

Catastrophe Modeling: A New Approach to Managing Risk

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What will be Unique About this Book

- Will bring together collective wisdom of the three leading firms in this area (AIR Worldwide, EQECAT, RMS) with the Wharton team on how to assess the risk from natural hazards
- Will explicitly address uncertainty in the context of catastrophe modeling, illustrating the nature of uncertainty in different case studies (e.g., Charleston, South Carolina region)
- Will illustrate the linkage of risk assessment and risk management through insurance rate making, insurance portfolio management and risk financing
- Will illustrate how uncertainty and risk transfer mechanisms affects the analysis of mitigation using three model cities (Oakland, Long Beach, Miami/Dade County)

Audience for the Book

The audience for this book is a sophisticated risk manager or policy maker who has some appreciation for the role that modeling and quantitative analysis can play in improving the decision making process. The September 11th terrorist attacks and ensuing activities makes this book more relevant than before given the interest by the private and public sectors in risk analysis and risk management for extreme events. The book could also be used in courses in risk management.

Style of the Book

The book is written at a reasonably sophisticated level; however, it will not be filled with equations. Sidebars in the chapters will be used to educate the reader interested in learning more about the details of risk assessment and risk management. Graphs, maps and photos will make the material interesting and accessible to a wider audience.

Producing the Book

This book is a joint effort with the three leading modeling firms [Applied Insurance Research Worldwide (AIR), EQECAT, and Risk Management Solutions (RMS)] and Wharton taking a lead on writing specific chapters, but with the other groups providing feedback and input. Chandu Patel of the KPMG and the Casualty Actuarial Society has been serving in an Editorial role and provided helpful comments on each chapter to make it more readable.

The material has been shared with the Technical Advisory Committee as well as the Sponsors of the *Wharton Managing and Financing Extreme Events Project* so we have received comments that has been helpful in putting together the final version of the book.

TABLE OF CONTENTS AND DETAILED OUTLINE OF BOOK

PART I - Framework for Risk Management using Catastrophe Models

CHAPTER 1: Introduction:

Major Contributors: Patricia Grossi and Howard Kunreuther

This chapter provides an overview of natural disaster risk. The book focuses on assessing the risks from *natural disasters* and developing better strategies for reducing future losses and providing financial assistance to aid the recovery effort following a catastrophe. We classify catastrophe risk as the potential economic loss associated with large-scale natural disasters. We discuss the *management* of this risk by individuals and organizations in the United States. Special attention is paid to the role of government at the federal, state, and local levels to manage catastrophe risk.

Chapter 2: An Introduction to Catastrophe Models and Insurance

Major Contributors: Patricia Grossi and Howard Kunreuther

This chapter discusses the history of catastrophe modeling and the role of insurance in the risk management process. The focus is on the residential insurance industry and how catastrophe modeling may enable insurers to provide coverage against natural disasters for fair and reasonable rates. The chapter ends by presenting a framework to integrate risk assessment with risk management, which will be used throughout the remainder of the book.

Part II – NATURAL HAZARD RISK ASSESSMENT

Chapter 3: The Risk Assessment Process: The Role of Catastrophe Modeling in Dealing with Natural Hazards

Major Contributors: M. Mahdyiar and Beverly Porter (Applied Insurance Research)

This chapter depicts the four components of a catastrophe model in a non-technical manner: hazard, inventory, vulnerability, and loss. Examples of earthquake hazard and hurricane hazard are emphasized throughout the chapter. It indicates the importance of scientific and engineering data in developing a catastrophe model, as well as indicating the importance of addressing the needs of the different interested parties concerned with the risk management process.

Chapter 4: Sources, Nature, and Impact of Uncertainties on Catastrophe Modeling

Major Contributor: Patricia Grossi

This chapter discusses the sources, nature, and impact of uncertainties on catastrophe modeling. It discusses how to classify and quantify uncertainty in assessing risks from natural hazards. Two case studies are presented that illustrate how uncertainty affects an

exceedance probability curve, one in Florida and one in Charleston, South Carolina. The Charleston example illustrates how to create confidence intervals for EP curves.

PART III LINKING RISK ASSESSMENT WITH RISK MANAGEMENT

Introduction

Major Contributors: Don Windeler (Risk Management Solutions)

This overview of Part III provides a brief summary on how insurers can utilize catastrophe models for rate making, portfolio management and risk financing. An illustrative example shows how the insurer can develop strategies to maximize its expected profits while at the same time meeting its survival constraint.

Chapter 5: Use of Catastrophe Models in Insurance Rate Making

Major Contributors: Dennis Kuzak and Tom Larsen (EQECAT)

This chapter covers the challenges associated with rate making for catastrophic risk. Special emphasis is given to risk classification and factors that lead to rates exceeding actuarial fair premiums (e.g., uncertainty in losses, insolvency concerns, difficulty of raising capital). The chapter also discusses how changes in some of the features of a policy (e.g. deductible levels, maximum coverage) affect the rates

Chapter 6: Insurance Portfolio Management

Major Contributor: Weimin Dong (Risk Management Solutions)

This chapter focuses on the use of catastrophe modeling to insurance portfolio management. It suggests a set of strategies for dealing with natural hazard risk, indicating the importance of correlation and data quality on assessing the risk to an insurer's portfolio. Additionally, the role that diversifications can play in the size and nature of an insurer's portfolio is illustrated through an example.

Chapter 7: Risk Financing

Major Contributors: Dave Lalonde (Applied Insurance Research)

Natural hazard risks are associated with high severity low frequency events. The significant losses caused by these events can lead to instability of earnings and drain on the economic value of organizations. There are many ways of financing these shock losses to alleviate the disruptions they cause. The chapter provides an overview of various funding mechanisms and how they respond to natural hazards. It discusses both economic benefits and regulatory reasons for various financing schemes. Finally it introduces an evaluation framework to assess one's options and make sound strategic risk financing decisions.

PART IV: MODEL CITY APPLICATIONS

Part IV reports on the analyses completed at the Wharton School under the guidance of

three leading catastrophe loss modeling firms, AIR, EQECAT, and RMS of three model cities: Oakland, California (subject to earthquakes), Long Beach, California (subject to earthquakes), and Miami/Dade County, Florida (subject to hurricanes).

Chapter 8: The Impact of Mitigation on Homeowners and Insurers: An Analysis of Model Cities

Major Contributors: Paul Kleindorfer (Wharton School, University of Pennsylvania), Patricia Grossi and Howard Kunreuther

This chapter focuses on the evaluation of specific loss reduction measures to property owners in the event of a natural disaster. The impact of such measures on insurers offering coverage to residential property owners is discussed first, and then the impact on the property owner is covered. Furthermore, the analysis incorporates uncertainty in the effects of mitigation measures. Effects include the change in the policy design and pricing, profitability, and solvency of a residential insurer, and the benefits of mitigation to the property owner.

Chapter 9: The Impact of Risk Transfer Instruments: An Analysis of Model Cities

Major Contributors: Howard Kunreuther, Paul Kleindorfer, and Patricia Grossi

This chapter focuses on the impact that risk transfer instruments (*for example*, insurance, reinsurance and indexed catastrophe bonds) and selective underwriting strategies have on the performance of insurers and investors with and without natural hazard mitigation. The EP curve is utilized as a way of structuring the analysis for a hypothetical insurance firm whose goal is to maximize its profits subject to two constraints: a safety-first constraint related to the probability of insolvency and a return on assets (ROA) constraint to satisfy the firm's shareholders and investors.

Chapter 10: Extending Catastrophe Modeling to Terrorism and Other Extreme Events

Major Contributors: Howard Kunreuther, Erwann Michel-Kerjan (Wharton School, University of Pennsylvania) and Beverly Porter

This chapter discusses the challenges in providing insurance against terrorism and other extreme events in the light of September 11th. Attention will be given to the difficulties in estimating probabilities and consequences of these events and how ambiguity affects insurer and reinsurer decision processes. Special attention will be given to the role of quantitative models and scenario analysis for aiding insurers and reinsurers in their rate estimation process and their determination of coverage limits. Future public-private partnerships will be examined by exploring terrorism insurance arrangements in the United States and other countries. The chapter will conclude by examining future research challenges as it relates to the role of modeling in developing risk management strategies, dealing with uncertainty and the linkage of loss protection with insurance

GLOSSARY

Major Contributor: Patricia Grossi