                    | 43%                  | 37%                  | 27%                 |
| CNA Insurance           | 9,024                           | 7,436                     | 1,805                       | 24%                  | 21%                    | 17%                  | 13%                  | 8%                  |
| Chubb                   | 9,365                           | 13,608                    | 1,873                       | 14%                  | 14%                    | 14%                  | 11%                  | 9%                  |
| Hartford Insurance      | 9,901                           | 18,006                    | 1,980                       | 11%                  | 10%                    | 10%                  | 7%                   | 5%                  |
| ACE INA                 | 7,766                           | 3,963                     | 1,553                       | 39%                  | 37%                    | 33%                  | 22%                  | 18%                 |
| Nationwide              | 5,376                           | 12,159                    | 1,075                       | 9%                   | 8%                     | 7%                   | 4%                   | 3%                  |
| <b>TOP 10:</b>          |                                 |                           |                             | Mean                 | Mean                   | Mean                 | Mean                 | Mean                |
| - Total                 | 134,459                         | 212,713                   | 26,892                      | ratio                | ratio                  | ratio                | ratio                | ratio               |
| - Average               | 13,446                          | 21,271                    | 2,689                       | 23%                  | 21%                    | 18%                  | 14%                  | 7%                  |
| State Farm              | 4,898                           | 68,565                    | 980                         | 1%                   | 1%                     | 1%                   | 1%                   | 1%                  |
| Allianz of America      | 3,524                           | 4,626                     | 701                         | 15%                  | 15%                    | 15%                  | 10%                  | 9%                  |
| W. R. Berkley           | 5,510                           | 4,639                     | 1,102                       | 24%                  | 22%                    | 20%                  | 14%                  | 11%                 |
| Great American P&C      | 3,592                           | 3,109                     | 715                         | 23%                  | 21%                    | 20%                  | 13%                  | 10%                 |
| FM Global               | 3,006                           | 6,500                     | 601                         | 9%                   | 10%                    | 11%                  | 10%                  | 8%                  |
| XL America              | 3,560                           | 2,824                     | 712                         | 25%                  | 23%                    | 20%                  | 14%                  | 10%                 |
| Cincinnati Insurance    | 2,600                           | 7,622                     | 520                         | 7%                   | 8%                     | 8%                   | 8%                   | 6%                  |
| Berkshire Hathaway      | 2,941                           | 84,182                    | 588                         | 1%                   | 1%                     | 1%                   | 0%                   | 0%                  |
| Auto-Owners             | 3,032                           | 4,346                     | 606                         | 14%                  | 11%                    | 9%                   | 6%                   | 4%                  |
| Safeco                  | 2,560                           | 4,699                     | 512                         | 11%                  | 10%                    | 9%                   | 7%                   | 5%                  |
| Progressive Insurance   | 3,059                           | 6,508                     | 611                         | 9%                   | 8%                     | 6%                   | 3%                   | 2%                  |
| Old Republic General    | 2,501                           | 2,215                     | 500                         | 23%                  | 19%                    | 15%                  | 10%                  | 6%                  |
| HDI U.S. Group          | 1,957                           | 561                       | 391                         | 70%                  | 57%                    | 46%                  | 33%                  | 19%                 |
| Allstate Insurance      | 1,942                           | 20,531                    | 388                         | 2%                   | 2%                     | 1%                   | 1%                   | 1%                  |
| Fairfax Financial (USA) | 1,299                           | 4,832                     | 260                         | 5%                   | 6%                     | 7%                   | 5%                   | 6%                  |
| Markel Corporation      | 1,990                           | 1,967                     | 398                         | 20%                  | 19%                    | 18%                  | 13%                  | 10%                 |
| Arch Capital Group U.S. | 3,323                           | 663                       | 665                         | 100%                 | 66%                    | 42%                  | 23%                  | 3%                  |
| GE Global               | 1,478                           | 8,467                     | 296                         | 3%                   | 3%                     | 3%                   | 2%                   | 2%                  |
| White Mountains         | 996                             | 3,181                     | 199                         | 6%                   | 6%                     | 7%                   | 4%                   | 4%                  |
| Erie Insurance Group    | 1,724                           | 3,967                     | 345                         | 9%                   | 7%                     | 6%                   | 4%                   | 3%                  |
| <b>TOP 30</b>           |                                 |                           |                             |                      |                        |                      |                      |                     |
| - Total                 | 189,951                         | 456,717                   | 37,982                      | Mean ratios          |                        |                      |                      |                     |
| - Average               | 6,332                           | 15,224                    | 1,266                       | 20%                  | 18%                    | 15%                  | 11%                  | 6%                  |

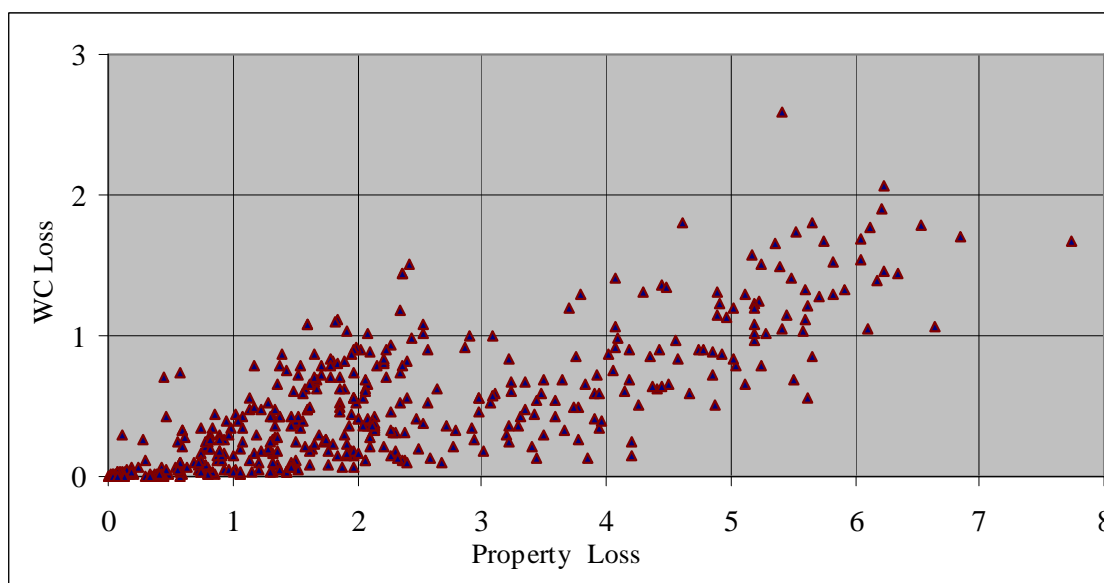
\* As in other tables, this represents shareholders' equity rather than policyholders' surplus.



## APPENDIX 6C

### Comparison of Aircraft Scenario with 5-Ton Truck Bomb Scenario: Simulations of Attacks to 447 High-Rise Buildings in the United States<sup>172</sup>

Similar simulations can be undertaken with an aircraft crashing against each of the 447 high-rise buildings that we considered in the body of the chapter for the 5-ton truck bomb scenario. Figure 6C.1 provides the magnitude of loss for property and workers' compensation for each of the 447 simulations. An important result emerging from this series of simulations is that WC maximum losses are likely to be capped at \$3 billion and property at \$8 billion for different buildings. Should simultaneous attacks occur in different locations, the losses would be additive.



**Figure 6C.1 Property Losses and Workers' Compensation Losses from Aircraft Attacks to 447 High-Rise Buildings in the United States (in \$ billion)**

<sup>172</sup> RMS and RAND provided the Wharton Risk Center with the data on the aircraft scenarios.

The next two series compare, for the same building, the impact of an aircraft vs. a 5-ton truck bomb for (1) property and (2) workers' compensation.

### Property damage

Points D and E in Figure 6C.2 are specific buildings in one of the major metropolitan areas. Figure 6C.2 indicates that the deterministic scenario with an aircraft crashing against Building E would lead to nearly \$5.5 billion in property losses (including business interruption). A 5-ton truck bomb in the same building will inflict about the same level of loss. Consider Building D. While an aircraft would inflict about \$2.5 billion in damage, a 5-ton truck bomb would be much more devastating (including damage to buildings located nearby) with estimated property losses at nearly \$6.7 billion.

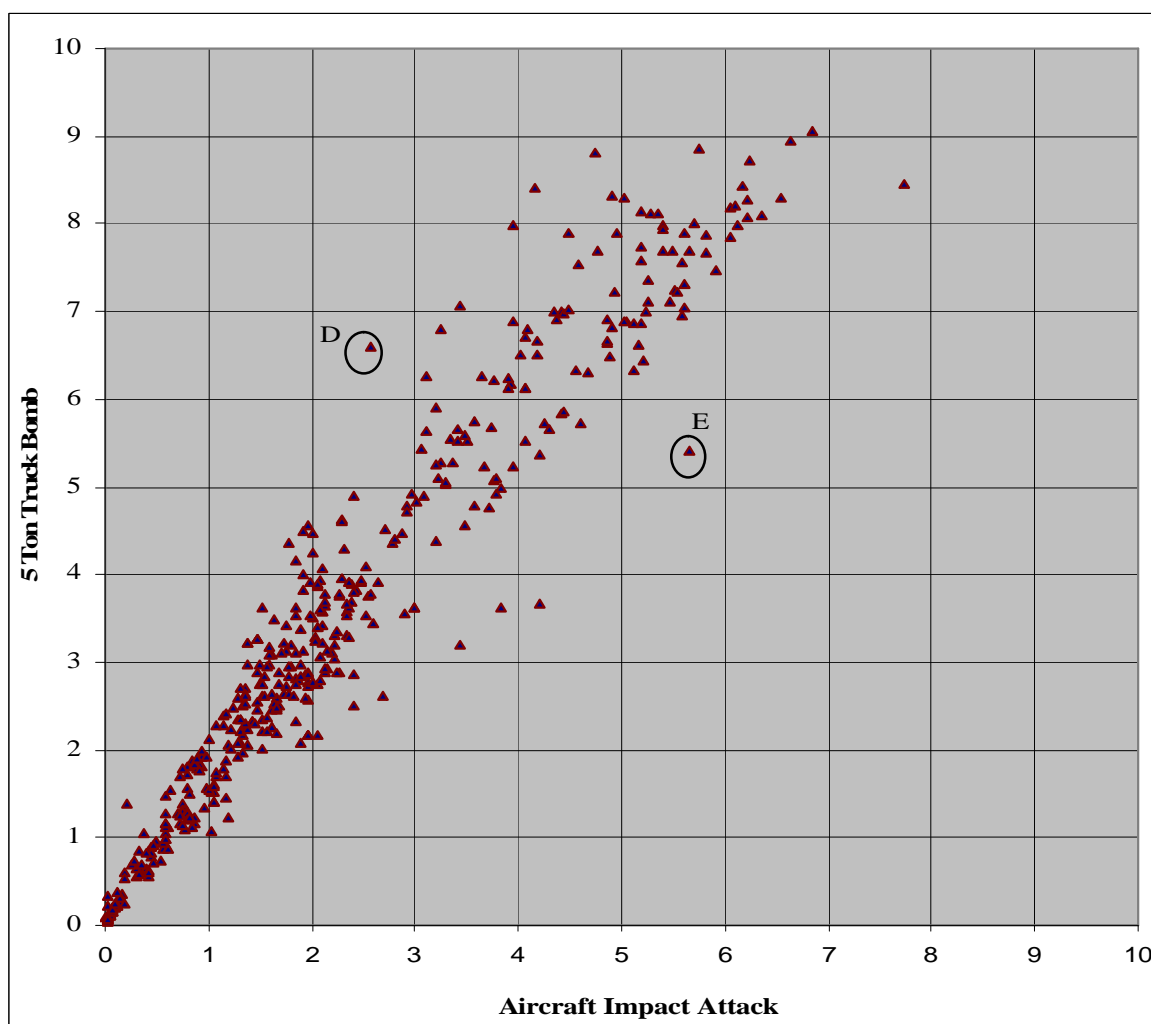
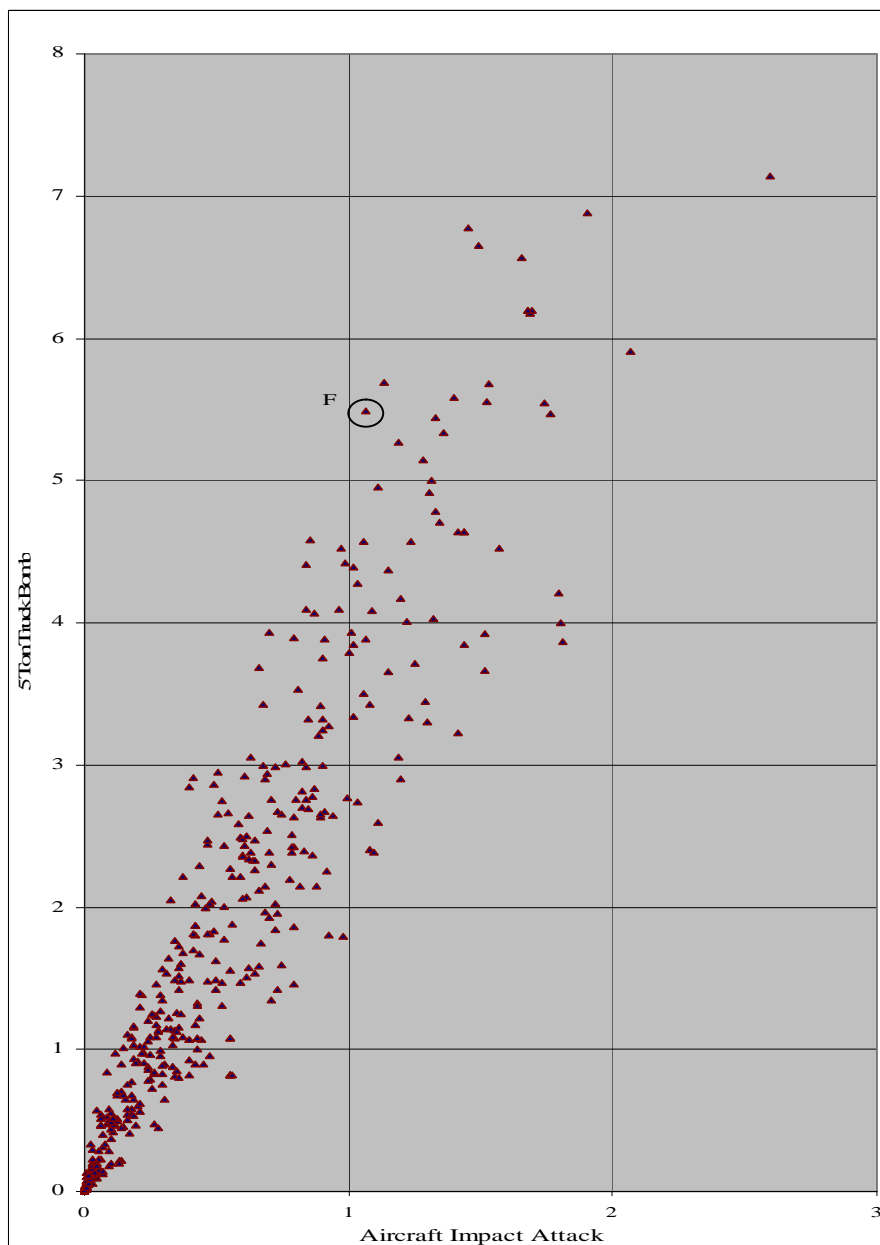


Figure 6C.2 Comparison of Property Loss Due to Aircraft Impact vs. a 5-ton Truck Bomb to 447 High-Rise Buildings in the United States (in \$ billion)



### ***Workers' Compensation***

Differences in estimated loss between the two types of attack are even greater for workers' compensation as shown in Fig. 6C.3 because the explosion of a bomb is much more likely to result in a large number of casualties and injuries than an aircraft crash. Consider Building F. The impact on WC might be five times as large in the case of a 5-ton truck bomb than if an aircraft were to crash into it.



**Figure 6C.3 Comparison of WC Loss from Aircraft Impact vs. 5-ton Truck Bomb to 447 High-Rise Buildings in the United States (in \$ billion)**



## APPENDIX 6D

### Loss sharing under TRIA in Metropolitan Areas in California and Texas

#### Sensitivity Analysis with Different Damage Levels from Terrorism Attacks

To analyze the impact of the magnitude of the damage on loss sharing we vary the total damage from \$0.5 billion to \$100 billion. The two tables below show how the loss is shared between the affected stakeholders as the magnitude of total damage increases.

**Table 6D.1 Los Angeles and San Francisco, California (Take-up rate property: 50%)**

| CA   | Non-insured | Insured Loss Sharing |                          |                                  |                          |
|--|-------------|----------------------|--------------------------|----------------------------------|--------------------------|
|  |             | Total insured        | Insurers' Payments       | All Policyholders <sup>173</sup> | Final Fed. Gov Taxpayers |
| Scenarios (total loss)                               |             |                      |                          |                                  |                          |
| Total: \$0.5bn<br>Property: \$0.25bn<br>WC: \$0.25bn | \$125mi     | \$375mi              | \$375mi                  | \$0                              | \$0                      |
| % total insured                                      |             |                      | 100%                     | 0%                               | 0%                       |
| Total: \$5bn<br>Property: \$2.5bn<br>WC: \$2.5bn     | \$1.25bn    | \$3.75bn             | \$3.675bn <sup>174</sup> | \$75mi                           | \$0                      |
| % total insured                                      |             |                      | 98%                      | 2%                               | 0%                       |
| Total: \$15bn<br>Property: \$9bn<br>WC: \$6bn        | \$4.5bn     | \$10.5bn             | \$8.5bn                  | \$2bn                            | \$0                      |
| % total insured                                      |             |                      | 71%                      | 19%                              | 0%                       |
| Total: \$25bn<br>Property: \$15bn<br>WC: \$10bn      | \$7.5bn     | \$17.5bn             | \$13.1bn                 | \$1.9bn                          | \$2.5bn                  |
| % total insured                                      |             |                      | 75%                      | 11%                              | 14%                      |
| Total: \$40bn<br>Property: \$28bn<br>WC: \$12bn      | \$14bn      | \$26bn               | \$20.35bn                | \$0                              | \$5.65bn                 |
| % total insured                                      |             |                      | 78%                      | 0%                               | 22%                      |
| Total: \$40bn<br>Property: \$12bn<br>WC: \$28bn      | \$6bn       | \$34bn               | \$18.9bn                 | 0\$                              | \$15.1bn                 |
| % total insured                                      |             |                      | 56%                      | 0%                               | 44%                      |
| Total: \$100bn<br>Property: \$50bn<br>WC: \$50bn     | \$25bn      | \$75bn               | \$35.8bn                 | \$0                              | \$39.2bn <sup>175</sup>  |
| % total insured                                      |             |                      | 48%                      | 0%                               | 52%                      |

<sup>173</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

<sup>174</sup> Including \$1.2 billion paid by the State Comp Insurance Fund of CA for workers' compensation.

<sup>175</sup> Including \$21.8 billion that would represent the 90% federal payment above the State Compensation Insurance Fund of California TRIA deductible.

**Table 6D.2 Houston and Dallas, Texas (Take-up rate property: 50%)**

| <b>TX</b>   | <b>Insured Loss Sharing</b> |                      |                           |  |                                 |
|---|-----------------------------|----------------------|---------------------------|--|---------------------------------|
|   | <b>Non-insured</b>          | <b>Total insured</b> | <b>Insurers' Payments</b> | <b>All Policyholders<sup>176</sup></b> | <b>Final Fed. Gov Taxpayers</b> |
| <b>Scenarios (total loss)</b>                               |                             |                      |                           |  |                                 |
| <b>Total: \$0.5bn</b><br>Property: \$0.25bn<br>WC: \$0.25bn | <b>\$125mi</b>              | <b>\$375mi</b>       | <b>\$375mi</b>            | <b>\$0</b>                             | <b>\$0</b>                      |
| <i>% total insured</i>                                      |                             | <i>100%</i>          | <i>0%</i>                 | <i>0%</i>                              |                                 |
| <b>Total: \$5bn</b><br>Property: \$2.5bn<br>WC: \$2.5bn     | <b>\$1.25bn</b>             | <b>\$3.75bn</b>      | <b>\$3.2bn</b>            | <b>\$550mi</b>                         | <b>\$0</b>                      |
| <i>% total insured</i>                                      |                             | <i>85.3%</i>         | <i>14.7%</i>              | <i>0%</i>                              |                                 |
| <b>Total: \$15bn</b><br>Property: \$9bn<br>WC: \$6bn        | <b>\$4.5bn</b>              | <b>\$10.5bn</b>      | <b>\$8.9bn</b>            | <b>\$1.56bn</b>                        | <b>\$0</b>                      |
| <i>% total insured</i>                                      |                             | <i>84.7%</i>         | <i>15.3%</i>              | <i>0%</i>                              |                                 |
| <b>Total: \$25bn</b><br>Property: \$15bn<br>WC: \$10bn      | <b>\$7.5bn</b>              | <b>\$17.5bn</b>      | <b>\$14.5bn</b>           | <b>\$0.5bn</b>                         | <b>\$2.5bn</b>                  |
| <i>% total insured</i>                                      |                             | <i>82.9%</i>         | <i>2.9%</i>               | <i>14.2%</i>                           |                                 |
| <b>Total: \$40bn</b><br>Property: \$28bn<br>WC: \$12bn      | <b>\$14bn</b>               | <b>\$26bn</b>        | <b>\$21.8bn</b>           | <b>\$0</b>                             | <b>\$4.2bn</b>                  |
| <i>% total insured</i>                                      |                             | <i>83.9%</i>         | <i>0%</i>                 | <i>16.1%</i>                           |                                 |
| <b>Total: \$40bn</b><br>Property: \$12bn<br>WC: \$28bn      | <b>\$6bn</b>                | <b>\$34bn</b>        | <b>\$20.6bn</b>           | <b>\$0</b>                             | <b>\$13.4bn</b>                 |
| <i>% total insured</i>                                      |                             | <i>60%</i>           | <i>0%</i>                 | <i>40%</i>                             |                                 |
| <b>Total: \$100bn</b><br>Property: \$50bn<br>WC: \$50bn     | <b>\$25bn</b>               | <b>\$75bn</b>        | <b>\$41bn</b>             | <b>\$0</b>                             | <b>\$34bn</b>                   |
| <i>% total insured</i>                                      |                             | <i>54.7%</i>         | <i>0%</i>                 | <i>45.3%</i>                           |                                 |

<sup>176</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

### Sensitivity Analysis with Different Terrorism Insurance Take-up Rates

In order to analyze the impact of policyholder's take-up rate on loss sharing, we consider the scenario with \$25 billion with \$15 billion damage in property (including business interruption) and \$10 billion in workers' compensation for California (Los Angeles or San Francisco) and Texas (Dallas or Houston). The two tables below, 6D.3 and 6D.4, show how the loss is shared between the affected stakeholders as the percentage insured increases from 0% to 100%. The results differ between the two states due to different market shares of insurers providing workers' compensation.

Table 6D.3 Loss Sharing Scenarios for California

| CA           | Insured Loss Sharing |               |                    |                                  |                          |
|--------------|----------------------|---------------|--------------------|----------------------------------|--------------------------|
|              | Non-insured          | Total insured | Insurers' Payments | All Policyholders <sup>177</sup> | Final Fed. Gov Taxpayers |
| Take-up rate |                      |               |                    |                                  |                          |
| 0%           | \$15bn               | \$10bn        | \$5.8bn            | \$4.2                            | \$0                      |
|              | % total insured      |               | 58%                | 42%                              | 0%                       |
| 25%          | \$11.25bn            | \$13.75bn     | \$9.47bn           | \$4.28bn                         | \$0                      |
|              | % total insured      |               | 69%                | 31%                              | 0%                       |
| 50%          | \$7.5bn              | \$17.5bn      | \$13.1bn           | \$1.9bn                          | \$2.5bn                  |
|              | % total insured      |               | 75%                | 11%                              | 14%                      |
| 75%          | \$3.75bn             | \$21.25bn     | \$16.85bn          | \$0                              | \$4.4bn                  |
|              | % total insured      |               | 79.4%              | 0%                               | 20.6%                    |
| 100%         | \$0                  | \$25bn        | \$20.5bn           | \$0                              | \$4.5bn                  |
|              | % total insured      |               | 82%                | 0%                               | 18%                      |

<sup>177</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

Table 6D.4 Loss Sharing Scenarios for Texas

| <u>TX</u>    | Insured Loss Sharing |               |                    |                                  |                          |
|--------------|----------------------|---------------|--------------------|----------------------------------|--------------------------|
|              | Non-insured          | Total insured | Insurers' Payments | All Policyholders <sup>178</sup> | Final Fed. Gov Taxpayers |
| Take-up rate |                      |               |                    |                                  |                          |
| 0%           | \$15bn               | \$10bn        | \$7.2bn            | \$2.8bn                          | \$0                      |
|              | % total insured      |               | 72%                | 28%                              | 0%                       |
| 25%          | \$11.25bn            | \$13.75bn     | \$10.85            | \$2.9bn                          | \$0                      |
|              | % total insured      |               | 79%                | 21%                              | 0%                       |
| 50%          | \$7.5bn              | \$17.5bn      | \$14.5bn           | \$0.5bn                          | \$2.5bn                  |
|              | % total insured      |               | 82.9%              | 2.9%                             | 14.2%                    |
| 75%          | \$3.75bn             | \$21.25bn     | \$18.1             | \$0                              | \$3.15bn                 |
|              | % total insured      |               | 85.1%              | 0%                               | 14.9%                    |
| 100%         | \$0                  | \$25bn        | \$21.6bn           | \$0                              | \$3.4bn                  |
|              | % total insured      |               | 86.4%              | 0%                               | 13.6%                    |

<sup>178</sup> The federal government is assumed to recoup the portion of insured loss it initially paid above insurers' payments up to an industry aggregate of \$15 billion in 2005.

## APPENDIX 6E

### Implications of Extending TRIA Indefinitely on Coverage Offered by Insurers

This Appendix determines the amount of terrorism coverage an insurer might want to offer if TRIA were extended indefinitely and insurers only have to pay 10 percent of any insured losses that exceed their TRIA deductible. TRIA requires all commercial policyholders to equally share the amount of any of these subsidized claims over a period of time that Treasury will determine based on the economic impact of the disaster on the economy and the insurance industry.

There is an economic incentive for any insurer with a low deductible/surplus ( $D/S$ ) ratio to write a large number of policies in a concentrated area (e.g. Times Square, Wall Street area) subject to a terrorist attack due to the positive correlation in these losses. In other words, the insurer knows that if one of these buildings is damaged or destroyed, the surrounding ones are also likely to suffer severe damage.

As discussed in Section 6.5, there are several factors that may inhibit the insurer from writing a large amount of coverage in one vulnerable area:

- Rating agencies may consider downgrading the insurer's rating if its *aggregate exposure/surplus ratio* exceeds a certain level for its terrorism exposure.
- The insurer may consider its survival constraint and want to keep the likelihood of claims from a terrorist attack exceeding  $L^*$  below some predetermined value  $p_l$  (see Section 2.1). The value of  $L^*$  is the loss in surplus that will cause financial concern to the insurer. The more structures that it insures, the higher the probability that the insurer's loss will be greater than  $L^*$ .
- Some insurers are very concerned about their 10 percent quota share above their TRIA deductible, particularly when thinking about nuclear, biological, chemical and radiological (NBCR) risks.

Below we examine how the aggregate exposure/surplus ratio impacts on the amount of coverage an insurer will want to provide if TRIA is extended indefinitely.

#### *Notation*

- $E^*$  = maximum insured terrorism exposure (i.e. deterministic scenario)
- $E$  = actual dollar claims incurred by an insurer from a deterministic scenario
- DEP = direct earned premiums written for TRIA lines of coverage
- $D = aDEP$  = TRIA deductible determined by the percentage  $a$  (e.g.  $a = 15\%$  in 2005)
- $S$  = current surplus
- $X = E/S$  = aggregate exposure for terrorism/surplus ratio
- $Y = D/S$  = deductible/surplus ratio

### Maximum Insured Terrorism Exposure

Given the difficulties in estimating the probability of a terrorist attack, rating agencies focus on deterministic scenarios in evaluating an insurer's credit rating. In discussions with A.M. Best they indicated that the scenario they focus on is the damage a 5-to-6-ton truck bomb will do to an insurer's portfolio of terrorism insurance. Hence we focus on insured losses from such a scenario in determining the maximum exposure an insurer will want to have. If an insurer experiences insured losses of  $E^*$  it determines its dollar claims ( $E$ ) as follows:

$$E = E^* \quad \text{if } E^* \leq D \quad (6E.1)$$

$$E = D + .1 (E^* - D) \quad \text{if } E^* > D \quad (6E.2)$$

Suppose that the maximum amount of terrorism exposure ( $E^*$ ) that an insurer wants to write is determined by a desired aggregate exposure/surplus ( $E/S$ ) ratio given by  $x$  (e.g.  $x = 10\%$ ). To determine the value of  $E^*$  the insurer first computes  $D/S = y$  and compares the value of  $y$  with  $x$ .

- *Condition 1:*  $y = x$ . The insurer knows that its claims are determined by (6E.1) (i.e.  $E = E^*$ ), since it is responsible for the entire loss on its own given that  $D/S > x$ . It thus sets  $E^* = xS$ .
- *Condition 2:*  $y < x$ . The insurer knows that its claims are determined by (6E.2) and the government will cover 90 percent of the insured loss above its TRIA deductible  $D$  given the federal backstop provision of TRIA. In this case, the insurer computes  $E/S = D/S + .1 (E^*/S - D/S)$  which can be written as

$$x = y + .1(E^*/S - y) \quad \text{or}$$

$$\boxed{E^* = (10x - 9y)S}$$

### Illustrative Example Determining $E^*$ Under TRIA

Let  $D=10$   $S=200$   $y=.05$   $x=.10$

Since  $y < x$ , Condition 2 holds and  $E^*$  is determined as follows:

$$E^* = (1 - 0.45) 200 = 110$$

Note: If an insurer were responsible for the entire loss, then  $E = E^*$  for all values of  $E^*$  so that  $E^* = xS$ . For this illustrative example  $E^* = .10(200) = 20$ , which is considerably lower.



## CHAPTER 7

### Supply of Insurance Following a Terrorist Attack

The previous chapter provided empirical analyses loss sharing arrangements between victims, insurers, policyholders and taxpayers should a terrorist attack occur on U.S. soil. This chapter discusses in more detail what is likely to be the *insurance market's reaction* in the aftermath of an attack with and without TRIA in place.

#### 7.1 Dynamics of Insurance Markets Following Catastrophes

Several studies have estimated the impact of 9/11 on the insurance market in particular and on the economy in general<sup>179</sup>. To what extent can we forecast the impact of a future major terrorism event? Fortunately, we understand much of the dynamics of insurance markets and there is a body of tested theory to help this exercise. While there are imponderables concerning the nature and size of the event and the political and military responses on the economic impacts, we can develop some likely scenarios.

Insurance markets are subject to periodic major shocks, when insurers are faced with an enormous influx of claims that seriously deplete their capital. Of course 9/11 was one such event, but in terms of its financial impact on the insurance industry, it was not unique. Earthquakes such as the 1989 Loma Prieta and 1994 Northridge disasters in California, and hurricanes, such as Hurricane Andrew in 1992 and the four hurricanes in Florida during the fall of 2004, all caused severe and sudden stress to the insurance industry. For example, Hurricane Andrew and the 2004 Florida hurricanes, when compared to other limited natural events, were of the same order of magnitude for the U.S. market (each over \$20 billion in today's dollars) as 9/11 (on the order of \$33 billion). Moreover, the losses from these storms were more quickly measured and settled than for 9/11 (where some liability claims may not be paid fully for many years), thus creating more immediate liquidity problems for some insurers.

The insurance market responds to sudden massive losses, whether from natural events or terrorism, in a fairly predictable way. Indeed, this response was first noticed after a different event, the sudden explosion of liability losses in the mid 1980s. A body of theory was developed to understand this event and has subsequently been used to explain the more recent catastrophic losses to the industry. This model was originally developed

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<sup>179</sup> Doherty N., Lamm-Tennant J. and Starks L. (2003), "Insuring September 11th. Market Recovery and Transparency", *Journal of Risk and Uncertainty*, 26: 2/3, pp. 179-199; Cummins, J.D. and Lewis, C. (2003), "Catastrophic Events, Parameter Uncertainty and the Breakdown of Implicit Long-Term Contracting: The Case of Terrorism Insurance," *Journal of Risk and Uncertainty*, 26, pp. 153-178.

independently by Ralph Winter (1988, 1991)<sup>180</sup> and Anne Gron (1994)<sup>181</sup> and subsequently expanded by Doherty and Posey (1997)<sup>182</sup>.

The Gron-Winter model is known as the *capacity constraint model*. In normal times, the supply of insurance is quite elastic (quantity of insurance available is highly dependent on price) and price is determined where supply equals demand. The supply elasticity is due in part to fairly low barriers to entry in the insurance industry. During normal times, prices tend to be competitive with insurers earning fairly low returns on their equity. Such times are known as “soft markets”. However, when a sudden flood of claims (e.g. from Andrew or 9/11), hits many insurers simultaneously, all suffer a loss of capital (or “surplus”). As pointed out in Chapters 2 and 4, the amount of coverage an insurance company will want to write is limited by its surplus. Hence, insurers start to cut back on their supply after a catastrophe if their surplus is significantly reduced.

This scarcity of supply is exacerbated by a concomitant increase in demand for insurance. After hurricanes, floods, earthquakes and terrorist attacks, people and firms want coverage for such events (Kunreuther, 1997)<sup>183</sup>. Thus, in the capacity constraint model, major catastrophes are followed by an increase in demand and a decrease in supply, which causes a “hard market” in which less insurance is traded and at higher prices. The immediate period following a major loss tends to be quite profitable for the insurance industry given the fixed supply and the increase in demand, which translates into higher premiums. However, the hard market attracts new capital and eventually supply expands with an ultimate softening of the market.

The capacity constraint model has been tested many times and these studies show that the insurance market does indeed behave as the theory predicts<sup>184</sup>. For example, after Andrew, there was a hardening of the market, but this created opportunities for new capital to exploit the high returns. This led to the establishment of a number of start-up insurers (notably the new Bermuda companies, the so called “class of ’92”). Eventually, the market settled down and prices and capacity returned to normal levels. Similarly, even before 9/11, insurance prices increased and insurers had their best underwriting results in 2001 for the past decade or more. New capacity was added (including start ups); only in 2004/5 did the market start to soften, partly delayed by the 2004 hurricanes in Florida<sup>185</sup>.

An important feature of a hard market is that it affects other lines of insurance, in addition to those affected by specific disasters. After Hurricane Andrew, most lines of insurance tended to be more expensive. After 9/11, terrorism insurance was certainly scarce and expensive but other insurance lines also saw price increases. Insurance

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<sup>180</sup> Winter, R. A. (1988), "The Liability Crisis and the Dynamics of Competitive Insurance Markets", *Yale Journal on Regulation*, Summer, 5, pp. 455-500. Winter, R. A., 1991 "The Liability Insurance Market", *Journal of Economic Perspectives*, Summer, 5, pp. 115-136.

<sup>181</sup> Gron, A. (1994), "Capacity Constraints and Cycles in Property-Casualty Insurance Markets", *RAND Journal of Economics*, Spring, 25, pp. 110-127.

<sup>182</sup> Doherty, N. A. and Posey, L. L., (1997), "Availability Crises in Insurance Markets: Optimal Contracts with Asymmetric Information and Capacity Constraints" *Journal of Risk and Uncertainty*, 15, pp. 55-80;

<sup>183</sup> Kunreuther, H. (1997), "Rethinking Society's Management of Catastrophic Risks" The Geneva Lecture in *The Geneva Papers on Risk and Insurance* 83, pp. 151-176, April.

<sup>184</sup> See the above referenced papers by by Gron, Winter, Doherty and Posey.

<sup>185</sup> See Chapter 6 (Appendix 6B) for the evolution of insurers' surplus between 2002 and 2004.

companies only have so much surplus, and this determines how much insurance they can sell. Thus, after 9/11, this surplus had to be rationed across all insurance lines<sup>186</sup>. However, the most dramatic shortages and price increases after 9/11 were for catastrophe insurance and after 9/11 the most dramatic market crunch was for commercial insurance.

## 7.2 How Would Markets Respond to Another Major Terrorism Event?

As discussed in Chapter 3, after 9/11, terrorism insurance was very scarce, very expensive and usually had low coverage limits. Very little reinsurance was available, and this further limited the capacity of the primary companies to offer coverage. Since 2002, coverage has increased as shown by various surveys. For example, recent Aon survey results show that for 2004 through the first quarter of 2005, more than half of their clients had taken up some form of terrorism insurance coverage.<sup>187</sup> Clearly, TRIA has had an impact on the amount of terrorism insurance sold and whether it is renewed (and in what form), will be an important factor in determining how the market will fare should another major terrorism event occur.

### *Market Response With TRIA*

Consider a very simple example. Suppose a terrorism loss were to occur in 2005 while TRIA is still in force. Currently, premiums for TRIA lines are in the region of \$200 billion<sup>188</sup>. With a 15 percent deductible facing each insurer, this means that the deductibles facing all insurers taken as a whole would total about \$30 billion. Insurers would also pay 10 percent of the losses above the deductible subject to an aggregate cap of \$100 billion for all insurer and government loss payments.

This means that if a terrorism event were to occur that caused insured losses of \$35 billion (which is roughly the same level of insured losses as 9/11)<sup>189</sup> and these losses were to be distributed across insurers in proportion to their TRIA lines' premiums, most of the first \$30 billion in losses would be borne by insurers themselves. Insurers would collectively pay only 10 percent of the amount above \$30 billion; i.e., \$0.5 billion.

Of course, as the analyses provided in Chapter 6 of the report show, the losses would not be nicely apportioned according to the premium distribution of insurers. Each insurer faces a separate deductible of 15 percent of its TRIA premiums. Depending on

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<sup>186</sup> For example, in the aftermath of 9/11, Golden Gate Park was unable to obtain terrorism coverage and its non-terrorism coverage was reduced from \$125 million to \$25 million. Yet the premiums for this reduced amount of protection increased from \$500,000 in 2001 to \$1.1 million in 2002. Smetters, K. (2004), "Insuring Against Terrorism: The Policy Challenge," In Litan, R. and Herring, R. (eds), *Brookings-Wharton Papers on Financial Services*, pp. 139-182.

<sup>187</sup> 57.3% bought either stand-alone coverage, TRIA-only coverage, TRIA and non-certified of TRIA and stand alone coverage. Figures provided by Aon. See Chapter 9 in the report.

<sup>188</sup> See Appendix 6B for detailed figures.

<sup>189</sup> It is noted that coverage available today is different from that available on 9/11. Many who were covered on 9/11 may not have obtained coverage under TRIA. So a recurrence of exactly the same events as 9/11 causing exactly the same level of damage, would not generate the same level of insured losses.

where the attack occurred and who covered the risk, individual insurers might be hit hard or escape scot-free. Some insurers' losses would exceed their deductibles and others would not. So one would expect some additional portion of the first \$30 billion to be paid by the federal government; precisely how much would depend on how the losses were distributed across insurers.

Thus, the total net bill to insurers would be something less than \$30 billion. In addition to the individual insurer deductibles, there is an industry aggregate retention which for 2005 is \$15 billion. If the sum of the individual deductibles was less than \$15 billion, the government will recover the difference between the actual industry losses and \$15 billion through surcharges on all commercial policies. Thus, the net industry liability would lie between \$15.5 billion and \$30.5 billion depending on how the loss happens to fall on different insurers.

The second factor, which would aggravate the impact of a 2005 loss, is that the government's TRIA contribution above the \$15 billion aggregate payment might be recouped at the government's discretion<sup>190</sup>. For example, if the total losses were \$35 billion and the total deductibles of all insurers suffering the losses were \$14 billion, then the loss would be distributed as follows:

|                 |  |                         |
|-----------------|--|-------------------------|
| Insurers pay    | \$14 billion plus 10% of (\$35 – 14) billion | = \$16.1 billion        |
| Government pays | 90% of (\$35 – 14) billion                   | = <u>\$18.9 billion</u> |
|                 |  | = \$35 billion          |

Because the insurance industry's payment exceeds their retention level of \$15 billion, the government cannot make *immediate* assessment but can recover all of its payments in subsequent years if it elects this option. Thus, the final bill to the insurance industry would be an immediate \$16.1 billion, and then a possible set of future surcharges amounting to as much as \$18.9 billion against all policyholders whether or not they had purchased terrorism insurance<sup>191</sup>.

Given the combination of the scarcity of private reinsurance and the ability of the government to recoup losses that it covers (i.e. the 90 percent payments above an insurer's TRIA deductible), the market dislocation from a \$35 billion insured event in 2005 would be more severe than from 9/11 even though they both caused similar levels of insured losses. In 9/11, primary insurers only ended up paying 1/3 of the losses, about \$11 billion, the other two thirds being reinsured<sup>192</sup>. The 2005 event leaves primary insurers and policyholders combined with somewhere between \$16.1 billion and \$30.5 billion minus a

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<sup>190</sup> This analysis complements the scenario analyses of loss sharing in Chap. 6 where we assumed that the Treasury would *not* recoup insurance industry losses above the TRIA market retention level of \$15 billion in 2005.

<sup>191</sup> TRIA is not very clear on that aspect as it states that "the Secretary may recoup, through terrorism loss risk-spreading premiums, such additional amounts that the Secretary believes can be recouped, based on-- (i) the ultimate costs to taxpayers of no additional recoupment; (ii) the economic conditions in the commercial marketplace, including the capitalization, profitability, and investment returns of the insurance industry and the current cycle of the insurance markets; (iii) the affordability of commercial insurance for small- and medium-sized businesses; and (iv) such other factors as the Secretary considers appropriate." Section 103. (e)(7)(D).

<sup>192</sup> Testimony of Jacques Dubois, Chairman and CEO Swiss Re America on behalf of Swiss Re before the United States Senate on Banking, Housing, and Urban Affairs, May 18, 2004.

small amount of private reinsurance with the prospect of future recoupment by the federal government.

Combining this numerical analysis with the type of market behavior we saw after 9/11, we foresee the following responses to a 2005 terrorism loss of \$35 billion.

- Significant capacity shortages across the industry in all lines, due to the loss of capital (surplus) by primary insurers.
- The reinsurance industry will not be as heavily hit as with 9/11 since reinsurers only provide coverage of the losses below the insurer's deductible under TRIA. Hence primary insurers may be able to compensate to some extent for their reduced capital by purchasing more reinsurance for non terrorism lines by exploiting the largely intact reinsurance capacity. This increased demand would tend to increase reinsurance prices.
- Despite the possible ameliorating effect of increased reinsurance capacity, the overall loss of capital to the industry would be large and significant price increases are likely to emerge in non-terrorism lines of insurance. Where price increases are constrained by regulation, there will be corresponding pressure for insurers to reduce the supply of coverage.
- Large price increases will occur in terrorism insurance (if permitted by state regulations) and other catastrophe lines that require a large allocation of capital (surplus) by insurers.
- In states where terrorism risk is price constrained, or where it is mandated, there may be a supply problem. In these states, some firms may leave the market, new firms will be reluctant to enter and existing firms may not offer lines for which terrorism risk cannot be excluded.
- The hard market would gradually soften as new capital entered. However, given the occurrence of a second major terrorism event, expectations about the degree of terrorism risk going forward are likely to be revised upwards. If this is the case then new capital might be even more limited. Thus the hard market may be more protracted compared to what it was after 9/11.

### ***Market Response without TRIA***

The market response to a future terrorism loss if TRIA were not renewed is more difficult to predict because of the uncertainty as to what coverage will be in place in the absence of TRIA. Unless there are changes in state regulations, which seem highly unlikely, insurers will continue to be required to include terrorism coverage under workers' compensation. In those states where insurers must cover losses from fire following a terrorist attack, the absence of TRIA will still leave terrorism exposure in place. In the absence of TRIA, workers' compensation insurers and property insurers in states that have a "fire following" requirement will make some adjustments to their portfolios by reducing their amount of terrorism insurance in place. Our discussion with reinsurers and the survey results presented in Appendix 1A show that in the absence of TRIA, it appears unlikely

that reinsurers will want to re-enter the market to replace the TRIA layers for catastrophic losses from terrorist attacks. Accordingly primary insurers are likely to severely restrict their offerings of terrorism coverage. Of course, this scarcity will create market opportunities and some insurers with abundant capital may be willing to exploit this situation. Thus, we expect a small post-TRIA market for terrorism insurance with the coverage limits on individual policies reduced from what they are today.

### **Summary of Chapter 7**

Following severe losses from a catastrophic event, insurers are likely to restrict the amount of coverage they offer on all lines of insurance due to a significant decrease in their surplus. This leads to a hard market in insurance but over time capital is infused in the industry and the market softens. There is substantial empirical evidence supporting this capacity constraint model from natural disasters as well as from the behavior of insurers following 9/11.

We would expect similar insurer behavior following another terrorist attack. Under TRIA, a loss similar to 9/11 would be much more costly to insurers. They would absorb a much larger proportion of the loss due to the limited amount of reinsurance in place today and the possibility of the government recouping its post attack payments over time. Should TRIA not be renewed, the losses from an attack of the magnitude of 9/11 to insurers providing workers' compensation insurance and those required to cover fire following would be more severe than if TRIA were in place. Hence these insurers are likely to reduce their coverage even before a terrorist attack occurs to avoid the possibility of these very large losses.





**PART C**

**THE DEMAND FOR TERRORISM RISK  
INSURANCE**



## CHAPTER 8

### Mitigation and Financial Protection against Terrorism

This is the first of two chapters of the report dealing with the demand for terrorism insurance. This chapter considers the major factors that affect the demand for coverage and the factors influencing investments in mitigation and protective measures. Chapter 9 discusses evidence from a survey of members of the National Association of Real Estate Investment Trusts (NAREIT) undertaken during the spring of 2005 by the Wharton Risk Center, presents the results of an analysis of terrorism insurance purchases by large firms using data provided to us by Aon and considers the demand for TRIA-backed terrorism insurance by firms with captive insurers.

#### 8.1 Theoretical and Empirical Evidence

The demand for terrorism insurance of commercial firms generally depends on the same broad factors that determine the demand for other types of insurance by individuals — their degree of risk aversion and the insurance premium. The amount of coverage purchased is predicted to decline as premiums increase. However, the willingness to pay for insurance is lower when the buyer would not have to bear the entire cost of losses either because of tax deductions or anticipation of federal assistance following a disaster.

Similar factors affect the demand for insurance by small businesses, where owners generally have significant proportions of their wealth invested in the business. In the case of larger businesses with widely held common stock, the demand for insurance is reduced because shareholders are able to reduce their risk of ownership through diversification across numerous investments. Basic theory thus predicts that factors other than risk aversion will drive insurance decisions for larger corporations with widely held stock. In particular, the theory predicts that the demand for insurance for such firms will depend primarily on the extent to which insurance:

- 1) Allows the firm to transact at more favorable terms with stakeholders who are not diversified (such as managers, employees, customers, suppliers) and who therefore prefer to deal with insured firms;
- 2) Reduces the expected costs of financial distress. Firms with higher debt to equity ratios will gain more from insurance than firms with lower leverage;
- 3) Lowers the firm's expected tax payments by stabilizing taxable income; and
- 4) Allows the firm to lower its after-tax cost of capital by financing with relatively more tax advantaged debt than equity.

Larger firms also are often able to achieve substantial risk reduction internally by having multiple exposures, but where the losses are not highly correlated across the exposures. In addition, they often are able to raise funds to finance losses after they occur

at more favorable terms than can smaller firms. Both factors reduce the demand for insurance by larger firms.

Aon and Marsh, the two largest insurance brokers operating in the U.S. insurance market, have both recently conducted studies detailing terrorism insurance purchases by their large U.S. clients<sup>193</sup>. Data compiled by Marsh from more than 2,300 businesses and government entities that renewed their property insurance policies in 2004 indicated that approximately half bought terrorism insurance (Marsh, 2005a, 2005b)<sup>194</sup>. Another survey by Aon (analyzed in more detail in Chapter 9) found that 57 percent of 500 commercial accounts that renewed their coverage between October 1, 2003 and September 30, 2004 also purchased terrorism coverage (Aon, 2004)<sup>195</sup>. These figures reveal a significant increase in the demand for coverage over the 20-30 percent range in early 2003.

Indeed, the Council of Insurance Agents and Brokers (CIAB) undertook the first national survey on the level of demand for terrorist coverage (CIAB, March 2003)<sup>196</sup>. At that time, 48 percent of the member group handling the largest accounts (customers who pay more than \$100,000 annually in commission and fees to the broker) indicated that less than 1 in 5 of their customers had purchased terrorism insurance. The low demand was even more pronounced for smaller companies (less than \$25,000 in commission and fees to the broker): 65 percent of the brokers indicated that less than 1 in 5 customers were purchasing insurance against terrorism. According to another national survey by the CIAB a few months later, 72 percent of the brokers indicated that their commercial customers were still not purchasing terrorism insurance coverage (CIAB, July 2003)<sup>197</sup>. Even in locations like New York City, the level of demand remained low in 2003. During the autumn of 2003, the New York-based insurance brokerage firm Kaye Insurance Associates surveyed 100 of its clients at middle market real estate, retail and manufacturing in the New York area on a series of insurance-related issues, including terrorism insurance. Only 36 percent of the companies indicated that they had purchased terrorism insurance (Kaye, October 2003)<sup>198</sup>.

One explanation for the increase in demand in 2004 is the decline in the price of terrorism coverage to half of what it was during the first quarter of 2003 just after TRIA was implemented. In February 2003, terrorism rates represented about 10 percent of the total premium for property insurance (and much higher in downtown Manhattan). In the third quarter of 2004, according to the Aon survey, the median rate had fallen to approximately 3.5 percent of total premium, making coverage more affordable. If buyers

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<sup>193</sup> We appreciated the opportunity of fruitful meetings with both Aon and Marsh as part of this Wharton Risk Center study.

<sup>194</sup> Marsh (2005-a), *Marketwatch: Terrorism Risk Insurance 2005*; Marsh (2005-b) "Nearly Half of Large and Mid-Sized U.S. Businesses Purchased Terrorism Insurance in 2004", Press release, April 25.

<sup>195</sup> Aon (2004), *Terrorism Risk Management and Risk Transfer Market Overview*, December.

<sup>196</sup> Council of Insurance Agents and Brokers (2003), "Many Commercial Interests Are Not Buying Terrorism Insurance, New CIAB Survey Shows." News Release, March 24.

<sup>197</sup> Council of Insurance Agents and Brokers (2003), "Commercial Market Index Survey." News Release, July 22.

<sup>198</sup> Kaye Insurance Associates (2003), *Middle Market Survey*. October, New York.

thought that the premiums had fallen by more than the expected loss from terrorism, the coverage would look more attractive. In addition, the decreases in property insurance rates in 2004 have enabled firms to free up funds from predetermined insurance budgets to purchase terrorism insurance coverage. The decreases in overall property rates have been continuing in 2005. These and other data discussed below suggest both price responsiveness and demand shifts.

Another factor that may have led to increased purchase of terrorism insurance is the series of alerts released by the federal government in 2004 about possible attacks in the United States that may have increased firms' concern with this risk. In the current Sarbanes-Oxley environment, it is likely that some executives prefer buying insurance rather than exposing themselves to the risk of being sued for negligence should the firm be the target of a terrorism attack. For this reason, terrorism insurance is often required as part of director's and officer's (D&O) coverage, which itself has been a growth area for corporate insurance in the last two years.

A fundamental driver of terrorism coverage in specific industries, such as real estate, has been the requirements by lenders and some rating agencies for terrorism coverage, especially in high-risk areas. For example, banks often require terrorism insurance coverage as a condition for loans and mortgages to protect their own financial interests<sup>199</sup>. Lenders and other financial service organizations selling or underwriting securities that are backed by insurance provide capital to borrowers, while providing a signal that the normal terms for repayment of principal and interest will, in fact, apply. Since it is not easy to measure the ability of a borrower to withstand various shocks, including those of terrorist attacks, terrorism insurance coverage can be an important signal of the quality of loans secured by real assets.

Other major findings of the Aon and Marsh studies include:

1. Firms purchase terrorism coverage in a variety of forms (TRIA coverage only, TRIA coverage plus coverage for non-certified acts, TRIA coverage combined with broader stand-alone coverage, and stand-alone coverage only). The most common arrangement was TRIA plus coverage for specified non-certified events (e.g., domestic terrorism).
2. Take-up rates for any terrorism coverage are lowest for the smallest accounts studied and the very largest accounts in relation to intermediate-sized accounts.<sup>200</sup>
3. Take-up rates vary considerably by industry and region.<sup>201</sup> For Aon accounts, take-up rates were highest in the South and lowest in the Southeast and West. For Marsh, which classifies accounts into four regions (Northeast, Midwest, South and West), take-up rates were higher in the Northeast and Midwest than in the South

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<sup>199</sup> A survey published in 2004 by the Mortgage Bankers Association (MBA) of 123,000 commercial/multifamily loans (totaling \$656 billion) showed that terrorism insurance was required by the mortgage investor and/or servicer on \$616 billion of these loans. Cited in Congressional Budget Office (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC, January.

<sup>200</sup> These take-up rates apply only to firms that have placed other insurance business with the mega brokers Aon and Marsh. They are not necessarily representative of the overall take-up rate of all firms.

<sup>201</sup> Region is defined as the location of the office where the business is written or serviced, generally the office closest to the buyer's headquarters.

and West. Take-up rates were highest for financial, real estate and health care firms, and lowest for pharmaceutical/chemical firms (Aon classification) and energy and construction (Marsh classification).

4. Many accounts with terrorism insurance purchase terrorism coverage limits less than their other property insurance coverage limits.
5. Terrorism premiums as a percentage of total property premiums generally are higher for the largest firms and highest in the Northeast.

### ***Why Firms May Not Purchase Terrorism Insurance***

The choice not to purchase terrorism insurance may sometimes be considered rational from a corporate risk management perspective. Most large public companies are owned by investors who have diversified portfolios. These investors are unlikely to be severely affected financially if the terrorism loss affects only one or two firms in their holdings. Likewise, large firms own many assets, and they will have low demand for insurance against events that will affect only a small number of those assets. If the premium for insurance is well above their perceived expected loss, it may be cost-effective for them to forego insurance.

Another reason why firms may not have purchased terrorism insurance is that their managers are not concerned about the risk. There is considerable empirical evidence on managerial decision-making that firms develop simplified decision rules to determine whether or not to undertake certain protective measures (Russo and Schoemaker, 1990).<sup>202</sup> One such rule is a threshold model of choice that implies that if the probability of a disaster that will seriously affect the firm financially is below a level of concern, it is not worth worrying about (Camerer and Kunreuther, 1989).<sup>203</sup> Three years after 9/11, many firms may perceive the likelihood of a future terrorist attack that will disrupt their operations to be sufficiently low that they are not interested in purchasing insurance; in other words, “it will not happen to us.”

Finally, as elaborated in the early work of recent Economic Nobel Laureates Finn Kydland and Edward Prescott, the federal government cannot credibly commit *ex ante* to refusing to bail out noninsured firms in the aftermath of an attack (Kydland and Prescott, 1977).<sup>204</sup> If a firm believes that the government will provide financial relief to those in need after another attack, they will have less interest in purchasing insurance coverage than if they were on their own. As pointed out in Section 5.1, this *Samaritan's dilemma* arises when society extends assistance to others and by so doing leads those at risk not to take appropriate *ex ante* actions that would have reduced their need for *ex post* assistance.

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<sup>202</sup> Russo, J. E. and Schoemaker, P. (1990), *Decision Traps*. New York: Simon & Schuster.

<sup>203</sup> Camerer, C. and Kunreuther, H. (1989), "Decision Processes for Low Probability Events: Policy Implications" *Journal of Policy Analysis and Management* 8: 565-592.

<sup>204</sup> Prescott, E. and Kydland, F. (1977), "Rules Rather than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy*, 85: 473-91.

### ***Mitigation of Terrorism Losses***

A survey by the Washington-based Council on Competitiveness undertaken in September 2002, before TRIA was passed, indicated that 92 percent of the 230 senior executives interviewed did not believe their companies would be targeted by a terrorist attack. Seventy percent of the survey respondents saw no way to implement needed security measures in ways that would be cost-justified on the basis of productivity growth or risk reduction. While firms with global operations have certainly initiated internal restructuring to address security and business continuity risks, including those from terrorism, this varies greatly by sector. The financial and real estate sectors, as well as global retailers, have paid a lot of attention to their exposures and to measures they can undertake for risk bearing and mitigation. For those who desire to implement such mitigation measures, the American National Standard on Disaster/Emergency Management and Business Continuity Programs (NFPA 1600) provide a useful set of criteria for evaluating and improving preparedness, disaster management and business continuity (NFPA, 2004)<sup>205</sup>.

However, as reported by the U.S. Congressional Budget Office (CBO), many firms have still not undertaken efforts to physically protect their assets aside from relatively inexpensive measures, such as hiring more security guards and installing lights and cameras at their facilities (CBO, 2005)<sup>206</sup>.

Several factors explain the reluctance of commercial enterprises to invest in physical protection against terrorism<sup>207</sup>. Those considering risk-reducing measures may conclude that they lack the information on the likelihood and consequences of the terrorism threat to evaluate their cost-effectiveness. Furthermore they may perceive themselves as *not* being a target for terrorist groups and decide not to evaluate mitigation measures. Firms may also view terrorism as a national security issue and consider it to be the role of the government to protect the country against possible terrorist attacks. Finally, firms may determine that additional protection measures are not cost-effective by making tradeoffs between the perceived reduction in the risk from investing in mitigation and the expenditures that would incur.

Firms may also feel that additional substantial investments in security will have a negative impact on their short-term competitive position and hence their profitability. Moreover, the existence of interdependencies may lead to a situation in which all or many organizations decide not to invest in protection because they know that the failure of others to take similar actions can harm them even if they exert care themselves (Kunreuther and Heal, 2003)<sup>208</sup>. This interdependency and interconnectedness of the global economy can

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<sup>205</sup> National Fire Protection Association (NFPA) (2004), *NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs*, Edition 2004.

<sup>206</sup> CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC, January.

<sup>207</sup> Appendix 8A provides a description of how United Educators, a risk retention group that covers about 1,200 colleges and universities, has developed mitigation measure plans for its member in order to gain access to terrorism risk insurance.

<sup>208</sup> Kunreuther, H. and Heal, G. (2003), "Interdependent Security." *Journal of Risk and Uncertainty*. 26: 2/3, pp.231-249.



undermine economic incentives for firms to voluntarily undertake protective measures. We note some examples of this below for global supply chains in the retail sector.

The Congressional Budget Office report released in January 2005 suggests that terrorism insurance premiums be based on *actuarial* rates should the private sector be forced to provide coverage on its own. The CBO report concludes that under such a program, higher premiums could encourage firms to adopt cost effective measures to reduce potential losses. As pointed out in Chapter 2, insurers feel that it is impossible to determine actuarial rates for terrorism insurance for a wide variety of reasons. As pointed out above, it is also unclear whether firms would, in fact, adopt mitigation measures even if such rates could be determined. In theory, a social insurance program can institute regulations, standards and incentive programs (e.g. tax reductions) to reduce the negative externalities produced by a terrorist attack. In practice, it is difficult to obtain the information to implement such policies in effective and unbiased ways<sup>209</sup>. Moreover, it is not clear how insurers would integrate such mitigation measures into their terrorism coverage and pricing decisions. Results of the insurer surveys undertaken for this study (see Appendix 6A) indicate a reluctance by most insurers to consider mitigation effort as part of their terrorism risk insurance decisions. For example, answering the question “Would the requirement for terrorism mitigation measures change the coverage limit you would offer to your clients should TRIA not be renewed?”, all of the surveyed insurers responded “No”. When asked *Why* two of the insurers responded as follows:

*“The type of terrorism event that would have a true financial impact on the company would not be mitigated by these control measures.”*

*“Would not change likely targets, and most modes of terrorist attack cannot be meaningfully mitigated by individual policyholders.”*

When asked the question “Would you be in favor of the federal government requiring certain terrorism mitigation measures to be adopted with certified third parties inspecting the facilities to determine whether these measures were adopted?”, 10 out of the 11 insurers responding to the survey answered “No”. Some of the reasons given were:

*“There may be the perceived value that the presence of these programs would equate to a reduction in the amount of terrorism premiums required to cover potential losses. We would disagree”*

*“Cost and time, not cost effective and a waste of time and effort”*

*“Unrealistic, cost prohibitive, impossible to monitor”*

In its report, the 9/11 Commission made the following recommendation: “We endorse the American National Standards Institute’s recommended standard for private preparedness. We also encourage the insurance and credit-rating industries to look closely at a company’s compliance with ANSI standard in assessing its insurability and credit worthiness” (9/11 Commission, 2004)<sup>210</sup>. As of today, such a link between mitigation and

<sup>209</sup> CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

<sup>210</sup> National Commission on Terrorist Attacks upon the United States (2004), *The 9/11 Commission Report*, Chapter 12, p. 398. Official Government Edition. Washington, DC.

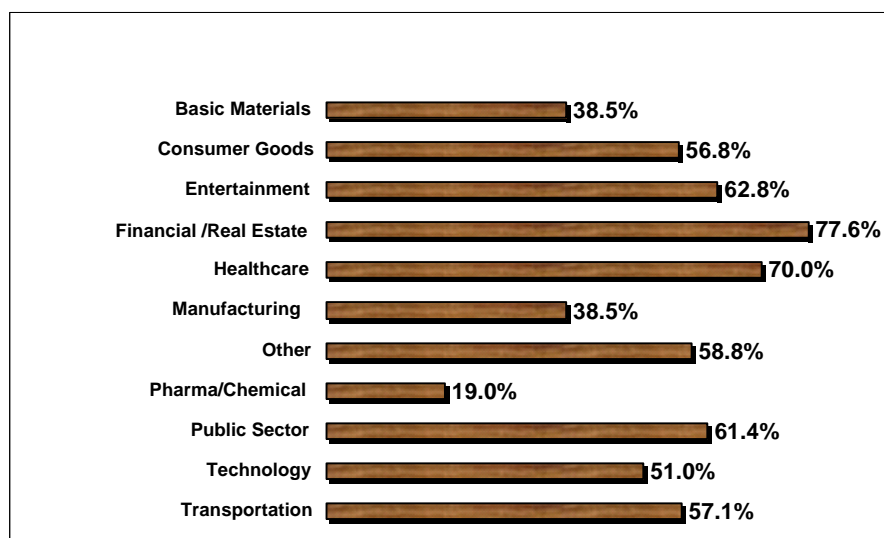


insurance with respect to terrorism risk is nonexistent (See Appendix 6A). A look abroad actually reveals that the absence of any link between insurance and mitigation with respect to terrorism risk is not specific to the U.S. According to a recent study on terrorism insurance markets in several countries undertaken by the Wharton Risk Center in conjunction with European research institutions, programs established in France, Germany, Spain and the UK have also not developed any systematic incentive policy, such as premium or deductible reduction, for encouraging insured firms to invest in security measures (Michel-Kerjan and Pedell, 2005)<sup>211</sup>.

## 8.2 Differences Between Specific Industrial Sectors

As noted above, there are significant differences in the take-up rates for terrorism insurance by different sectors of the economy. Figure 8.1 shows the differences in take-up rates for a sample of Aon accounts in 11 sectors that renewed their terrorism coverage (both TRIA and combined coverage) during the period October 1, 2003 to September 30, 2004.

Sectors like entertainment, financial services/real estate and healthcare exhibit high take-up rates while basic materials, manufacturing and pharmaceutical/chemical sectors exhibit much lower take-up rates. As noted in Aon (2004)<sup>212</sup>, the latter are characterized by global activities and are typically serviced by non-domestic carriers that are not required to provide mandatory terrorism coverage. Many of these companies use a captive insurer to manage their terrorism risk (see Section 9.3).



**Figure 8.1 Take-up Rate by Industry**  
*Source: Aon (2004)*

<sup>211</sup> Michel-Kerjan, E. and Pedell, B. (2005), "Terrorism Risk Coverage in the Post- 9/11 Era: A Comparison of New Public-Private Partnerships in France, Germany and the U.S.," *The Geneva Papers on Risk and Insurance*, 30: 1, pp. 144-170

<sup>212</sup> Aon (2004), *Terrorism Risk Management and Risk Transfer Market Overview*, December.

Corporate demand for insurance depends, among other things, upon the price of the coverage, the degree of risk aversion of firms in the sector, the buyer's expectations of losses, and the level of diversification of risks in a company's portfolio. In addition, other factors influence firms' decision processes, such as perceived responsibility for mitigating and responding to terrorist attacks, interdependencies with other actors, spillover effects from these sectors resulting in indirect losses, and synergies with other risks faced by competitors. We discuss each of these factors below, and illustrate them using examples from interviews conducted in three specific sectors: chemicals, the real estate sector, and retailing.

### ***Perceived Responsibility for Mitigation and Response***

The chemical sector has a long history of company-specific responsibility for mitigation and response to accidental releases, whatever their source. There are data on both the nature of chemical risks and worst-case scenarios for some 15,000 facilities in the U.S. that report under the Risk Management Plans (RMP) Rule of Section 112(r) of the Clean Air Act Amendments<sup>213</sup>. As a result of this regulation, there are well-developed emergency response procedures, maintenance and safety protocols, regulations and reporting requirements in the chemical industry.

The extension of these procedures from accidental releases to releases caused by purposeful agents has begun, but large-scale incidents would certainly tax any regional or municipal authority, notwithstanding the increases in readiness that have been achieved since 9/11. There has also been considerable effort on the part of the American chemical industry to codify best practices relating to safety and security at chemical facilities<sup>214</sup>.

Contrast this behavior in the chemical industry with the real estate sector and retail stores, where there was limited concern and understanding of what to do in the event of a major terrorist attack prior to 9/11. Since that time, to be sure, large building owners and retail companies have developed much better crisis management and business continuity procedures, but these are relatively untested in comparison to the chemical sector. The status of preparedness and emergency response capability by building owners remains to be studied and no doubt varies greatly across different regions of the country.

The greatest concern for retailers is clearly supply chain disruptions. There has been considerable work on cargo security, much of it under the banner of the provisions of C-TPAT (Customs-Trade Partnership against Terrorism, developed in cooperation with the Department of Homeland Security and the Transportation Security Administration). The thrust of the C-TPAT has been to develop principles that can be used to integrate security with maritime and air cargo shipments, without so much additional cost as to undermine

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<sup>213</sup> Kleindorfer, P., Belke, J., Elliott, M. Lee, K. Lowe, R. and Feldman, H. (2003), "Accident Epidemiology and the U.S. Chemical Industry: Accident History and Worst-Case Data from RMP\*Info", *Risk Analysis*, 23:5, pp. 865-881.

<sup>214</sup> See, e.g., Center for Chemical Process Safety (CCPS) (2002), "Guidelines for Analyzing and Managing the Security Vulnerabilities of Fixed Chemical Sites", Center for Chemical Process Safety, New York, NY, August.

the international trade channels that have developed and flourished in the past two decades.<sup>215</sup>

### ***Diversification of Risk***

There are significant differences across industrial and retail sectors in the degree of diversification of risk across corporate assets and facilities. For example, we see in Figure 8.1 that the take-up rate for terrorism coverage among retailers in the consumer goods sector is more than 20 percent lower than for the financial/real estate sector. This is partly because the effects of diversification are more fully recognized in retailing, with its largely dispersed, low-rise structures, than in the real estate sector, which often faces loan covenants by its lenders that require terrorism coverage. We consider the real estate sector in more detail in Section 9.1.

The chemical sector is an interesting case. Given the hazards involved in this sector, one might expect a relatively high demand for terrorism coverage. The problem in the chemical sector is that hundreds of facilities in the U.S. already have non-terrorism worst-case scenarios that could cause death and injury to more than 100,000 people, thus exceeding any reasonable possibility of having private insurance at the corporate level able to provide coverage for many possible events. According to the Aon (2004) report, the demand for terrorism insurance in the chemical sector has been minimal largely because two decades of retrenchment for the larger companies towards self-insurance has already occurred<sup>216</sup>. This explains the very low take-up rate for the pharma/chemical sector depicted in Figure 8.1.

In interviews we have conducted as part of this study, larger chemical companies claim that they have “owned” the risk from major accidents, whatever their cause, for some time and can provide cheaper risk bearing capital to cover these risks than going to a pure outside solution. Some have portfolios of insurance placed with both outside insurers and captives. Smaller chemical companies cannot make this claim, and may well be going bare because they perceive an attack will not against them and/or they do not have sufficient resources to afford to buy the coverage. Whatever the reason, the empirical results of the next chapter definitely show that the pharmaceutical and chemical sectors are amongst the weakest in take-up rates for terrorism insurance, according to several measures.

Finally, pooling the risk within a risk retention group constitutes another alternative for financial protection. A risk retention group (RRG) is an entity that provides liability insurance to its owner-members. Traditionally, it is created when insurance is not available or premiums are so high that few buyers feel they can afford coverage. One of the advantages of such RRGs is that the members determine conditions for newcomers to

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<sup>215</sup> For a discussion of security issues in global supply chains, see Kleindorfer, P. and Saad, G. (2005), “Disruption Risk Management in Supply Chains”, *Production and Operations Management*, 14: 1, Spring, pp. 53-68.

<sup>216</sup> Aon (2004), *Terrorism Risk Management and Risk Transfer Market Overview*, December.

enter the group<sup>217</sup>. Appendix 8A discusses some features of United Educators, a RRG covering universities and colleges against terrorism throughout the U.S.

### *Interdependencies and Spillover Effects*

Interdependencies can play a significant role in determining the magnitude of losses from a terrorist attack. Consider the retail sector. For major retailers (like Wal-Mart and Home Depot) involved in container-based trade (some 9,000,000 containers come into the U.S. annually), a joint solution that assures continued facilitation of international trade with a high level of security is a necessity. Interdependencies arise because disruptions to any retailer from terrorist activities will have significant negative impacts on other retailers, especially if they occur at a major port. These negative externalities arise because lack of care by any given retailer (in its own operations or in its oversight of its suppliers) in loading, shipping or assuring tamper-proof containers can give rise to an exploitable weakness that could cause huge disruptions to many other retailers by shutting down ports or major rail depots.<sup>218</sup>

The port strike in 2002 on the West Coast was one such disruption that had ripple effects for the retail sector that lasted for over a year. This event illustrates the impact on large retailers (e.g., Wal-Mart, Home Depot, Target) should the federal government order a major port to shut down after discovering credible threats that marine cargo containers might have on the resulting damage from nuclear or toxic devices designed to be exploded in major port cities, such as Miami, New York or Los Angeles. The interdependencies associated with terrorism risk pose a significant limitation to insurance because, except for very specific policies (e.g., contingent business income coverage), losses are normally not covered unless the insured is the direct target of an attack (see Section 3.2).

In the chemical sector, there are large concentrations of facilities in several regions (Houston, Texas, the Kanawha Valley in West Virginia, the Delaware Valley, and the

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<sup>217</sup> The airline industry considered forming such a mutual company when coverage for third party liability for terrorism and war risks was withdrawn within 10 days after 9/11. New policies offered by insurers limited their aggregate third party liability to \$50 million, falling far short of the \$3.5 billion of aviation liability losses from 9/11. As a temporary measure, the federal government provided this protection for U.S. airlines, as did other governments worldwide. When first warned that government coverage was going to cease, the U.S. airlines created their own RRG, *Equitime* in June 2002. See Insurance Journal (2002), "Airlines Look to Provide Their Own War and Terrorist Coverage." November 11.

However, this group never became operational. European airlines planned also to create their own RGG, *Eurotime*, which never became operational either. A principal reason for the failure of the U.S. RRG has been the continued subsidized financial protection of airlines by the federal government, crowding out the emergence of private solutions at a competitive price. Indeed, a temporary Federal Aviation Administration (FAA) terrorism insurance program, which covers approximately 75 U.S. air carriers, had been in effect since September 2001; the program is still operating today. See Kunreuther, H. and Michel-Kerjan, E (2005), "Insuring (Mega)-Terrorism: Challenges and Perspectives", in OECD (2005), *Terrorism Risk Insurance in OECD Countries*, July 5.

For a detailed analysis of this issue, see Strauss, A. (2005), "Terrorism Third Party Liability Insurance for Commercial Aviation, Federal Intervention in the Wake of September 11", The Wharton School, Center for Risk Management and Decision Process, June.

<sup>218</sup> For a detailed discussion on port and container security issues, see Flynn, S. (2004), *America the Vulnerable*, New York: Harper Collins.

Northern New Jersey/New York area). As with any adverse economic event, terrorism attacks in any of these areas could have significant spillovers for the entire economy. Beyond these normal economic effects, there are also significant spillover possibilities from transportation risks, with chlorine rail transport in and around major urban areas being an important case in point. The sudden and catastrophic rupture of a chlorine tank in Washington, DC, triggered by explosive devices, could kill and injure thousands of people, in addition to its being a direct attack on Washington, D.C., obviously a key symbolic target in America. In the real estate sector, building collapse could lead impair surrounding structures, but the damage is spatially more limited than for chemicals.

Effects on a regional or even the national economy from a terrorist attack could be significant whatever the sector. In the retail sector, the spillover effects of an attack at a major mall could have a chilling effect on retail traffic at other malls. So too could product contamination. It might induce social amplification effects across other products and regions. The direct damage from such events could be covered by insurance, but protecting against other aspects of these events, such as business losses from spillovers, would be much less feasible. To the extent that such business losses dominate property losses, the incentives for purchasing insurance against terrorism losses would be reduced.

### *Synergies Across Protective Activities*

Synergies with other protective activities make investments in mitigation easier to justify. They also presumably decrease the price of insurance and/or improve the insurability of a company or facility. The chemical sector exhibits strong synergies across risk mitigation for process risks and terrorism risks. Inherently safer processes and improvements in worst-case scenario drivers can reduce both. Together with public pressures and associated regulations, this has led to significant investments in reducing risks from process accidents in the chemical sector. But, as we see from Figure 8.1, this has not led to a higher take-up rate for terrorism insurance coverage. Rather, the larger chemical companies have tended to use captives for coverage for both their process risks and their risks from terrorism.

In the retail sector, there are similar synergies in that decreasing security risks can also reduce theft and shrinkage, as well as contraband and drug traffic. Location and tamper-proof container identifiers can also lead to benefits from dynamic rerouting in the face of port congestion. In the real estate sector, “guns, guards and gates” for security purposes can also lead to reduced theft and other non-terrorist losses. Also, mitigation of homes and businesses to reduce damage from natural disasters has obvious synergies with reducing the risk of certain types of losses from terrorism.

For both retail and chemical sectors, synergies across protective activities clearly exist and provide a reasonable business case for mitigation of combined security and other disruption risks. Moreover, as we see from the Aon survey, this has led to a weak take-up of insurance coverage in these sectors and there is no reason to believe this would change if TRIA were not renewed. Arguably, in these sectors, the ability and responsibility for mitigating business risks is a partial substitute for terrorism insurance coverage, at least at

the lower levels beneath the catastrophic levels covered by TRIA. The situation is quite different in the real estate sector which we now consider in more detail in the next chapter.

### **Summary of Chapter 8**

The joint demand for terrorism coverage and mitigation is linked to a number of characteristics of the underlying terrorism risk. These factors vary across firms and sectors and reflect the normal drivers of demand for insurance, including the interaction and substitution of mitigation for insurance. Weaker demand for terrorism insurance in some sectors indicates increased opportunities for diversification, but it may also indicate fundamental problems with supplying insurance to cover business interruption risks due to interdependencies across firms.

Our discussion is supported by evidence from the three studied industry sectors: chemical, real estate and retail. The chemical sector has had a long history of responsibility for reducing the risks of accidents prior to 9/11 which has applicability to the terrorism risk. In the case of the other two sectors studied here, building owners and retailers have had less experience and have only undertaken measures to reduce the risk of a major terrorist attack only after 9/11.

Some sectors would obviously be more hard-pressed than others if TRIA is not renewed. Current demand for terrorism insurance is one of the key indicators of the necessary adjustments that would have to occur in a sector if lower capacity or significantly higher premiums for coverage were to materialize.





## APPENDIX 8A

### **Risk Retention Groups: How United Educators Covers Colleges and Universities against Terrorism<sup>219</sup>**

Can a university or school obtain liability insurance for acts of international terrorism committed on U.S. soil? Since 9/11, an educational institution may seem to an outside observer an unlikely target for politically motivated violence. Yet our universities are worldwide symbols of American values. Thus, a university facility or collegiate sporting event could be at elevated risk of a terrorist attack.

As a reciprocal risk retention group, United Educators (UE) provides liability coverage to its 1,200 members, all of which are educational institutions or related entities. Since its creation in 1987, UE has offered broad “all risks” general liability coverage that included acts of terrorism in the United States. After the tragedies of 9/11, UE reinsurers questioned their terrorism coverage, seeking to understand UE plans for underwriting and pricing the exposure. United Educators set out to determine its members’ main terrorism exposures and ultimately identified two major concerns:

- 1) **Scientific research with materials called select agents:** These are ultra-hazardous biological materials such as Ebola, anthrax, and botulism. If stolen from a research laboratory, they could pose widespread threats to public health. Under this scenario, the university becomes an unwitting accessory to a terrorist attack.
- 2) **Mass gatherings:** UE concluded that NCAA Division 1-A football games posed the greatest mass gathering risk. These sporting events attract huge audiences, are widely publicized, and often involve more than one UE member institution. With this exposure, the university itself is a target.

During the analysis phase, United Educators identified the particular institutions that faced these potential exposures, a list of about forty of its members. The implementation phase began with discussions between the institutions and their brokers, followed by development of supplemental underwriting guidelines.

UE created a series of questions about potential exposures and control practices in the two major areas thought most likely to be targets of an attack. They found widely varying practices among the institutions. Some laboratories working with select agents had superb security protocols, while others lacked even basic inventories of their toxic materials. Some sports programs had excellent screening and evacuation plans for their stadiums, while others had none. For those institutions with good risk management practices, UE agreed to continue to cover terrorism without an additional premium charge. For those with weaker practices, UE offered risk management suggestions. Depending on the circumstances, UE will price the risk and offer additional risk management services to help

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<sup>219</sup> This appendix is based on fruitful discussions with United Educators. We would like to thank Michael Horning and Ann Franke, respectively Chief Financial Officer and Vice President for Finance and Administration, and former Vice President for National Issues and Chief Knowledge Officer with United Educators, for sharing a detailed description of UE’s operation with respect to terrorism threats.

the institution reduce the risks. Overall, the process has rewarded institutions with good practices and provided incentives to others to make improvements. Subsequent to their underwriting changes, the Centers for Disease Control developed rigorous laboratory protocols for researchers working with selective agents, creating a new layer of protection for public health.<sup>220</sup>

According to United Educator executives, the federal backstop provided by TRIA has been vital to their efforts. “We simply could not continue terrorism coverage, with limits up to \$25 million, without reinsurer support. TRIA has given our reinsurers the safety margin necessary to accept the steps we have taken to protect our, and their, potential exposures.”

More than 100 universities play Division 1-A football. Without liability insurance for terrorism, some universities might choose to “go bare,” continuing their programs without insurance coverage. Should a catastrophe occur, they would have to pay liability claims from their institutional funds. Some public institutions might seek to rely on state appropriations or governmental immunities, but these protections vary greatly from state to state and also change over time. Other institutions might prefer to revert to a lower NCAA status or even discontinue their programs.

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<sup>220</sup> The USA PATRIOT Act, passed in 2002, strengthened federal requirements for work with select agents.

## CHAPTER 9

### **Purchase of Terrorism Coverage: an Empirical Analysis**

This chapter provides empirical evidence on the demand for terrorism insurance from (1) a survey of members of the National Association of Real Estate Investment Trusts (NAREIT), (2) analysis of data on terrorism coverage purchased by large clients of Aon, and (3) information on purchases of terrorism coverage through captive insurance companies.

#### **9.1 Survey of Real Estate Sector**

The Wharton Risk Center was fortunate to gain the support of the National Association of Real Estate Investment Trusts (NAREIT) to distribute a survey instrument to their members. Returns from this survey provide interesting insights into the factors that have led to a high demand for terrorism insurance coverage in this sector.

Before summarizing the NAREIT survey responses, let us briefly note some of the elements that have driven growth in the real estate sector over the past several decades. Real estate projects in and around major urban areas have long been recognized as capital-intensive activities, requiring significant expertise in finance and execution during the development phase and focused administrative, marketing and building management competencies once projects have been developed. Real estate investment trusts (REITs) were an organizational response to these demands, and these organizations have become an important vehicle for financing, developing and managing major real estate projects, from housing developments to high-rise office buildings and industrial warehousing.<sup>221</sup>

Most of the active REITs achieve economies of scale and diversification by investing in properties and projects across several urban areas. REITs serve as a fundamental access point for real estate into capital markets, facilitating significant financing for major projects and providing investment opportunities for investors. Investment vehicles cover a wide spectrum, from equity funding to the REITs through the stock market, to bonds secured by specific REIT investments to special purpose vehicles for particular projects. Because of the size and complexity of REIT projects, rating

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<sup>221</sup> According to REITnet ([www.reitnet.com](http://www.reitnet.com)), REITs trace their origins back to the 1880s in the U.S., with considerable acceleration in their importance arising from the 1986 and 1993 legislative changes that allowed REITs to manage their own properties and to eliminate barriers to investment in REITs by pension funds. There are some 193 active REITs in the U.S. as of April 2005, with assets in excess of \$500 billion and with about two-thirds of these trading on national stock exchanges.

agencies often provide investors with information on the quality of bond issues and other instruments.<sup>222</sup>

The terrorist attacks of 9/11 had a profound effect on the entire real estate sector, including on REITs, as many of them are active in major urban areas. In the ensuing period, insurance underwriters began to sort out pricing and accumulated exposure information for their terrorism coverage of REITs. Unsurprisingly, pricing and demand for terrorism coverage for REITs varied greatly. High profile, single asset deals and REITs containing high concentrations of trophy buildings saw significant additional insurance expenses relative to their pre-9/11 all-risk (including terrorism) policies. Office towers and high-rise structures with the greatest risk of loss through collapse, and other structures located in high-risk areas, had major difficulty in obtaining all-risk coverage as required by the loan covenants imposed by lenders. With many projects essentially on hold, and terrorism coverage scarce and expensive, the passage of TRIA in 2002 enabled the commercial mortgage-backed securities (CMBS) industry, including REITs, to settle down.

Within the context of TRIA's high-end coverage, rating agencies (for both the CMBS industry and for insurers) established standards and procedures for assessing the consequences of terrorism exposure for ratings and for loan documents and terrorism coverage<sup>223</sup>. The current uneasy calm, awaiting the outcome of the TRIA renewal discussion, is characterized by the multiple approaches of insurance underwriters, rating agencies and firms in the real estate sector. One constant in the current mix of approaches, however, has been the central role of TRIA in assuring availability of coverage under all-risk policies at affordable rates. It is of some interest, therefore, to inquire as to the factors currently driving demand for terrorism coverage in this sector and the views of major firms on what they plan to do if TRIA is not renewed. These were the basic objectives of the survey designed by the Wharton Risk Center team and distributed to 200 NAREIT member companies in April 2005.

We received 17 responses to our survey from NAREIT members. The survey covered a variety of questions on the extent of their terrorism insurance coverage and the rationale for their purchase of such coverage. All of the respondents indicated that they had purchased terrorism insurance within the past year (either under TRIA policies or as a stand alone policy). Deductibles on their coverage ranged from 0 to \$1 million, with an average deductible of \$125,000. Limits ranged from \$10 million to \$1 billion, with an average limit of \$484 million.<sup>224</sup>

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<sup>222</sup> For a discussion of the role of rating agencies for Commercial Mortgage-Backed Securities industry, with and without TRIA, see Carlson, R., Cerda, L. and Merrick, S. (2005), "TRIA's Impact on CMBS", special report of FitchRatings, available at [www.fitchratings.com](http://www.fitchratings.com), May 24. An extended analysis of TRIA's impact on the real estate sector, with some case examples, is provided in Pendergast, L. and Hanna, J. (2005), "To Terminate or Not to Terminate? That is the TRIA Question," report by RBS Greenwich Capital, available at [www.gcm.com](http://www.gcm.com), March 1. The Wharton Team also profited from detailed discussions with Moody's and Standard & Poor's.

<sup>223</sup> See the references in previous footnote for details.

<sup>224</sup> This compares to the reported median terrorism limit for all financial institutions and real estate companies reported in Aon (2004) of \$150 million (see Chapter 8). Thus, NAREIT members in our survey

On the question of lender requirements for terrorism coverage, 10 of 17 respondents indicated that terrorism insurance remains a necessary condition for almost all real estate loans for their companies. Of the remaining respondents, 6 indicated that the purchase of terrorism coverage depended on the financial institution providing the loan and 1 referred to the geographic area of the assets securing the loan.

Beyond the requirements imposed by lenders, the following additional factors were noted by the respondents as considerations in determining the demand for terrorism coverage:

- *Location of assets, and their exposure to terrorism risk*
- *Signal to our investors (and the public) that we have addressed this type of risk*
- *Protecting our company (as a public company) from liabilities*

On the last point, one respondent with low-risk properties summarized the issue as follows:

*“The threat posed by terrorism is low for our properties, which are primarily suburban. ... However, the threat remains as a potential liability, and as a public company we face additional scrutiny. As long as the coverage is available at a price we deem affordable, we will probably continue to buy the coverage.”*

Respondents in this survey were asked for the portion of the total (replacement) value of their assets in commercial property located within the city limits of 11 named top tier cities<sup>225</sup> and in the remainder of the country. They were also asked for the percentage of the value of commercial assets in each city/region covered by terrorism insurance. The results are shown in Table 9.1. It is interesting that there is less than a 10 percent difference between the percentage of commercial property value for NAREIT respondents covered under terrorism insurance in the 11 top tier cities and in the remainder of the U.S. Based on these responses, most of the property in both parts of the country are insured against terrorism coverage.

**Table 9.1 Exposure versus Coverage for NAREIT Sample**

|                                 | <b>% of Commercial Property Value Located</b> | <b>% of Commercial Property Value Covered by Terrorism Insurance</b> |
|---------------------------------|---|--|
| <b>in 11 Top Tier Cities</b>    | 27.2%   | 93.5%  |
| <b>in Remainder of the U.S.</b> | 72.8%   | 85.5%  |

sample had average take-up limits about three times the typical (median) financial institution/real estate company reported in the Aon Survey.

<sup>225</sup> Manhattan, Washington DC, Philadelphia, Chicago, San Francisco, Boston, Seattle, Los Angeles, Las Vegas, Houston and Miami.

Respondents were also asked for the likely consequences for their companies if TRIA were not renewed. Most respondents noted significant negative repercussions of non-renewal, but the expected effects varied considerably depending on the company's capital structure, and its location and type of assets. The following are representative responses to the consequences of non-renewal of TRIA for REIT members.

- *In the short term, there will be displacement as lenders try to get risk covered; in the long term, there will be very little effect on our operations as lenders will adjust and factor in additional risk into pricing.*
- *Some of our loan portfolio will default; our leased property portfolio will be at risk; and loans on our owned assets will be difficult to place without terrorism coverage.*
- *Non-renewal (of TRIA) will impact ability to refinance property debt and obtain financing for acquisitions and development.*
- *Most property owners will be uninsured for this loss unless lenders specifically require it.*
- *There will be less capacity in the marketplace, higher premiums, lender issues that could result in loan defaults if not reasonably addressed, and additional tenant expenses.*
- *There will likely be a flight to the stand-alone market, which at present is not equipped to handle the surge in submissions. With limited supply and high demand, pricing is likely to go up.*
- *All of our operations would be affected, even those outside the top tier cities identified in this survey, since our lending requirements do not distinguish between where the properties are located.*
- *The coverage will be very hard to purchase and no doubt with higher deductibles and other restrictions.*
- *Since we are Landlords and use a "Triple Net Lease" arrangement, we would still require our Tenants to be responsible for the peril of terrorism. Thus they might have to use London or other non-traditional markets to accomplish this, probably at higher prices than are currently being charged.*
- *We would have to obtain coverage for those lenders who require it through our insurer at a substantially higher premium due to the loss of TRIA.*
- *CMBS loan requirements will be negatively affected, with less ability to risk transfer to third party markets.*
- *We foresee little to no effect of non-renewal for us at this point as our debt is 75 percent or greater in corporate unsecured debt.*
- *This will affect all aspects of our business including sale leasebacks, mortgage financing and loan securing.*
- *Capacity will be reduced, causing premiums to increase dramatically. Non renewal will impact the following significant lines of coverage: Property Damage, Business Interruption, Workers' Compensation, General Liability, Excess Liability and Builders Risk.*

Respondents were asked also how, in the absence of TRIA, they would expect the real estate industry to address the financial risks associated with terrorism. Their responses were generally (11 of 17) to continue to rely on terrorism insurance, partly driven by the expectation that their lenders would require this. About half of the respondents (9 of 17) also indicated that they expected to rely on increased reserves against terrorism risk.

As noted in Section 8.2, mitigation and risk assessment initiatives have increased since 9/11, although it is difficult to determine the real effectiveness of some of these measures. The real estate sector is no exception, with 12 of the 17 respondents indicating that they had undertaken a risk assessment process to determine or quantify the risks their assets face from terrorism. Most of these risk assessments were undertaken by external consultants or by insurance company representatives as part of the underwriting process. In terms of investments in the mitigation of assets with respect to terrorism risk, companies that had undertaken a risk assessment typically also made significant new investments in areas such as access barriers (guns, guards and gates), personnel monitoring and certification, protective building measures (ventilation, blastproof windows) and crisis management/emergency communication systems. Interestingly, nearly all respondents believe that these are essential roles for both the private sector and the government to play in mitigation.

Finally we asked respondents whether in the event of TRIA non-renewal, the government would provide funding to uninsured firms after a large terrorist attack on U.S. soil. Their answer was mostly negative with only 4 of 17 respondents indicating that some government assistance would be forthcoming for real estate firms. A typical response was: "There is too much uncertainty regarding the nature of an attack and the political response to be able to rely on the possibility of government funding."

These results show some of the variation across companies in the real estate sector, but the modal response here is clearly one of concern about the consequences for a functioning and liquid real estate market should TRIA not be renewed. Further results on the demand for terrorism coverage in the financial institution/real estate sector in relation to other sectors can be seen in the broader empirical studies reported below. These empirical results reinforce the general picture arising from the NAREIT survey that terrorism insurance coverage is considered an essential element of commercial real estate markets as they currently function.

## **9.2 Statistical Comparison by Firm, Industry and Location**

In order to provide additional insight into terrorism insurance take-up, pricing, and demand, including tests for statistical significance of differences related to firm size, region, and industry, we received data from Aon on terrorism insurance purchases for large accounts (i.e. commercial firms) with the start of coverage from April 2004 through early May 2005.



The identities of the firms were not disclosed. The data included information on:

- The type of terrorism coverage (TRIA only, TRIA and coverage of non-certified acts, TRIA coverage and stand alone terrorism coverage, stand alone coverage only, and no terrorism coverage).
- Annual terrorism limits and premiums.
- Annual property program premiums, coverage limits and all-risk deductibles total insurable value, defined as “replacement property values plus one-year of business interruption value”, which was used as a proxy for firm size.
- Primary industry (sector) and geographic region of the client firms (as proxied by the location of the Aon regional office).

The sample that we analyze includes 478 accounts. Among the sample, 201 accounts purchased no terrorism coverage, and 277 purchased some terrorism coverage. Among the latter group, 94 firms purchased a terrorism coverage limit less than their general commercial property insurance limit (which we denote as “partial” terrorism coverage), and 183 purchased terrorism limits equal to their commercial property limit (“full” terrorism coverage). Fifty-one firms purchased TRIA coverage only, 193 purchased TRIA and coverage for non-certified terrorism losses, 10 purchased a combination of TRIA and stand alone coverage, and 23 purchased stand alone coverage only.

Table 9.2 summarizes the sample distributions of (1) property limit / insurable value, (2) terrorism limit / property limit, (3) terrorism premium / property premium, and (4) insurable value by type of terrorism program and partial versus full terrorism coverage. Median insurable values are larger for firms with stand alone coverage, with or without TRIA coverage, than for firms without stand alone coverage. Consistent with broader coverage on a stand-alone basis (e.g., coverage of more terrorism perils, such as biological or chemical damage, or risky property outside of the U.S.), the average and median terrorism premium as a percentage of the property premium is higher for firms with any stand alone coverage. The mean ratio of terrorism premium/property premium is lower for firms with TRIA and non-certified coverage (e.g., coverage of losses from domestic terrorism) than for firms with TRIA coverage only, suggesting that lower risk firms on average may be more likely to buy non-certified coverage. Firms with TRIA and non-certified coverage also on average insure a larger percentage of insurable value than firms with TRIA coverage only.

For firms with partial terrorism coverage (of any type) compared with their property coverage limit, the terrorism limit averages 28% of the property limit, with an average terrorism premium equal to 5.9% of the property premium. For firms with full terrorism coverage, the average terrorism premium is 6.6% of the property premium and the terrorism limit averages 47% of the property limit. The fact that the average premium for full terrorism coverage is less than 1% higher than for firms with partial terrorism coverage, which average only 28% of their property limits, suggests that firms with partial coverage face significantly higher premium rates for terrorism insurance than firms with full coverage. Those higher rates in turn may help explain why less than full coverage is



purchased. We return to this issue below when we discuss our estimation of the relationship between terrorism limits and terrorism premium rates.

**Table 9.2 Summary Statistics for Selected Coverage Variables by Type of Terrorism Coverage**  
(478 AON accounts Incepting April 2004 through early May 2005)

| Coverage                       | Variable                          | Mean           | Std. Dev. | Min.          | 25th perc. | Median  | 75th perc. | Max.     |
|--------------------------------|-----------------------------------|----------------|-----------|---------------|------------|---------|------------|----------|
| Stand alone<br>(N=23)          | Property limit / insurable value  | 38.6%          | 40.3%     | 1.8%          | 6.3%       | 17.5%   | 91.4%      | 100.0%   |
|                                | Terror limit / property limit     | 54.6%          | 39.3%     | 1.3%          | 16.8%      | 41.2%   | 100.0%     | 100.0%   |
|                                | Terror premium / property premium | 8.3%<br>\$5,63 | 13.2%     | 0.0%          | 3.6%       | 5.4%    | 7.4%       | 65.6%    |
|                                | Insurable value                   | 0              | \$8,730   | \$5           | \$144      | \$1,150 | \$10,400   | \$33,000 |
| TRIA only<br>(N=51)            | Property limit / insurable value  | 34.5%          | 28.9%     | 0.2%          | 14.4%      | 26.5%   | 49.2%      | 100.7%   |
|                                | Terror limit / property limit     | 76.6%          | 38.0%     | 0.4%          | 50.0%      | 100.0%  | 100.0%     | 100.0%   |
|                                | Terror premium / property premium | 7.4%<br>\$4,95 | 8.8%      | 0.0%          | 1.6%       | 4.3%    | 8.6%       | 42.9%    |
|                                | Insurable value                   | 0              | \$14,900  | \$27          | \$289      | \$480   | \$1,820    | \$89,100 |
| TRIA+ non-certified<br>(N=193) | Property limit / insurable value  | 54.2%          | 37.5%     | 0.6%          | 19.6%      | 45.3%   | 97.9%      | 131.4%   |
|                                | Terror limit / property limit     | 78.3%          | 35.9%     | 0.6%          | 50.0%      | 100.0%  | 100.0%     | 100.0%   |
|                                | Terror premium / property premium | 5.8%<br>\$1,89 | 5.9%      | 0.0%          | 2.2%       | 4.3%    | 7.4%       | 44.8%    |
|                                | Insurable value                   | 0              | \$3,940   | \$51          | \$263      | \$564   | \$1,540    | \$28,700 |
| TRIA+ stand alone<br>(N=10)    | Property limit / insurable value  | 44.3%          | 41.2%     | 10.4%         | 14.1%      | 18.8%   | 92.3%      | 112.4%   |
|                                | Terror limit / property limit     | 70.0%          | 42.5%     | 5.9%          | 14.3%      | 100.0%  | 100.0%     | 100.0%   |
|                                | Terror premium / property premium | 8.4%<br>\$4,23 | 10.5%     | 0.0%          | 2.9%       | 4.8%    | 7.2%       | 34.0%    |
|                                | Insurable value                   | 0              | \$2,900   | \$833         | \$2,490    | \$3,190 | \$6,280    | \$9,490  |
| None<br>(N=201)                | Property limit / insurable value  | 39.9%          | 33.9%     | 0.2%          | 11.5%      | 26.4%   | 58.6%      | 121.2%   |
|                                | Terror limit / property limit     | 0.0%           | 0.0%      | 0.0%          | 0.0%       | 0.0%    | 0.0%       | 0.0%     |
|                                | Terror premium / property premium | 0.0%<br>\$2,30 | 0.0%      | 0.0%          | 0.0%       | 0.0%    | 0.0%       | 0.0%     |
|                                | Insurable value                   | 0              | \$4,970   | \$4           | \$198      | \$486   | \$1,770    | \$31,300 |
| Partial<br>(N=94)              | Property limit / insurable value  | 52.5%          | 40.2%     | 0.8%          | 14.9%      | 44.3%   | 100.0%     | 117.9%   |
|                                | Terror limit / property limit     | 28.4%          | 26.3%     | 0.4%          | 6.1%       | 20.0%   | 40.0%      | 100.0%   |
|                                | Terror premium / property premium | 5.9%<br>\$3,12 | 8.0%      | 0.0%          | 1.7%       | 3.9%    | 7.4%       | 65.6%    |
|                                | Insurable value                   | 0              | \$5,660   | \$61          | \$387      | \$1,050 | \$2,910    | \$33,000 |
| Full<br>(N=183)                | Property limit / insurable value  | 47.1%<br>100.0 | 35.4%     | 0.2%<br>100.0 | 18.1%      | 34.6%   | 80.0%      | 131.4%   |
|                                | Terror limit / property limit     | %              | 0         | %             | 100.0%     | 100.0%  | 100.0%     | 100.0%   |
|                                | Terror premium / property premium | 6.6%<br>\$2,71 | 7.2%      | 0.0%          | 2.4%       | 4.6%    | 8.2%       | 44.8%    |
|                                | Insurable value                   | 0              | \$8,580   | \$5           | \$242      | \$480   | \$1,520    | \$89,100 |

*Source: Wharton Risk Center*

Note: Partial indicates purchased terrorism limit less than property limit; full indicated terrorism limit equal to property limit.

***Take-up Rates and Premiums by Region and Industry***

Table 9.3 shows the percentage and number of firms purchasing terrorism coverage by region (regional office) and industry. Consistent with the Aon report, the overall take-up rate is highest in the South (76.0% in our sample) and West (65.5%) and lowest in the Southeast (47.5%). In order to test whether such differences are statistically significant, we estimated a linear probability model of purchasing any terrorism coverage, as a function of region and industry. The results indicate that the terrorism coverage take-up rate is significantly lower (at the 5 percent significance level for a one-tailed test) in the Southeast and Central regions (but not in the Northeast) than in the South and West. In other words, the tests imply that the probability that the differences would arise from chance alone is less than 5 percent.

**Table 9.3 Percentage of Firms Buying Any Terrorism Coverage by Sector and Region**  
(478 AON Accounts Incepting April 2004 through early May 2005)

| Sector                  | Region  |           |        |           |        | Total |
|-------------------------|---------|-----------|--------|-----------|--------|-------|
|                         | Central | Northeast | South  | Southeast | West   |       |
| Basic Materials         | 50.0%   | 45.5%     | .      | .         | 20.0%  | 40.0% |
|                         | 4       | 11        | 0      | 0         | 5      | 20    |
| Construction            | 0.0%    | 50.0%     | .      | .         | 100.0% | 40.0% |
|                         | 2       | 2         | 0      | 0         | 1      | 5     |
| Consumer Goods          | 67.7%   | 55.0%     | 100.0% | 33.3%     | 71.4%  | 60.3% |
|                         | 31      | 20        | 1      | 12        | 14     | 78    |
| Entertainment           | 66.7%   | 61.5%     | 66.7%  | 60.0%     | 90.9%  | 70.2% |
|                         | 15      | 13        | 3      | 5         | 11     | 47    |
| Financial & Real Estate | 60.0%   | 86.7%     | 100.0% | 60.0%     | 92.3%  | 78.9% |
|                         | 15      | 30        | 3      | 10        | 13     | 71    |
| Health Care             | 75.0%   | 100.0%    | 33.3%  | 76.5%     | 33.3%  | 66.7% |
|                         | 12      | 1         | 3      | 17        | 6      | 39    |
| Heavy Industry          | 28.6%   | 50.0%     | 66.7%  | 0.0%      | 60.0%  | 40.6% |
|                         | 28      | 20        | 6      | 5         | 10     | 69    |
| Other                   | 50.0%   | 57.1%     | 100.0% | .         | .      | 58.3% |
|                         | 4       | 7         | 1      | 0         | 0      | 12    |
| Pharma/chemical         | 0.0%    | 18.2%     | .      | 0.0%      | 50.0%  | 15.8% |
|                         | 3       | 11        | 0      | 3         | 2      | 19    |
| Public Sector           | 75.0%   | 42.9%     | .      | 100.0%    | 51.5%  | 56.9% |
|                         | 8       | 7         | 0      | 3         | 33     | 51    |
| Technology              | 45.5%   | 47.1%     | 75.0%  | 0.0%      | 75.0%  | 52.8% |
|                         | 11      | 17        | 4      | 5         | 16     | 53    |
| Transportation          | 75.0%   | 33.3%     | 100.0% | 0.0%      | 100.0% | 71.4% |
|                         | 4       | 3         | 4      | 1         | 2      | 14    |
| Total                   | 54.7%   | 56.3%     | 76.0%  | 47.5%     | 65.5%  | 57.9% |
|                         | 137     | 142       | 25     | 61        | 113    | 478   |

*Source: Wharton Risk Center* The number of accounts in each cell is shown below the percentage.

Firms in the Consumer Goods, Entertainment, Financial & Real Estate, Health Care, Public Sector and Transportation sectors have take-up rates of 60 percent or above. Firms in Basic Materials, Construction, Heavy Industry, and especially Pharma/Chemical have relatively low take-up rates. Based on linear probability model estimates, and except for Construction (only 5 firms), their take-up rates are significantly lower than for Consumer Goods (the sector with the largest number of firms and a 60 percent take-up rate). The difference between the 79 percent take-up rate for Financial & Real Estate and the 60 percent take-up rate for Consumer Goods is highly significant in a statistical sense (very low probability of arising by chance alone).

Table 9.4 shows average terrorism premiums as a percentage of property premiums for firms that purchased terrorism limits equal to property limits. Limiting the comparisons to firms purchasing full terrorism coverage permits an assessment of regional and industry differences in relative premium rates that is not confounded by partial coverage, where the terrorism premium/property premium ratio will tend to decline as the terrorism limit shrinks relative to the property limit. The average terrorism premium/property premium is highest in the Northeast (9.6%) and lowest in the Southeast (4.7%). The differences between the average value in the Northeast and the average values for the Southeast and West are statistically significant. The average terrorism premium/property premium ratio is highest in the Transportation and Financial & Real Estate sectors (8.4% and 8.3%, respectively) and lowest in Consumer Goods (3.2%), and both differences are highly significant statistically. The average values of terrorism premium/property premium ratio for Entertainment, Health Care and Public Sector also are significantly higher than for Consumer Goods<sup>226</sup>.

The regional and industry comparisons shown in Table 9.4 (and the results from the Marsh and Aon studies) may be affected by differences in insurable values across regions and industries. Such differences could cause average terrorism premiums to vary across regions and industries if higher insurable values are associated with relatively higher exposure to terrorism losses than other property losses. The average insurable value, for example, was highest in the South at \$5.9 billion (median \$1.9 billion), compared with \$1.8 billion (median \$777 million) in the West and \$2.8 billion (median \$724 million) in the Northeast.

In order to control for the possible effects of differences in insurable values on relative premiums for terrorism and property coverage, we regressed the terrorism premium/property premium variable (for firms with full terrorism coverage) on the logarithm of insurable value and region and industry indicators. We then calculated the predicted average ratio of terrorism premiums to property premiums by region and industry for a firm with insurable value equal to the average insurable value of firms in the sample.

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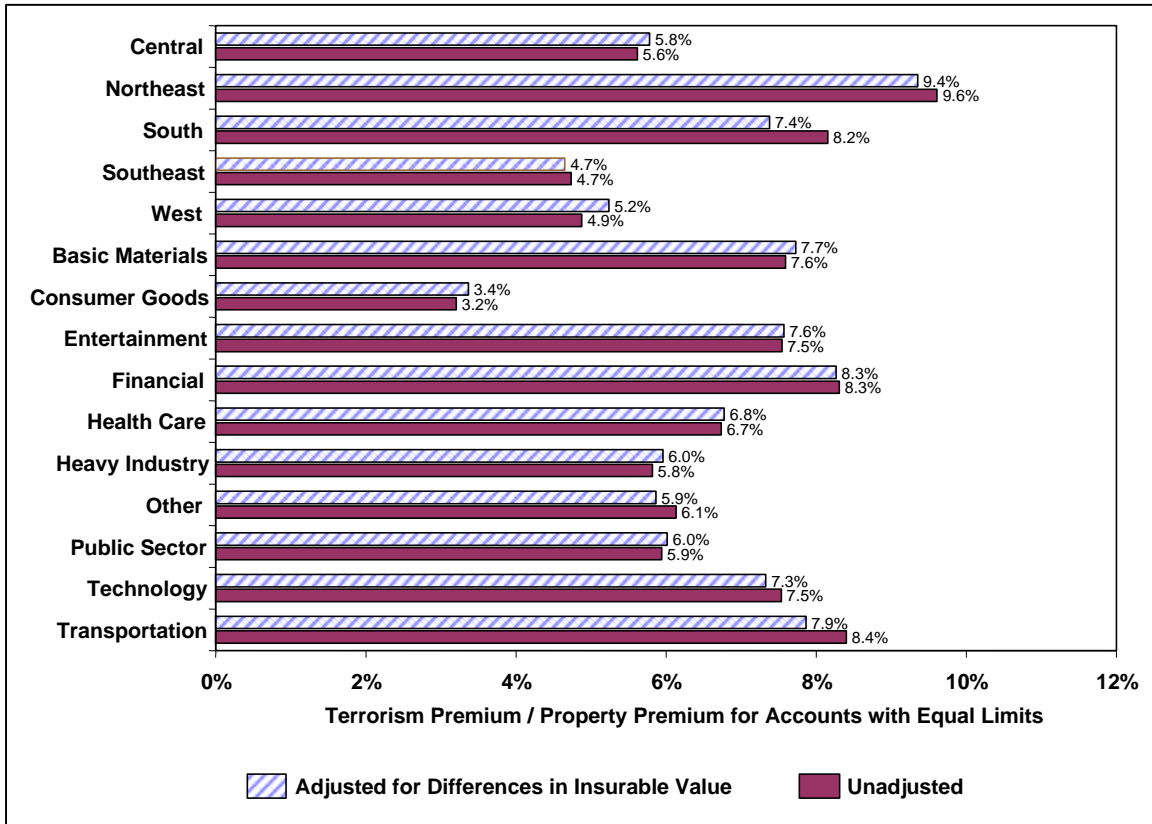
<sup>226</sup> Note that many of the sector-region cells have very few accounts, and no accounts in the construction and pharma/chemical sectors had terrorism limits equal to property limits. The 44.8% value for Health Care in the South is the value for a single account.

**Table 9.4 Terrorism Premium as a Percentage of Property Insurance Premium by Sector and Region**  
(183 AON Accounts with Terrorism Limit Equal to Property Limit)

| Sector                  | Region  |           |       |           |      | Total |
|-------------------------|---------|-----------|-------|-----------|------|-------|
|                         | Central | Northeast | South | Southeast | West |       |
| Basic Materials         | 8.6%    | 7.1%      | .     | .         | .    | 7.6%  |
|                         | 1       | 2         | 0     | 0         | 0    | 3     |
| Consumer Goods          | 3.8%    | 2.5%      | 4.6%  | 2.8%      | 2.5% | 3.2%  |
|                         | 14      | 5         | 1     | 1         | 7    | 28    |
| Entertainment           | 8.1%    | 10.1%     | 4.3%  | 0.0%      | 7.2% | 7.5%  |
|                         | 7       | 5         | 2     | 1         | 8    | 23    |
| Financial & Real Estate | 8.7%    | 12.8%     | 3.8%  | 7.0%      | 2.4% | 8.3%  |
|                         | 6       | 18        | 3     | 3         | 11   | 41    |
| Health Care             | 5.1%    | .         | 44.8% | 5.2%      | 4.2% | 6.7%  |
|                         | 9       | 0         | 1     | 12        | 2    | 24    |
| Heavy Industry          | 4.6%    | 7.4%      | 4.8%  | .         | 4.2% | 5.8%  |
|                         | 5       | 8         | 2     | 0         | 3    | 18    |
| Other                   | 3.6%    | 7.4%      | .     | .         | .    | 6.1%  |
|                         | 2       | 4         | 0     | 0         | 0    | 6     |
| Public Sector           | 6.4%    | 15.0%     | .     | 1.8%      | 5.7% | 5.9%  |
|                         | 4       | 1         | 0     | 2         | 10   | 17    |
| Technology              | 3.6%    | 10.3%     | 4.9%  | .         | 7.8% | 7.5%  |
|                         | 2       | 5         | 3     | 0         | 7    | 17    |
| Transportation          | 6.9%    | 8.0%      | 9.6%  | .         | .    | 8.4%  |
|                         | 2       | 1         | 3     | 0         | 0    | 6     |
| Total                   | 5.6%    | 9.6%      | 8.2%  | 4.7%      | 4.9% | 6.6%  |
|                         | 52      | 49        | 15    | 19        | 48   | 183   |

Source: Wharton Risk Center Note: The number of accounts in each cell is shown below the percentage. No accounts in the construction and pharma/chemical sectors had terrorism limits equal to property limits.

Figure 9.1 shows the resulting average size-adjusted ratios of terrorism premiums to property premiums by region and industry, along with the unadjusted averages (which correspond to those shown in Table 9.4). The average adjusted-value for the South is 7.4%, compared with 8.2% without the adjustment, but the adjustment for differences in insurable value does not change the overall ranking by region of the average terrorism premium as a percentage of property premiums. The difference between the Northeast and the West shrinks with the adjustment, but it remains sizable and statistically significant. The adjustment for differences in insurable value also has relatively little effect on the industry comparisons. Thus, the regional and industry differences in average terrorism premiums in relation to property premiums for firms with full terrorism coverage cannot be explained by differences in the average size of insured properties.



**Figure 9.1 Average Terrorism Premium as Percentage of Property Insurance Premium for 183 AON Accounts with Terrorism Limit Equal to Property Limit by Region and Industry, Unadjusted and Adjusted for Differences in Insurable Values Across Regions and Industries**

### *Take-up Rates by Firm Size*

Figure 9.2 plots terrorism coverage limits versus insurable value for all firms in the overall sample. The plot indicates wide variation in insurable values (firm size) within the subsamples of firms that purchase full, partial and no terrorism coverage. It also suggests that larger firms on average were more likely to purchase some terrorism coverage, but that larger firms with terrorism coverage often purchased relatively low terrorism limits in relation to their property limits compared to many of the smaller firms who purchased coverage.

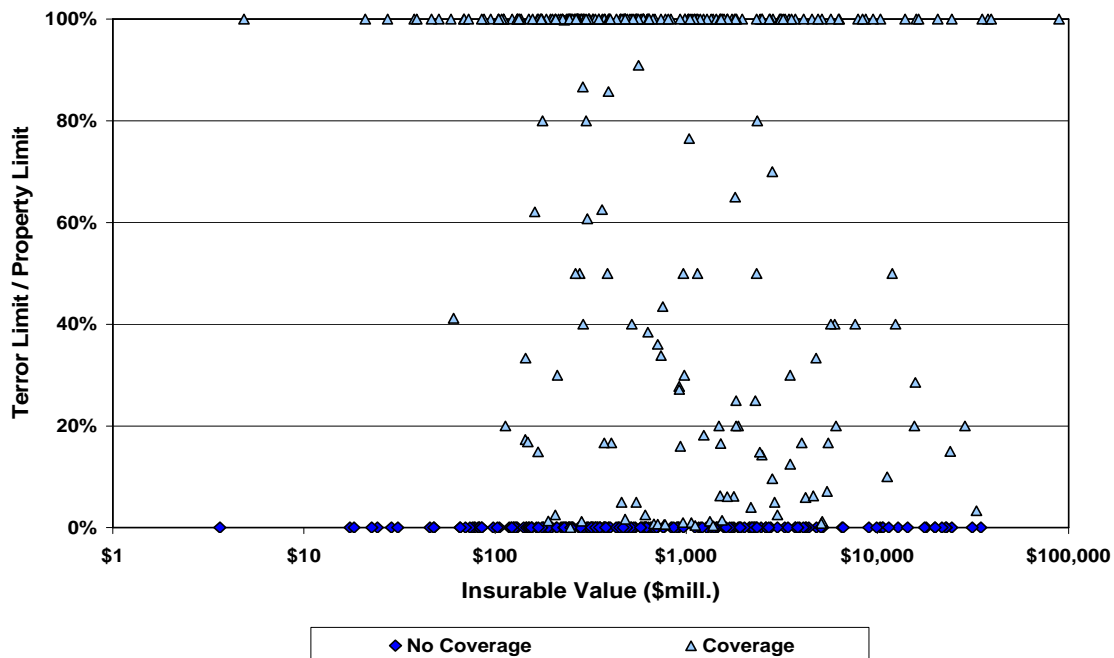
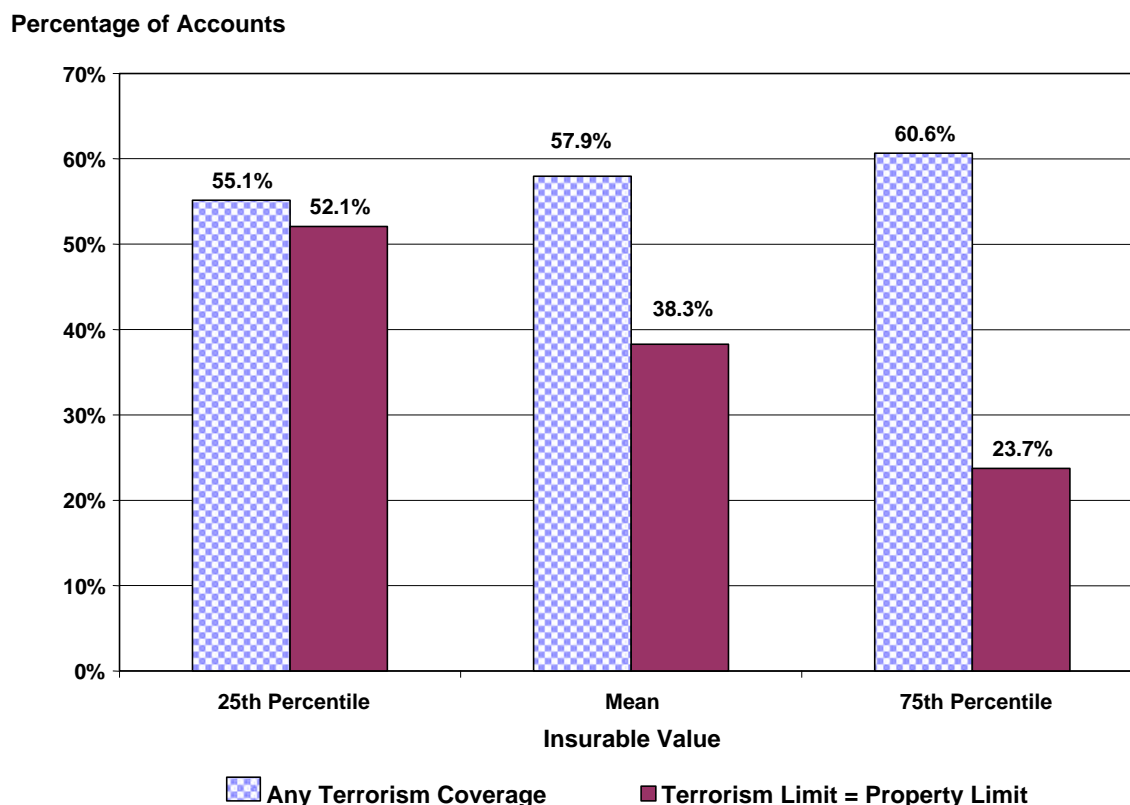


Figure 9.2 RatioTerrorism Limit/Property Limit by Insurable Value (478 AON accounts)

Source: Wharton Risk Center

In order to provide further insight into the relationship between firm size and take-up rates controlling for differences in take-up rates across regions and industries, we estimated linear probability models of (1) the probability of purchasing any terrorism coverage and (2) the probability of purchasing full terrorism coverage in relation to the firm's property limit, in both cases as a function of firm size (measured as the logarithm of insurable value), region, and industry. Firm size was positively and significantly related to the probability of purchasing any terrorism coverage, and it was negatively and significantly related to the probability of purchasing terrorism limits equal to property limits.

Figure 9.3 shows the predicted probabilities from these models for three values of firm size: the 25th percentile value in the overall sample, the sample mean insurable value, and the 75th percentile value. The results indicate a modest increase in the likelihood of purchasing any terrorism coverage as firm size increases from the 25th percentile of insurable value to the 75th percentile (an increase from 55 percent to 61 percent). Thus, larger firms were somewhat more likely to buy some coverage than smaller firms. The estimates indicate a relatively large decrease in the likelihood of purchasing full terrorism coverage in relation to the firm's property limits as firm size increases. The predicted probability for the 25th percentile of insurable value is 52 percent compared with 24 percent at the 75th percentile. This result could reflect that larger firms on average are able to bear relatively more risk of loss from terrorism and/or face relatively higher terrorism premium rates.



**Figure 9.3 Predicted Probabilities of Purchasing Terrorism Coverage for Accounts at 25<sup>th</sup> Percentile, Mean, and 75<sup>th</sup> Percentiles of Insurable Value**

### ***Terrorism Coverage and Terrorism Premium Rates***

In order to investigate the sensitivity of the demand for terrorism insurance to the price of coverage, it would be desirable to have terrorism insurance premium rates and a suitably detailed set of firm characteristics that would be correlated with the risk of loss from terrorism. Such data would allow estimation of the effects of premium rates on the demand for coverage controlling for the risk of loss, so that the estimated effects would reasonably measure the impact of “price” (premium loading) on demand. It also would be desirable to have data on premium rates offered to firms that declined to purchase any terrorism coverage, or at least data on firm characteristics that would be related to such rates. Finally, it would be desirable to have information on firms’ financial and other characteristics that are related to non-price factors that are predicted to affect demand (e.g., factors affecting the expected costs of financial distress, the degree to which non-shareholder stakeholders are diversified, and the firm’s debt-to-equity ratio).

The Aon data include premiums and coverage limits for firms that purchased terrorism coverage, which allows us to calculate premium rates in relation to coverage limits (premium/coverage limit) for those firms. As described earlier, the insurable value, region and industry variables are likely to be correlated with differences in the risk of loss

from terrorism across firms. Confidentiality requirements prevented us from matching the Aon data with firm characteristics obtained from other sources. We were therefore unable to estimate a full model of the demand for coverage, including the effect of price and premium rate on the decision to purchase any coverage. It is also important to note that we did not have information on insurance requirements in loan covenants, which is likely a significant determinant of whether firms purchase any terrorism coverage and the amount of coverage purchased.

We are able, however, to employ the Aon data to provide evidence of the relationship between terrorism premium rates and the amount of terrorism coverage purchased in relation to insurable value and property coverage for firms that purchased some terrorism coverage. To this end, we estimated simple models of the ratio of the firm's terrorism coverage limit to its insurable value, as a function of:

1. the relative rate for terrorism coverage versus property coverage, where the terrorism rate equals terrorism premium/terrorism coverage limit and the property rate equals property premium/property coverage limit;
2. the ratio of the property limit to insurable value, a measure of the firm's general demand for coverage; and
3. insurable value, a measure of firm size.

We estimated the models with and without region and industry indicators. To the extent that expected losses from terrorism vary by region and industry, including these indicators provides some control for differences in expected losses across firms, so that the estimated coefficients on the terrorism premium rate variable may capture relatively more of the effect of differences in price and relatively less of the effect of differences in expected loss.

The dependent variable and the independent variables apart from the indicator variables are measured in logarithms. The coefficients for these variables are therefore "elasticities," (estimated percent change in dependent variable for a 1 percent increase in the independent variable). We used data for the 248 accounts that purchased some terrorism coverage with non-zero premiums shown for such coverage.<sup>227</sup>

The results of estimating the model are shown in Table 9.5. The coefficient on the relative rate for terrorism versus property is negative, approximately the same with and without the region and industry indicator controls, and statistically significant in both specifications, indicating that on average firms that faced higher terrorism insurance rates purchased lower limits in relation to their property limits. The coefficients predict that a 10 percent increase in the relative premium produces approximately a 6.5 percent reduction in the amount of terrorism coverage purchased in relation to insurable value in both specifications. Thus, the estimated coefficients are economically as well as statistically significant.

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<sup>227</sup> Virtually the same results were obtained when the 29 accounts with zero premiums were included in the sample, the relative rate variable was set equal to zero for those observations, and an indicator variable for those accounts was added as a control variable.



**Table 9.5 Regressions of Terrorism Limit / Insurable Value on Terrorism Premium Rate  
Relative to Property Rate and Control Variables**  
(248 Aon accounts with any terrorism coverage and non-zero premiums)

| Variable                              | Without Region and Industry |              | With Region and Industry |              |
|---------------------------------------|-----------------------------|--------------|--------------------------|--------------|
|                                       | Coeff.                      | p-value      | Coeff.                   | p-value      |
| Constant                              | -1.499                      | 0.043        | -1.279                   | 0.055        |
| <b>Terrorism rate / property rate</b> | <b>-0.646</b>               | <b>0.000</b> | <b>-0.664</b>            | <b>0.000</b> |
| Property limit / insurable value      | 0.879                       | 0.000        | 0.860                    | 0.000        |
| Insurable value                       | -0.067                      | 0.052        | -0.054                   | 0.078        |
| Central                               | 0.344                       | 0.003        |                          |              |
| Northeast                             | 0.334                       | 0.020        |                          |              |
| Southeast                             | 0.256                       | 0.059        |                          |              |
| South                                 | 0.413                       | 0.031        |                          |              |
| Basic Materials                       | -0.430                      | 0.129        |                          |              |
| Construction                          | 0.789                       | 0.002        |                          |              |
| Entertainment                         | 0.505                       | 0.005        |                          |              |
| Health                                | 0.486                       | 0.008        |                          |              |
| Heavy Industry                        | 0.084                       | 0.343        |                          |              |
| Financial & real estate               | 0.498                       | 0.001        |                          |              |
| Other                                 | 0.286                       | 0.118        |                          |              |
| Pharma/chemical                       | -0.351                      | 0.124        |                          |              |
| Public Sector                         | 0.568                       | 0.000        |                          |              |
| Technology                            | 0.271                       | 0.084        |                          |              |
| Transportation                        | 0.141                       | 0.279        |                          |              |
| R-squared                             | 81.3%                       |              | 78.5%                    |              |

Note: Dependent and independent variables in logs except for indicator variables. Terrorism rate=terrorism premium/terrorism limit; property rate=property premium/property limit. The p-value is the (one-tailed) probability of observing the estimated coefficient by chance if the true coefficient is zero using heteroskedasticity consistent standard errors.

The coefficients on property limit/insurable value are positive, close to 1 as might be expected, and highly significant statistically. The coefficient on the logarithm of insurable value is negative and statistically significant, albeit only weakly, in both specifications, suggesting again (see Figure 9.3) that larger firms on average purchase less terrorism coverage in relation to insurable value, controlling for the other variables. The coefficients for the regional indicators imply that significantly higher amounts of terrorism

coverage were purchased in the Central, Northeast, South and Southeast regions compared with the West (the omitted category), although the coefficient for the South falls outside the 95 percent confidence region. The coefficients for the industry indicators for Construction, Entertainment, Health, Financial & Real Estate and Public Sector are all positive and significant, implying higher amounts of coverage purchased in these sectors, after controlling for the relative rate for terrorism versus property coverage, and the amount of property insurance purchased in relation to insurable value. While the largest coefficient is for Construction, there was only one account in that sector in this sample.

The analysis is necessarily limited by the available data. However, the overall results are broadly consistent with a negative impact of terrorism premium rates and, plausibly, terrorism insurance prices (premium loadings) on the amount of terrorism coverage purchased.

### 9.3 Accessing TRIA through Captives<sup>228</sup>

We now turn to another source of risk coverage: captives. A significant portion of large U.S. corporations use a captive insurer to manage one or more risks. There are approximately 5,000 U.S. owned captives. Most captives are owned by a single parent corporation, which often own more than one captive. There are also many group captives, which provide coverage to multiple corporate owners (and their affiliates), usually in the same industry. A substantial majority of captives are off-shore corporations, which historically have few regulations and are allowed special tax treatments. However, since the late 1980s there has been significant growth in domestic captives as a result of legislation enacted in many states, notably Vermont, to permit captives and streamline their regulation. Vermont is by far the largest captive domicile in the United States, with over 700 licensed captives as of year-end 2004. About 150 captives are licensed in Hawaii, with smaller numbers in South Carolina, Colorado and a number of other states.

From an economic perspective, single-parent captives essentially represent a special form of self-insurance. The parent company and commonly one or more of its subsidiaries or affiliates purchase insurance from the captive. The captive generally retains (self-insures) a significant amount of the risk of loss and purchases reinsurance for large losses. Although there are legal and subtle economic distinctions, the nature of the risk transfer is qualitatively similar to that achieved by a corporation that retains the same amount of risk on its balance sheet and buys coverage for large losses directly in the commercial insurance market. Advantages of using captives as a form of self-insurance combined with the purchase of excess insurance for large losses include:

- (1) direct access to the reinsurance market (no insurer intermediary), where coverage terms and pricing are more flexible than in the direct insurance market, which is subject to more regulation;

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<sup>228</sup> This section benefited from fruitful interaction with Aon and Marsh captive specialists as well as with officials of the States of Vermont and Hawaii who provided us with data on industry captives established in their states.

- (2) the ability to allocate costs of risk and losses to units through formal premium charges and deductibles; and
- (3) advantages that arise under certain conditions if transactions with the captive are considered insurance for accounting and tax purposes.

### *Captives under TRIA*

After the enactment of TRIA, the Treasury clarified that domestic captives licensed in a state that received premiums for commercial property-casualty insurance were considered insurance companies under TRIA, including captives formed after its enactment. Domestic captives providing property-casualty coverage are thus subject to TRIA's make available requirement: they must offer coverage for certified losses to their policyholders (parents and affiliates). The federal government is offering the same insurance option for losses from terrorism to U.S. corporations that choose to utilize a domestic captive as is available to commercial insurers. If coverage is purchased in 2005, the captive bears the risk of initial losses from terrorism up to its TRIA deductible (i.e., 15 percent of the captive's commercial property-casualty premiums in 2004) plus 10 percent of the loss above that amount. The government bears 90 percent of a captive's terrorism losses above the deductible<sup>229</sup>.

In other words, when foreign terrorism losses exceed \$5 million so that the attack is certified under TRIA, a captive will have 90 percent of its losses above its TRIA deductible subsidized by the federal government. Because the aggregate level of captive premiums is typically small compared to those of commercial insurers, the TRIA deductibles are small as well. That might have induced captives with very low deductible to provide a very large amount of terrorism coverage (the *E\** strategy discussed in Section 6.5). Indeed, Treasury Department guidelines have held that coverage provided by captives for nuclear, biological and chemical events are covered under TRIA. Corporations thus have the ability to access TRIA coverage for such risks through domestic captives, even though the cost of such coverage in the commercial insurance market would likely be much higher. The Treasury has also ruled that captives can provide terrorism coverage with limits greater than the policyholder's general property limits. Should their insured losses exceed their TRIA deductible, captives are not required to pay funds to their policyholders prior to receiving payment from the federal government.

A large majority of captives provide property coverage for terrorism. Workers' compensation is much less common, in large part because states generally do not permit captives to write first dollar direct workers' compensation coverage (Hawaii is an exception). When captives cover terrorism risk, coverage is often provided on a stand-alone basis for certified events, and sometimes for non-certified events and/or domestic terrorism. Some captives purchase reinsurance for any terrorism coverage not backed by TRIA. An early 2005 Marsh survey indicated that 17 percent of its captive clients provided stand-alone terrorism coverage, mostly for property, with nearly half of the policies including some coverage for nuclear, biological or chemical events. About one-fourth

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<sup>229</sup> See Section 1.2 for a description of risk sharing design under TRIA.

purchased reinsurance to cover all or part of the TRIA deductible and/or the captive's share of losses (10 percent) above the deductible.<sup>230</sup>

Treasury has issued several cautionary statements about possible abuse of TRIA protection through captives<sup>231</sup>. If terrorism coverage under a captive arrangement deviates significantly from arrangements found in the regular commercial market, Treasury may interpret the arrangement as a form of gaming or strategizing. Possible sanctions under TRIA include denial of any claims to be paid by the federal government if the losses exceed the TRIA deductible and/or fines levied on the captive. A September 24, 2004, Treasury interpretive letter states:

"The *post*-enactment formation or utilization of a captive insurer that will only provide Stand-Alone, single-risk *TRIA-only* coverage for losses from acts of terrorism raises questions regarding the integrity of the program. We believe that an entity considering forming a captive insurer for Stand-Alone, single risk terrorism insurance should be strongly cautioned and advised against undertaking such proposed action if it is doing so in order to avoid the Act's deductible requirements."<sup>232</sup>

### *Evidence from Vermont and Hawaii*

We obtained data on captives' coverage of terrorism from the two largest domestic captive domiciles, Vermont and Hawaii. Of the 717 Vermont captives at year-end 2004, approximately 60 provided terrorism coverage on a stand-alone basis (under "separate terrorism policies"), predominantly for property exposures. The limits of coverage totaled about \$30 billion. We do not have information on how many captives provided terrorism coverage as part of the same policy issued for other property risks, as opposed to providing it on a stand alone basis. Figure 9.4 shows the distribution of total limits under stand alone coverage according to the primary industry sector of the captive's parent. Financial and manufacturing firms represented over half of the capacity.

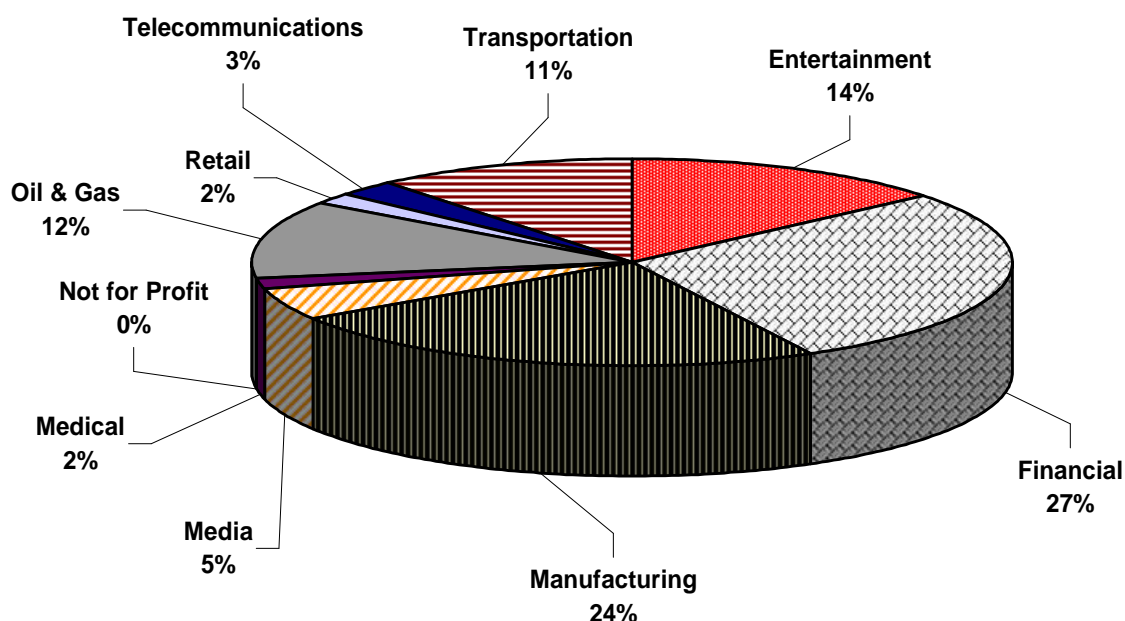
Figure 9.5 shows the number of new captive insurers licensed in Vermont by year during the period 1981-2004. The number of new licenses increased significantly in 2002 and 2003. The extent to which the desire to obtain TRIA protection influenced the increase is uncertain. New captive formations generally increase during hard property-casualty insurance markets, when rates are rising rapidly. A significant increase in formations also occurred during the mid 1980s' hard market for commercial property-casualty insurance. Discussions with major brokers involved in captive services in Vermont, suggest that TRIA was the primary motive in relatively few captive formations (e.g., "10 percent").

<sup>230</sup> Marsh (2005), *Marketwatch: Terrorism Insurance 2005*, p. 25. Note that many captives routinely purchase reinsurance for part of any property losses from other causes.

<sup>231</sup> See Aon (2004), *Terrorism Risk Management and Risk Transfer Market Overview*, December, pp. 28-29 for summary and discussion.

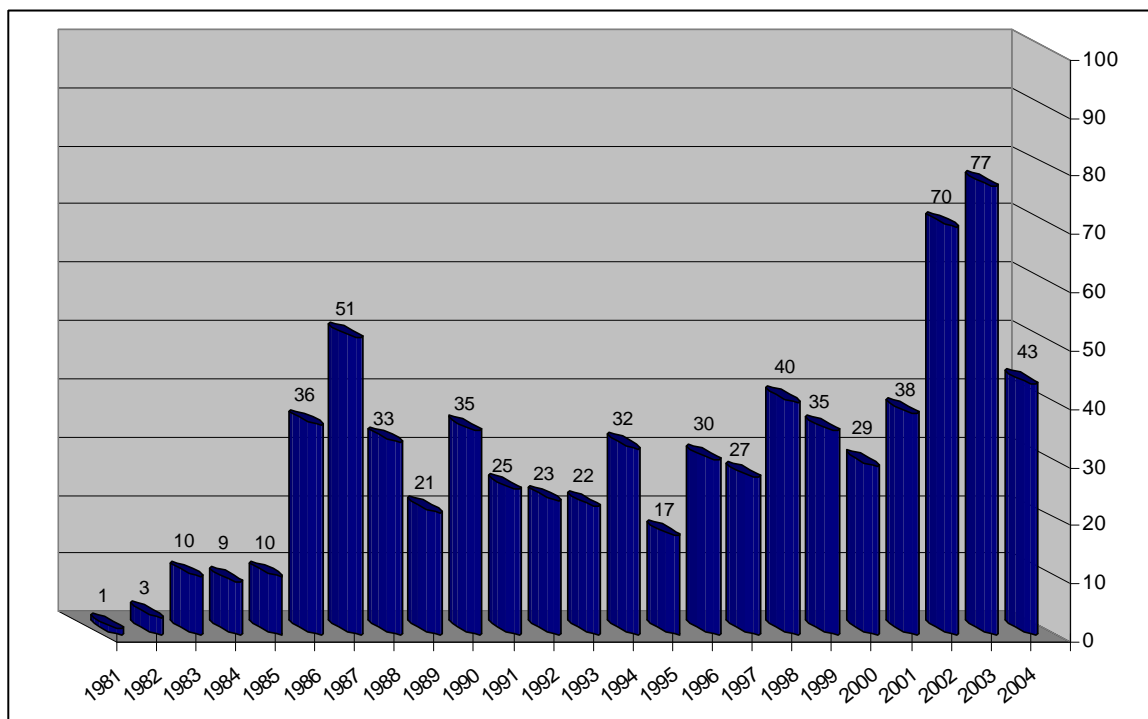
<sup>232</sup> U.S. Department of Treasury (2004). Interpretative letter from Jeffrey Bragg, Executive Director, Terrorism Risk Insurance Program. Washington, DC. Available at: [http://www.treas.gov/offices/domestic-finance/financial-institution/terrorism-insurance/pdf/0924\\_2.pdf](http://www.treas.gov/offices/domestic-finance/financial-institution/terrorism-insurance/pdf/0924_2.pdf)

Information from Hawaii indicates that 50 out of 155 Hawaii-licensed captives provided coverage for terrorism. Forty-five were single parent captives; five were group captives. Forty-nine of the 50 provided coverage for TRIA certified events only. The limits of terrorism coverage totaled \$2.6 billion, composed almost entirely of property coverage (\$1.2 billion) and liability coverage (\$1.4 billion). Five of the captives provided direct workers' compensation coverage (permitted in Hawaii), for which there are no statutory policy limits. The largest sectors in terms of numbers of captives were (1) real estate development and construction, (2) health and medical care and (3) manufacturing.



**Figure 9.4 Vermont Captives Terrorism Limits by Sector**  
*Sources: Wharton Risk Center with data provided by the State of Vermont.*

While the full scope of terrorism coverage under captives is uncertain, it is clear that domestic captives offer corporations the ability to obtain substantial protection under TRIA, including protection of nuclear, biological and chemical events at relatively low prices. It also seems probable that the use of captives for terrorism risk would expand significantly if TRIA were made permanent in its current form.



**Figure 9.5 Vermont Captives Licensed per Year as of December 31, 2004**

*Sources: Wharton Risk Center with data from the State of Vermont*

### **Summary of Chapter 9**

Surveys undertaken by the Wharton Risk Center of members of the National Association of Real Estate Investment Trust (NAREIT) in Spring 2005 revealed that today most lenders require terrorism coverage for real estate loans. If TRIA were not renewed, there was a general feeling by survey respondents that the impact would be negative in the short-run because there would be higher premiums and less coverage. Some NAREIT members felt that their leased property portfolio would be at risk and that they would have to use other nontraditional markets to buy coverage.

An analysis of data provided by Aon to the Wharton Risk Center on their large accounts revealed that approximately 58% of the 478 firms in the sample had purchased some terrorism insurance between April 2004 and early May 2005. Consistent with the NAREIT survey, there was considerable demand for coverage in the real estate sector. Take-up rates and premiums for terrorism coverage vary significantly across regions and industries. Many firms purchased terrorism coverage with limits less than their general property limits. Larger firms in the sample were significantly more likely to buy some terrorism coverage, but on average, bought lower terrorism limits compared with their property limits than smaller firms purchasing terrorism coverage.

Premiums for terrorism coverage as a percentage of property premiums were highest in the Northeast, and lowest in the Southeast and West, even after controlling for differences in average insurable values across regions. The amount of coverage purchased in relation to property limits was negatively related to premium rates for terrorism coverage.

The federal government is offering the same reinsurance option for losses from terrorism to utilize a domestic captive as available to commercial insurers. Empirical data from Vermont and Hawaii, the two states with the most domestic captives, suggest that some captives have provided terrorism coverage to their owners (and affiliates), notably in the manufacturing and financial sectors.





# **PART D**

## **BEYOND TRIA**



## CHAPTER 10

### The Future of Terrorism Insurance

This final chapter aims to frame a more economically effective, socially equitable and politically sustainable program to cover U.S. commercial firms against the economic consequences of terrorism. It also raises a set of questions that need to be addressed in order to achieve this goal.

As discussed throughout the report, threats posed by terrorism have had a higher profile with respect to national security since the tragedy of September 11, 2001. There has been a recognition that terrorists are sophisticated and capable of learning quickly. With limited resources they can wait for the best time and best way to cause mass casualties, economic disruption and increased fear. While much has been accomplished to increase our security, it is very likely that the country will face terrorist attacks on its soil again in the coming years.

It is thus surprising how little attention and resources have been devoted to addressing the question of terrorism risk financing since TRIA was signed into law by President Bush on November 26, 2002. In fact, TRIA was established as a temporary three-year program to give the nation enough time to rethink the most effective and sustainable way for handling the consequences of terrorism with a minimal impact on the economic and social continuity of the country.

The Wharton Risk Center team began this study on *TRIA and Beyond* at the end of 2004 and has had numerous interactions with interested parties in the private and public sectors both in the United States and abroad as well as with other research institutions and universities concerned with the problem. The team has concluded that the delicate question of the financial impact of a terrorist attack on the different affected parties — potential victims, the insurance industry, commercial policyholders and the U.S. taxpayers — and the roles and responsibilities of these and other groups have not been fully addressed in the context of TRIA. The terrorist bombings on the transit system in London in July 2005 have increased interest and debate on the future of TRIA.

Building on the earlier studies cited throughout this report, this concluding chapter suggests future directions for terrorism insurance. Two relevant facts provide some perspective on the debate that the U.S. Congress will likely be having on this issue in the next several months:

- Following the terrorist attacks of September 11, 2001, most commercial enterprises discovered that they were insured against terrorism losses although they had not been charged any explicit premiums for this coverage. The \$34 billion in claims payments by insurers and reinsurers was the most costly event in their history. In addition to these payments, the Federal Victim Compensation Fund established by Congress in 2001 provided nearly \$7 billion in payments to the families of 9/11

victims in return for their relinquishing the right to sue, thus limiting liability losses that might have otherwise been incurred by the insurance industry.

- Approximately two thirds of the insured losses after 9/11 were paid by the reinsurance industry, most being European-based companies. This will not be the case should another attack occur on U.S. soil whether or not TRIA is renewed. Our discussion with reinsurers coupled with the survey results presented in this report (see Appendix 1A) reveals that reinsurers have no intention of providing protection against catastrophic losses from terrorism as they did prior to 9/11.

Although TRIA has provided an important and necessary temporary solution to the problem of providing terrorism insurance to commercial firms, we do not believe it is an appropriate long-term program. Building on the findings of this report, we first suggest ways that TRIA could be modified so it is more efficient and equitable. We then raise a set of issues that need to be addressed in more detail when designing a permanent terrorism insurance program. Given the potential of a large-scale terrorist attack that could cause catastrophic losses to the private sector coupled with existing state requirements for terrorism protection with respect to workers' compensation and fire following an event, there is a need for some involvement by the public sector in providing terrorism protection.

## **10.1 How Should TRIA be Modified?**

TRIA was passed by Congress because of the limited availability of terrorism insurance from the private sector and the demand for coverage by commercial firms either because of lending requirements and/or a desire to be protected against catastrophic losses. In evaluating the performance of TRIA, here are some of the findings that have emerged from this study:

- Approximately half of U.S. commercial firms have now purchased coverage against terrorism. Firms purchase coverage in a variety of forms but the most common purchase is TRIA insurance plus coverage for specified non-certified events such as domestic terrorism
- Data from Aon and Marsh, two brokers who have been involved in this study, reveal that take-up rates vary by region of the country but there are no aggregate data to indicate how much terrorism coverage is written in high-risk urban areas. Take-up rates appear to be highest for firms in the financial, real estate and health care sectors.
- According to a survey of members of the National Association of Real Estate Investment Trusts (NAREIT) that we undertook as part of this study, most lenders require terrorism coverage for their real estate loans.
- Terrorism losses are automatically covered under workers' compensation insurance in all states and losses from fire following a terrorist attack are covered by fire policies in one third of the states. Hence insurers are responsible for paying these

losses whether or not the commercial firms in these states have purchased terrorism insurance.

- In making decisions on how much terrorism coverage they would like to provide, insurers do not incorporate probabilities of a loss as part of their decision process as to how much coverage to offer or where to offer it. Instead, they focus on their exposure from deterministic scenarios such as the detonation of a 5-ton truck bomb in a major urban area in the United States. This is due to the large uncertainties associated with estimating the likelihood of terrorist attacks. This decision process is important to consider when evaluating the pros and cons of any terrorism insurance program, including TRIA.
- Most of the top 30 insurers (based on TRIA-line direct earned premiums in 2004) are likely to bear large amounts of risk as a percent of their surplus under TRIA today because of the large deductibles under the program (15 percent in 2005). An analysis of the deductible (*D*) to surplus (*S*) ratios for the top 451 insurers in the U.S. reveals that in 2003, only 36 insurers had a *D/S* ratio above 20 percent. There were 80 such insurers in 2004 and 162 such insurers in 2005 (including 8 of the top 30).
- Analyses of a terrorist attack causing losses of \$25 billion in New York City revealed that insurers either directly or through a surcharge on their policyholders would cover 86 percent of the insured losses. One would expect similar loss sharing arrangements between insurers and the government should the attack occur in Dallas, TX or Los Angeles, CA. Only if the damage is extremely high (e.g. \$100 billion) will taxpayers bear a significant portion of the loss under the current TRIA program. In states such as California and New York, where only a few companies insure the largest portion of the workers compensation market, these insurers are likely to bear the largest portion of the losses as well. Should a large-scale terrorist attack occur and inflict mass casualties, their loss would then greatly exceed their TRIA deductible. Under the current operation of TRIA, 90 percent of the losses above their deductibles would initially be covered by the federal government and eventually be paid by all commercial policyholders and taxpayers. Since workers' compensation providers are not able to exclude terrorism from their policies, if TRIA were not renewed some of these insurers are likely to become insolvent after a large terrorist attack unless they were able to obtain protection against catastrophic losses from the private sector.
- Empirical data from Vermont and Hawaii, the two states with the most domestic captives, suggest that many corporations, notably in the manufacturing and financial sectors, are eligible for TRIA protection by purchasing insurance through their captives. For example, approximately 60 Vermont captives (out of a total of 717) provided terrorism coverage on a stand-alone basis (under "separate terrorism policies") at the end of 2004, with limits of coverage that totaled approximately \$30 billion. To the extent that these captives have low deductibles relative to their surplus, a large portion of their losses from a terrorist attack is likely to be above their TRIA deductible. Other commercial policyholders will subsidize these losses under the current TRIA program.

- If TRIA is renewed *indefinitely* and maintains its current design, some insurers with very low deductible/surplus ratios may want to write considerably more terrorism coverage than they currently do because they only have to pay 10 percent of the insured losses above their TRIA deductible but would be able to keep all the premiums they collect. They would know that this loss sharing arrangement would be permanent. This creates inequities since all policyholders and taxpayers would be responsible for paying the other 90 percent following the attack.
- Based on the experience of 9/11 as well as the lessons learned from large-scale natural disasters, it is likely that the federal government will provide considerable assistance to uninsured victims of a terrorist attack. This so-called “Samaritan’s dilemma”<sup>233</sup> needs to be considered when designing any terrorism insurance program.
- While efforts to mitigate risk should be integrated with the price of insurance we found no evidence of such a link in the case of terrorism due to the uncertainties and interdependencies associated with this risk. Hence both insurers and insureds are not clear on how to measure and price the real effectiveness of any specific mitigation efforts.

The Wharton Risk Center team concluded that the current structure of TRIA, whereby insurers only pay 10 percent of losses above their deductibles, is a form of free upfront reinsurance that can produce inefficiencies and inequities, including those that result from crowding out private sector capacity. Rather than maintaining this arrangement over the long run, we recommend that consideration be given to other types of arrangements for dealing with catastrophic losses that are discussed in the next section of the chapter.

The development of a strategy for managing terrorism losses needs to be based upon careful analyses of alternative programs in collaboration with key interested parties. In our view this process cannot be completed within the short deadline for determining whether or not TRIA should be renewed. Hence we cautiously recommend that TRIA be renewed for a relatively short period of time and that the federal backstop provision be retained during this period in its present form.

If the federal backstop provision is maintained, we recommend that Congress raise the trigger for providing TRIA coverage from \$5 million to \$500 million.<sup>234</sup> This means

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<sup>233</sup> The Samaritan’s dilemma was introduced by Nobel laureate James Buchanan; see Buchanan, J. (1975), “The Samaritan’s Dilemma”, pp. 71-85 in Phelps, E. (ed), *Altruism, Morality and Economic Theory*, New York: Russell Sage Foundation. The basic idea is that the government (the Good Samaritan) wants to help victims after a major loss. While such an attitude is likely to generate public approval after a disaster it has potentially negative effects on potential victims’ behavior prior to the event. Indeed, it creates moral hazard problems by encouraging risk-taking behavior (including not purchasing insurance) by those who feel they will be financially protected by the government action after an event. That is the Samaritan’s dilemma.

<sup>234</sup> We proposed this increase in certification limits in the June 15, 2005 draft version of *TRIA and Beyond* circulated to sponsors and other parties who provided us with data to for this study. In the U.S. Treasury report on TRIA issued June 30, 2005, we were pleased to see that they came out with the same recommendation.

that any event where the aggregate losses from a foreign terrorist attack are less than \$500 million would be covered entirely by private insurance. This change would reduce the likelihood that captives and other insurers with very low deductible/surplus ratios have their losses after a terrorist attack passed on to general commercial policyholders and/or taxpayers. An increase in the certification limits should also encourage demand for additional private reinsurance, especially for small firms with relatively low surpluses that otherwise would stand to lose a considerable amount of their capital should a terrorist attack occur with aggregate losses in the \$50 to \$500 million range.

Our empirical analyses on the impact of terrorist attacks on loss sharing between victims, insurers, all policyholders and taxpayers indicates that there is uncertainty as to who will eventually be responsible for covering the losses that are paid by the federal government after a terrorist attack. Under TRIA's design the federal government recoups funds from all commercially insured policyholders whether or not they have purchased terrorism coverage. Today, the amount and timing of repayment by commercially insured policyholders to the federal government is at the discretion of the Secretary of the Treasury. We recommend that if a TRIA-like program is renewed by Congress the legislation clarifies how much the government will recoup from whom and over what period of time. Knowing in advance who is responsible for paying losses is an important component of any program that involves the public and private sectors.

## 10.2 Long-Term Alternatives to TRIA

One challenge in providing terrorism insurance is to spread the risks appropriately between the insured parties, the insurance industry, broader capital markets and the government (the taxpayers). For those who recognize protection against terrorism losses as an important component of a national security program, there is a role for federal participation. This is a different rationale than calling for federal intervention in insurance markets because of market failure. In addition, the government has the capacity to diversify risks over the entire population and to spread past losses to future generations of taxpayers, a form of diversification that the private sector cannot achieve because of the incompleteness of intergenerational private markets and legal limitations for insurers to accumulate financial reserves (Kunreuther and Michel-Kerjan, 2004)<sup>235</sup>. However, the creation of a pure government program would exclude the insurers' expertise and financial and operational capacity, such as nationwide operating networks to collect premiums, and the expertise needed to estimate the losses and provide claims payments rapidly.

If a TRIA-like program is renewed for a relatively short period of time, then there is a set of alternative options to be studied that involve the private and public sectors in providing protection against terrorism losses on a more permanent basis. We now turn to these alternatives. Some combination of these alternatives and perhaps other options should be considered in designing a program that provides protection against terrorism

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<sup>235</sup> Kunreuther, H. and Michel-Kerjan, E. (2004), "Policy Watch: Challenges for Terrorism Risk Insurance in the United States", *Journal of Economic Perspectives*, 18: 4 (Fall 2004), pp.201-214.

losses and encourages risk-reducing measures by those who are potential targets of a future attack.

*Deploy Capital of Potential Target Firms* When a firm buys insurance, it is using the insurance firm's capital to bear that risk rather than its own. This often makes sense because the insurer can diversify the risk. But using the insurer's capital is not always the cheapest way to allocate risk. Indeed, the so-called "market failure" in terrorism insurance (low supply and high prices) is a reflection of the very high capital charge that insurers must make to write this form of coverage. Modern enterprise risk management has shown that it often makes sense for a commercial firm to use its own capital to absorb risk, rather than insuring against a loss. In these circumstances, the firm can manage the risk through its own capital management strategy. For example, the firm may lower its debt financing in relation to equity to be able to tolerate more risk. Other more focused strategies include the use of structured debt (e.g. warrants, convertible and forgivable debt) and more recently the use of contingent capital (i.e., financing, such as catastrophe bonds, that is contingent on the occurrence of specified events). Thus, we would envision that a large part of terrorism risk is, and will continue to be, absorbed by the commercial firm's own capital, so that it is, in fact, self insured.<sup>236</sup>

The demand for TRIA was, in part, a response to the real estate development industry's requirement for coverage to secure debt financing. Those institutions providing long-term debt financing to developers could possibly underwrite potential losses from terrorism and charge higher interest rates to reflect the additional risk. Equity capital investors could hold more diversified portfolios, so no single investor would suffer a large and disproportionate diminution in the total value of assets in the event of an attack.

*Reduce Insurers'/Reinsurers' Tax Costs of Holding Capital* As discussed in Section 5.2, U.S. federal tax policy increases the costs of private sector arrangements for spreading catastrophe risk, thus reducing the supply of insurance and alternative risk spreading vehicles. Insurers cannot establish tax deductible reserves for events that have not occurred. More importantly, providing insurance against rare but potentially enormous losses requires insurers to hold large amounts of equity capital, which is primarily invested in marketable securities. Investors can readily purchase the same types of securities directly or through investment funds, in which case the returns on the securities are subject to personal taxes only. When held by an insurer to back the sale of its policies, the returns are taxed twice, at the corporate level and personal level, because insurers cannot hold such capital in tax deferred accounts. In order for the securities to be used to back insurance policies, the premiums must therefore be high enough to compensate investors for the extra layer of taxes. The total cost can be very large for the amounts of capital that must be invested to back the sale of insurance for rare but potentially extreme events, such as large losses from terrorist attacks.

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<sup>236</sup> For more details on strategies that firms can use to self-insurance against risks see Doherty, N. (2000), *Integrated Risk Management*, New York: McGraw-Hill.



The private sector's capacity to offer coverage for losses from terrorism (and other extreme events) would therefore expand if insurers and reinsurers were allowed some form of tax-deferred reserves for terrorism coverage. Such a policy could reduce the costs to insurers and reinsurers of holding the large amounts of capital necessary to provide coverage. This should increase supply and reduce premium rates. This approach should be weighed carefully in view of the potential benefits and the following possible drawbacks: short-term reduction of tax revenues, the disadvantage of industry-specific tax rules, possible difficulty in designing a system that would produce the potential benefits without allowing significant tax deferral unrelated to the program's objectives of expanding the capacity to insure losses from terrorism and possibly other extreme events.

*Deploy Capital of Reinsurers* One potential private market solution that has been discussed is to increase the transfer of risk through reinsurance (Congressional Budget Office, 2005)<sup>237</sup>. Since reinsurance portfolios normally cover sizable losses in the tails of the distribution, reinsurers normally need to hold relatively large amounts of capital compared with primary insurers. During the past several years, most major reinsurers experienced reductions in capital, in part due to the 9/11 attacks, and several of them were downgraded by rating agencies. They decided not to allocate much of their scarce capital to terrorism risk, instead focusing their capital on other lines.

Results from the survey of reinsurers undertaken as part of this study (see Appendix 1A) as well as analyses by the Reinsurance Association of America indicate that the reinsurance industry capacity for providing terrorism coverage under the TRIA program in 2005 is in the range of \$5-6 billion. If TRIA were not renewed, reinsurers responding to the Wharton questionnaire indicated that companies will either maintain the same amount of reinsurance coverage or reduce how much they provide.

There needs to be a more detailed analysis as to the role that private reinsurance could play in providing protection against catastrophic losses from terrorism. One possibility would be a TRIA-like program without individual insurer deductibles that would only provide payments once losses exceeded a large aggregate threshold<sup>238</sup>. This approach would stimulate the demand for reinsurance and avoid some of the distortions associated with individual insurer deductibles and inclusion of captives in the program. Another, not mutually exclusive possibility, would be to base any federal reimbursement of terrorism losses on net (i.e., after reinsurance) losses without requiring that reinsurers make terrorism coverage available. Such a change might significantly increase the scope of reinsurance and associated risk spreading. The terms of reinsurance would reflect the federal backstop, i.e., the reinsurer's ability to be reimbursed for losses, so that reinsurance

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<sup>237</sup> Congressional Budget Office (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC, January.

<sup>238</sup> It is interesting to see that the leading reinsurance companies reentered several European markets for terrorism insurance after 9/11. Most of them did so because their exposure was limited and that they were all part of a pooled reinsurance tranche of a national program. See Michel-Kerjan, E. and Pedell, B. (2005), "Terrorism Risk Coverage in the Post- 9/11 Era: A Comparison of New Public-Private Partnerships in France, Germany and the U.S.," *The Geneva Papers on Risk and Insurance*, 30: 1, pp. 144-170. This article also discusses programs in Spain (established in 1954) and the UK

prices would decline. Primary insurers would be free to either buy reinsurance if available at an affordable price or keep similar exposures as under the current system.

*Facilitate the Use of Terrorism Catastrophe Bonds*<sup>239</sup> A catastrophe bond transfers the risk of a large loss from the insurance/reinsurance industry to the financial markets. As discussed earlier in the report, it has the following structure: under explicit conditions specified at its issuance the bond pays a higher than normal interest rate, but the interest and/or principal payments will be lost if a catastrophe occurs. In the aftermath of Hurricane Andrew (1992) and the Northridge Earthquake (1994), insurers collaborated with the investment banking community to develop new classes of financial instruments for transferring part of the risks of large losses from some natural disasters to the capital markets.

A significant market for catastrophe bonds to cover losses from terrorist attacks has not emerged since 9/11. To date, only three terrorism-related cat bonds have been issued and these were part of multi-event coverage for other risks such as natural disasters and pandemics. The first bond was issued in Europe in August 2003. The world governing organization of association football (soccer), the FIFA, which is organizing the 2006 World Cup in Germany, developed a \$262 million bond to protect its investment. Under very specific conditions, the catastrophe bond covers losses resulting from both natural and terrorist extreme events that would result in the cancellation of the World Cup game without the possibility of it being re-scheduled to 2007 (U.S. General Accounting Office, 2003)<sup>240</sup>. The second bond (Vita Capital) is a securitization of catastrophe mortality risk that was undertaken in December 2003 by Swiss Re (transferring \$400 million of risk to capital markets). The structure of the Vita Capital catastrophe bond is based on a combined mortality index, which applies predetermined weights to the annual general population mortality in several countries including the U.S. A payment of this bond would be triggered if the mortality index during a predefined measurement period up to the end of 2006 is 30 percent higher than expected (based on the 2002 mortality index built by Swiss Re). In April 2005, Swiss Re issued a new bond, Vita Capital II, which operates in a similar manner with a 2010 maturity. The principal of the Vita Capital II bond is at risk if, during a measurement period of any two consecutive years within the risk coverage period, the combined mortality index exceeds predefined percentages of the expected mortality level. The reinsurer would receive up to \$362 million in the event of severe population mortality (Swiss Re, 2005)<sup>241</sup>. These two bonds, however, are not related to any specific peril, so they would cover Swiss Re whether the threshold is triggered by a pandemic that may or may not be terrorist-related (e.g., SARS, influenza) or a terrorist attack using

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<sup>239</sup> Section based on Kunreuther, H. and Michel-Kerjan, E. (2005) "Insuring Mega-Terrorism: Challenges and Perspectives". Report for the OECD Task Force on Terrorism Insurance. In OECD: *Terrorism Insurance in OECD Countries*, July 5.

<sup>240</sup> Congressional Budget Office (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC, January.

<sup>241</sup> Swiss Re (2005), "Swiss Re successfully closes its second life catastrophe bond and obtains \$362 million of mortality risk coverage through the Vita Capital II programme", Press release, April 15.

weapon of mass destruction; in this sense they are potentially terrorism-related, but not terrorism-specific.

The lack of interest in new financial instruments for covering terrorism risk may be due to one or more of the following concerns:

- Investment managers considering investing in these instruments may be worried that if there is a large loss from a cat bond, their reputations (and possibly compensation) will suffer.
- There may be a moral hazard problem associated with issuing such bonds if terrorist groups are connected with financial institutions having an interest in the U.S. For example, the proposed Defense Advanced Research Projects Agency (DARPA) terrorism futures market, FutureMap, considered by the Pentagon in 2003, was aborted due to moral hazard concerns: a terrorist group supported by specific investors might have an obvious financial interest to perpetrate a terrorist attack against a public figure on whose life odds were placed (Science, 2003)<sup>242</sup>.
- Another reason for the limited issuance of terrorism catastrophe bonds was the reluctance of reinsurers to provide protection against this risk following the terrorist attacks of September 11<sup>th</sup>. Financial investors perceive reinsurers as experts in this market. Upon learning that the reinsurance industry required high premiums to provide protection against terrorism, investors were only willing to provide funds to cover losses from terrorism if they received a sufficiently high interest rate (Kunreuther, 2002).<sup>243</sup>
- Most investors and rating agencies consider terrorism models as too new and untested to be used for pricing a catastrophe bond covering terrorism risks. The models are viewed as providing useful information on the potential severity of the attacks but not on their frequency. Without the acceptance of these models by major rating agencies, the development of a large market for terrorism catastrophe bonds is unlikely (U.S. General Accounting Office, 2003)<sup>244</sup>.
- Institutional, tax and regulatory constraints also have discouraged the growth of terrorism-related and other catastrophe bonds (Jaffee, 2005; U.S. Government Accountability Office, 2005)<sup>245</sup>.

A study should be undertaken to analyze behavioral, institutional and regulatory obstacles to the development of a more robust market for terrorism cat bonds and what steps could be taken to modify the current situation.

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<sup>242</sup> Science (2003), 'Terrorism Futures' Could Have a Future, Experts Say" *Science*, 301, p. 749, August 8.

<sup>243</sup> Kunreuther, H. (2002) "The Role of Insurance in Managing Extreme Events: Implications for Terrorism Coverage", *Risk Analysis*, 22: 427-37.

<sup>244</sup> U.S. General Accounting Office (GAO) (2003), *Catastrophe Insurance Risks. Status of Efforts to Securitize Natural Catastrophe and Terrorism Risk*. GAO-03-1033. Washington, D.C.: September 24.

<sup>245</sup> Jaffee, D. (2005), "The Role of Government in the Coverage of Terrorism Risks", Chapter 7 in OECD (2005), *Terrorism Risk Insurance in OECD Countries*, July 5; U.S. Government Accountability Office (GAO) (2005), *Catastrophe Risks, U.S. and European Approaches to Insure Natural Catastrophe and Terrorism Risks*. Appendix III, GAO-05-199, Washington, D.C., February 28.

*Mutual Insurance Pools* Another alternative would be to allow insurers to form an insurance pool to deal with specific lines of coverage, perhaps with some federal backing for large losses. In effect, a group of companies would provide reinsurance to each other. For example, firms insuring high risk assets in the United States and around the world could form their own mutual insurance pools. This solution has the advantage of spreading the risk over a large number of insurers who join these pools, but it is unclear whether this alternative would provide adequate coverage against mega-terrorism.

A group of fourteen U.S. workers' compensation insurers, accounting for roughly 40 percent of the market, teamed up with Towers Perrin so it could assess the feasibility of a workers' compensation terrorism reinsurance pool. This feasibility study undertaken in 2004 concluded that, while the pool could create some additional capacity for each of its members, it would not be enough to matter in the case of a large-scale terrorist attack. The report stated that extreme terrorist attacks could inflict workers' compensation losses of over \$90 billion, three times the capital backing of the private industry's capacity for covering this line of business. In addition, the report concluded that it would be difficult to reach an agreement on the rates that should be charged based on the terrorism exposure of pool participants (Towers Perrin, 2004)<sup>246</sup>.

Pool solutions developed in other countries should be analyzed in more detail to determine their potential application to the U.S. market<sup>247</sup>. A pool does not have to provide coverage for an entire country but can be focused on certain types of risks and/or industries.

*Publicly Administered Mutual Insurance* The need for federal protection against terrorism risks and those of other extreme events arises from the combination of two problems. The loss probability is highly uncertain and the maximum possible loss is large relative to the amount of private reinsurance and catastrophe bonds available to insurers. One strategy for dealing with these two problems is to construct a publicly administered mutual insurance-type program.

There are two key conditions that must hold for this arrangement to be feasible. First, although losses on individual properties can be highly correlated so that the aggregate damage can be large, the losses cannot be perfectly correlated. For example, there might be a severe attack on Houston, New York City or San Francisco, but not necessarily on the three simultaneously. Second, buyers need not agree on what they think the loss probability is at each site, but they must be able to agree (in the simplest case) that it is the same, or (in a more complex case) on what the relative likelihoods are. For example, all buyers might agree that a large-scale assault is twice as likely in Houston and New York City as in San Francisco.

The insurance would work as follows for the case of a mutual insurance program protecting insurers providing terrorism coverage in these three cities. Each insurer would choose a level of protection through the mutual pool and pay an estimated premium. If no

<sup>246</sup> Towers Perrin. (2004), "Workers' Compensation Terrorism Reinsurance Pool Feasibility Study". March.

<sup>247</sup> See OECD (2005), *Terrorism Risk Insurance in OECD Countries*, July 5.

attack occurs on any site after a predefined period of time, any excess premiums above a certain threshold are returned to the insurers in proportion to their original purchase. Suppose a loss does occur in Houston. If its magnitude is less than resources accumulated by the pool to that point, all claims are paid. But if total insured losses exceed claims, insurance buyers would be assessed an additional amount to cover claims. In this example, New York and San Francisco policyholders would furnish the capital to cover excess claims in Houston. If the program included policyholders in Boston, Chicago, Los Angeles and other cities, participants in the pool would furnish some of their capital as well to pay for the losses in Houston. In effect, this arrangement uses as its source of excess capital the undamaged assets of pool participants who have not suffered a loss. Such an arrangement might be voluntary, but it might be made compulsory as well, with the *ex post* assessments proportional to the additional coverage that was made mandatory.

*Federal Reinsurance with Explicit Premiums* Another possible response to the limited capacity of private insurers and reinsurers to furnish coverage against catastrophic losses is a federal reinsurance program with explicit premiums. The most obvious technique for pricing federal reinsurance would be for the government to calculate a premium. It would make its own estimate of the probability of a major attack and the extent of the damages, calculate the expected loss, add a modest amount for administrative expense, possibly tack-on a “risk premium” and offer unlimited amounts of coverage for sale at this premium.

Federal reinsurance would work as follows: in years without any major terrorist attacks, no benefits would be paid out. If an attack were to occur, these collected funds would be used to cover the catastrophic portion of the losses against which insurers had purchased federal reinsurance. If the losses protected by federal reinsurance exceeded the premiums collected, the government would have to finance these claims from other sources of taxpayer revenue. Over time, if the premiums reflected the risks of terrorist attacks, the government reinsurance fund would be replenished.

### 10.3 Some Open Issues

In this section, we highlight the following open issues that have not been analyzed in detail in this study but that should be addressed in the future:

- Gaining knowledge of terrorism premiums collected
- Considering possible federal pre-emption of certain state regulations affecting terrorism insurance
- Considering incorporating both domestic and foreign terrorism acts as part of a terrorism insurance program
- Developing incentive programs for encouraging mitigation

*Gaining Knowledge of Terrorism Premiums Collected* There is great uncertainty associated with the likelihood of any specific terrorist attack occurring during a specific period of time in a specific location. In fact, we have indicated that it is almost impossible to establish such a probability, as the terrorism threat is continuously evolving. If one knew the premiums an insurer collected for a given amount of terrorism coverage for a particular structure in a given location, it would be possible to calculate a range for the implicit probability that the insurer associates with terrorism attacks, as long as reasonable assumptions could be made about the capital costs (charges) included in the premiums. The same logic applies at an industry level.

To date no one has collected and made public the total premiums for terrorism coverage levied by insurers over the three-year operation of TRIA. Such information would be very useful to have available so one can do a more detailed analysis of the impact of TRIA and possibly alternative programs on the determinants of terrorism insurance rates.

*Possible Federal Pre-Emption of Certain State Regulations and Requirements* As explained in detail in Chapter 5, a variety of state regulations constrain private parties' ability to enter into optimal contracts in the presence of terrorism risk. Workers' compensation insurance coverage must include coverage for worker injuries caused by terrorism. About a third of the states continue to require property insurance policies to cover fire losses from terrorism. Rate regulation remains prevalent, especially for workers' compensation insurance, and it could be used to prevent increases in premium rates with or without a federal terrorism insurance backstop. The results could include significant shortages in coverage available from workers' compensation insurers in the "voluntary" market in states that contain relatively high-risk locations. This would lead to an attendant increase in the size of state workers' compensation insurance "residual" markets, at rates perceived as inadequate by insurers. Significant disruptions could also occur in commercial property insurance markets in some states if regulators were to attempt to hold rates below those perceived as necessary by insurers to provide coverage.

Consideration should be given to federal pre-emption of state regulation of terrorism insurance rates as part of any long-term federal involvement in terrorism insurance markets. Consideration likewise should be given to federal pre-emption of state requirements that fire insurance policies cover fire losses following terrorism, as there is no economic basis for such selective restrictions on private contracting. An analysis should be undertaken as to whether there is a need for mandatory coverage of terrorism losses in workers' compensation insurance and possible alternatives to this requirement.

*Considering Covering Both Domestic and Foreign Terrorism*<sup>248</sup> Another question that needs to be addressed is whether the arbitrary distinction that TRIA makes between so-called "foreign" and "domestic" terrorism reflects the current nature of the terrorism threat.

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<sup>248</sup> We appreciated discussions on this domestic terrorism issue with James O. Ellis III (Memorial Institute for the Prevention of Terrorism in Oklahoma City), Mark Potok (Southern Poverty Law Center) and with Henry Schuster (CNN).



TRIA stipulates that a terrorist attack would be certified as an act of terrorism only if it is perpetrated by “an individual or individuals acting on behalf of any foreign person or foreign interest, as part of an effort to coerce the civilian population of the United States or to influence the policy or affect the conduct of the United States Government by coercion.”<sup>249</sup> This definition poses at least two major problems.

First, the evolution of international terrorist activities from more locally organized and even national groups to global organizations makes it difficult to distinguish between domestic and foreign terrorism as illustrated by the July 2005 bombings in London, UK<sup>250</sup>. Some of these terrorists had been trained in Pakistan. Should one thus conclude that they were “acting on behalf of a foreign person or foreign interest”? On the other hand, they had been living in London for years, studying or working there. Should one conclude they acted on behalf of their own ideology? In that case, should we conclude that the nearly 800 casualties were victims of domestic terrorism? Had these events occurred in the U.S. and been more financially damaging, would they have qualified for TRIA coverage? Today this gray zone is likely to inflict legal costs to both victims and insurers, and considerably delay claims payments to victims of the attacks.

Second, the decision to exclude domestic terrorism from TRIA because it was not considered a serious threat needs to be reevaluated in light of the threats posed by extremist groups in the United States<sup>251</sup>. Data on domestic terrorism from the U.S. Federal Bureau of Investigation reveal that over 350 acts of domestic terrorism have been perpetrated on U.S. soil during the period 1980-2001. Although the annual number of such attacks decreased during the 1980s and mid 1990s, it started increasing again in the past ten years averaging 15 attacks a year nationwide during the period 1996-2001 (FBI, 2002)<sup>252</sup>. It is likely that this increase has been galvanized by anti-globalization imperatives. In addition to these organized groups, we also need to consider the emergence of so-called lone wolves. They are harder to find but no less threatening, as illustrated by extremist Timothy McVeigh’s bombing of Oklahoma City ten years ago. While none of these domestic attacks (except for Oklahoma City) have inflicted large-scale damage and casualties to date, they illustrate the potential of homegrown terrorism as a significant threat.

Consideration should therefore be given as to whether it is desirable to include domestic terrorism as part of the events covered in a national terrorism insurance program. The analysis should determine whether the economic rationale for government

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<sup>249</sup> **NEED REF**

<sup>250</sup> For an insightful analysis of the London bombing in that regard, see the series of articles in *The Economist* (2005), “In Europe’s midst”, July 16.

<sup>251</sup> For discussions on the nature of these groups and their operation, see Ellis III, J. “Terrorism in the Homeland: A Brief Historical Survey of Violent Extremism in the United States”, Memorial Institute for the Prevention of Terrorism, Oklahoma City; Hoffman, B. (1998) *Inside Terrorism*. New York: Columbia University Press; Stern, J.. (2003). *Terror in the Name of God: Why Religious Militants Kill*. New York: Harper Collins. Potok, M. (2004), “The American Radical Right: The 1990s and Beyond.” in Eatwell, R. and Mudde, C. (eds) *Western Democracies and the New Extreme Right Challenge*, Routledge; Chalk, P. Hoffman, Reville, R. and B. Kasupski, A-B. (2005) *Trends in Terrorism*, Santa Monica, CA: RAND Corporation, June.

<sup>252</sup> U.S. Department of Justice, Federal Bureau of Investigation (2002), “Terrorism 2000/2001”, FBI, Counterterrorism division, Publication 0328.

involvement in covering the risk of large losses from domestic terrorism is any different from that of foreign terrorism, as well as the problems associated with the arbitrary distinction made by TRIA between “foreign” and “domestic” acts.

*Developing Incentive Programs for Encouraging Mitigation* Further analysis is needed on incentive programs to adequately reward private sector investment in security and by lowering the price of terrorism risk financing and/or providing any other economic incentives such as more favorable tax treatment needs to be analyzed further. As discussed in the report, the absence of a link between insurance and investment in security is not specific to the U.S., as most industrialized countries have not yet implemented such incentive programs either.

However, in the U.S. perhaps more than anywhere else, because nearly 85 percent of our critical services are operated by the private sector, there may also be more opportunities, and a real necessity, for the development of stronger collaborations between the public and private sectors. At the end, that might be one of the critical conditions to really improve our security in a measurable and sustainable way<sup>253</sup>.

#### 10.4 Establishing a National Commission

As stated by the White House in its 2002 National Strategy, homeland security is “the concerted effort to prevent attacks, reduce America’s vulnerability to terrorism, and minimize the damage and recover from attacks that do occur”<sup>254</sup>. We agree. To succeed, security must be a comprehensive national effort.

As part of this effort, this report on *TRIA and Beyond* provides different perspectives and views of the interested parties with whom we have been fortunate to interact over the past six months. It integrates the question of terrorism risk financing with the global challenge associated with national security. It also builds on the research experience of Wharton Risk Center team members on managing and financing this and other low probability-high consequence events. This report provides conceptual and empirical analyses of the supply and demand for terrorism insurance under TRIA as well as under other alternatives. We have concluded that unless one examines in further detail a broader set of policy options, such as those proposed in this chapter, one will not be able to provide a well-reasoned set of recommendations as to the appropriate roles of the private and public sectors in providing terrorism insurance.

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<sup>253</sup> For a more developed analysis of that question in the context of the protection of critical industry sectors, see Auerswald, P. Branscomb, L., La Porte, T. and Michel-Kerjan, E. (eds). *Protecting Critical Infrastructure. Private Efficiency, Public Vulnerability*. Cambridge University Press (forthcoming).

<sup>254</sup> The White House (2002), *National Strategy for Homeland Security*. Washington, DC., July.



As some of us advocated recently<sup>255</sup>, Congress and the White House should consider establishing a national commission on terrorism risk coverage. Indeed, the challenges associated with terrorism risk financing are fundamental, but they will not be solved overnight. Experts and representatives from the public and private sectors should be called upon to suggest the most effective and sustainable way for the nation to recover from future terrorist attacks and the role that insurance can and should play in this process. We look forward to working with others on this important question over the coming months.

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<sup>255</sup> See Howard Kunreuther and Erwann Michel-Kerjan (2005), "Terrorism Insurance 2005. Where Do We Go from Here?" *Regulation. The Cato Review for Business and Government*, Washington, DC: The Cato Institute, Spring 2005 pp. 44-51.



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**Erwann Michel-Kerjan** Erwann Michel-Kerjan is a researcher (faculty) at the Wharton School's Risk Management and Decision Processes Center. Dr. Michel-Kerjan joined the Wharton School in 2002 where his research since has been focused on strategic crisis management and on managing and financing extreme events, primarily terrorism. In particular, his interest is in the creation, implementation and development of private-public partnerships to deal with large-scale emerging risks. He is also acting as project manager of the Wharton-Columbia Radiant Trust, a joint initiative of the Wharton School and the Columbia Business School, established in partnership with Lockheed Martin Corporation and the U.S. Department of Homeland Security. Dr. Michel-Kerjan has been working on these issues in collaboration with industry, governments, academia and international organizations in North America and in Europe for 8 years. He is invited regularly to bring

his dual experience from and to each side of the Atlantic. His first book, *Treatise on New Risks*, (with O. Godard, C. Henry and P. Lagadec) was published in 2002 (Gallimard). As a joint GMU-Harvard-Wharton initiative, he's currently working with P. Auerswald, L. Branscomb and T. LaPorte on a new book, *Protecting Critical Infrastructure: Private Efficiency, Public Vulnerability* (Cambridge University Press).

**Mark V. Pauly** Mark V. Pauly currently holds the position of Bendheim Professor in the Department of Health Care Systems at the Wharton School of the University of Pennsylvania. He is Professor of Health Care Systems, Insurance and Risk Management, and Business and Public Policy at the Wharton School and Professor of Economics in the School of Arts and Sciences at the University of Pennsylvania. Dr. Pauly is a former commissioner on the Physician Payment Review Commission and an active member of the Institute of Medicine. One of the nation's leading health economists, he has made significant contributions to the fields of medical economics and health insurance. His classic study on the economics of moral hazard was the first to point out how health insurance coverage may affect patients' use of medical services. Subsequent work, both theoretical and empirical, has explored the impact of conventional insurance coverage on preventive care, on outpatient care, and on prescription drug use in managed care. His interests in health policy deal with ways to reduce the number of uninsured through tax credits for public and private insurance, and appropriate design for Medicare in a budget-constrained environment. Dr. Pauly is a co-editor-in-chief of the *International Journal of Health Care Finance and Economics* and an associate editor of the *Journal of Risk and Uncertainty*. He has served on Institute of Medicine panels on public accountability for health insurers under Medicare and on improving the financing of vaccines. Dr. Pauly is a former member of the advisory committee to the Agency for Health Care Research and Quality, and most recently a member of the Medicare Technical Advisory Panel.

**Irv Rosenthal** Isadore (Irv) Rosenthal was employed at Rohm and Haas for 38 years in a variety of chemical research, development, business unit and corporate staff positions. After his retirement from Rohm and Haas in 1990, Dr. Rosenthal joined the Wharton Risk Management and Decisions Processes Center as a Senior Research Fellow. His areas of research are focused on the management of risks associated with low probability-high consequence accidents, process safety management, market-based alternatives to government regulation of industrial risks and the methodology of risk assessment. The Senate confirmed President Clinton's nomination of Dr. Rosenthal as a member of the United States Chemical Safety and Hazards Investigation Board (CSB) in November 1998 and he joined the Agency. After completing his five-year term at the CSB on November 2003, Irv rejoined the Wharton Risk Center as a Senior Fellow. His current principle area of research at the Risk Center is focused on evaluating whether the critical elements of effective process safety systems can be identified through application of epidemiology tools to the results obtained from employee survey instruments.

**Peter Schmeidler** Peter Schmeidler is a Senior Fellow at the Risk Management and Decision Processes Center of the Wharton School of the University of Pennsylvania where he is leading projects on the use of third party auditors for safety inspections in lieu of regulatory inspectors. He is also editor of the Risk Center's newsletter, *Risk Management Review*. He retired from the Rohm and Haas Company after 40 years of distinguished service in the area of process design, development and technology. He graduated from Columbia University with both Bachelor's (1959) and Masters (1961) degrees in Chemical Engineering. He also has an MBA from Rutgers - Camden (1982). Mr. Schmeidler is a registered Professional Engineer in the State of Pennsylvania. He is currently doing research on the benefits of certification to the International Standards Organization (ISO) Environmental Management Systems Standard 14001 using a survey of all the facilities that are registered by ISO. The results will be published in 2006 in book form. He is also working with the Economic Research Services of the USDA to arrange a conference in early December on the role of insurance and third party inspections as an enhancement to regulatory oversight in the area of food safety.



