Springer Texts in Business and Economics

For further volumes:
http://www.springer.com/series/10099

Peter Zweifel • Roland Eisen

Insurance Economics

Springer

Prof. Dr. Peter Zweifel
University of Zurich
Department of Economics
Hottingerstrasse 10
8032 Zurich
Switzerland
peter.zweifel@econ.uzh.ch

Prof. Dr. Roland Eisen
Dr. Böttcher-Str. 12
81245 Munich
Germany
rolandeisen@googlemail.com

Original German edition published with title "Versicherungsökonomie"

ISBN 978-3-642-20547-7 e-ISBN 978-3-642-20548-4
DOI 10.1007/978-3-642-20548-4
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2011945421

© Springer-Verlag Berlin Heidelberg 2012
This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.
The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

While insurance can be traced back over millennia, it is only in the last half century that we have come to a comprehensive and deep understanding of this most vital, yet complex, economic institution. To really understand insurance takes a deep knowledge of the subtleties of risk and probability, of how rational (and not so rational) people behave when faced with risk; of how insurance companies can be structured to cope with risk; of how governments can effectively intercede when insurance markets fail to deliver. Such a journey will take us to such interesting phenomena as "adverse selection" and "moral hazard"; it will expose us to modern financial theories such as asset pricing theory and option theory and, in doing so, will expose us to such exotic financial instruments as catastrophe bonds. It will take us deep into public policy and the welfare state and into the challenges of operating universal health insurance programs. And it will face us with the challenges of a world where new and unpredicted risks (many of which were revealed in 2007/9 financial crisis) are appearing and for which normal insurance mechanisms may not function. Such is the journey for which Peter Zweifel and Roland Eisen will guide us.

It would be hazardous to try to pinpoint the first attempts to explain an economic theory of insurance. Adam Smith, predictably, had something sensible to say. With commendable parsimony, he captures in two sentences the essential ingredients for such a theory, risk aversion, diversification and the need for capital.

"The trade of insurance gives great security to the fortunes of private people, and, by dividing among a great many that loss which would ruin an individual, makes it fall light and easy upon the whole society. In order to give this security, however, it is necessary that the insurers should have a very large capital. (Wealth of Nations, page 619)".

But Smith does not have too much more to offer on insurance.

While the actuarial processes for insurance have been in continuous development since Adam Smith's time, it really took till the second half of the twentieth century for a modern theory of insurance economics to emerge. I would suggest that the catalyst was Kenneth Arrow's 1963 paper in the American Economic Review which laid out a model of an optimal insurance contract between risk-averse consumers and an insurance company capable of diversification. From this seminal paper has sprung an ever growing field of enquiry in which rational consumers and rational insurers come to together in a mutually beneficial trade of risk. While this line of enquiry deepened our understanding how people come to share risk in an insurance market, and the natural frictions that occur (particularly the conflicting incentives of the policyholders and insurers), there was growing dissatisfaction with a theory that ignored the quirkiness of actual behavior; in real life people might not be quite so rational. How would insurance market work in a world of limited rationality?

At about the same time that Kenneth Arrow was describing how insurance might be explained from rational consumer behavior, the Norwegian actuary and economist, Karl Borch was to produce another idea that was to have profound implications, not only for our understanding of insurance, but also for the manner in which capital markets functioned. In a paper nominally about reinsurance, Borch laid out a complete theory of asset market pricing, which appeared shortly thereafter as the Capital Asset Pricing Model (and for which Bill Sharpe was awarded the Nobel Prize). This had fascinating implications for insurance, for it implied that publicly traded firms should not need insurance – their shareholders could diversify risk just as well as insurance companies. Thus, we needed a new theory for corporate insurance which would explain not only why firms bought insurance, but also how insurance companies manage risk.

But modern financial theory has another set of fascinating implications for those interested in insurance. An insurance policy is simply a financial instrument - strictly speaking it is of the class of instruments known as options. This insight itself may help us to understand, and to price, insurance policies in different ways. But it also reveals why the function of insurance (to transfer risk from one person to another) can also be achieved with other financial instruments. These include options and forward and future contracts in many simple and complex forms. Such instruments are now used routinely as alternatives to insurance by sophisticated risk managers, but are also used by insurance companies to offload their own risk so that they can enhance the security they provide to their own policyholders. But such strategies are not for the faint of heart. Derivatives also have their dark side and have been at the heart of several financial crises, including the recession of 2007/9 (in this case in the form of credit derivatives such as default credit swaps). Thus, rather like a surgeon's scalpel, derivatives can be used for good or bad and their treatment will demand some care and subtlety.

These historical illustrations reveal what a rich and complex phenomenon modern insurance is. And the delight of this book is that it addresses insurance in all its subtleties and richness. Any foundational book on modern insurance will need to prepare students well in the basic disciplines of probability, economics and finance and this is achieved admirably by Roland Eisen and Peter Zweifel. After preparing the reader with a thorough grounding in risk and diversification, they introduce the theory of decision making under risk which leads seamlessly to model of insurance in which all can benefit by a pooling of risk. They guide us through the frictions that can hinder insurance markets when information is not available or shared. With appropriately dismal titles, moral hazard (the lack of care people often exercise when they are protected by insurance) and adverse selection (the tendency for insurance to be bought by those most at risk), are examined along with the clever strategies for their resolution. The financial theory of risk and insurance is dealt with in similar exquisite detail including, not only a rationale for corporate risk management, but also detailed explanation of the financial and operational management of insurance companies, and of the use of reinsurance options and other financial instruments for hedging risk.

Given their intellectual background, it is not surprising that the authors go much further than simply explaining the economic and financial foundations of insurance. Insurance markets are, not surprisingly, quite heavily regulated and such regulation presumably should improve equity and efficiency. Having examined theories of regulation, and described existing and new regulatory initiatives (such as Solvency II), they review the evidence and show when regulation contributes to the common good and when it does not. In similar vein, their treatment of Social Insurance goes far beyond a simple description of programs in place, to address the political-economic foundations for state insurance programs and to embark on a critical examination of such programs and the challenges these face. Throughout all, Peter Zweifel and Roland Eisen are careful to blend the basic theoretical concepts, with real life illustration and a dispassionate review of the evidence.

But the world is changing. And as it does, new risks are appearing which will create a demand for their management and will present new challenges to insurers. Certainly cyber risk has emerged as a mega concern. Climate change is creating new risks of quite unknown magnitude and who will ever be quite so complacent about systemic risk after the recent financial crisis. No treatise can accurately anticipate these new risks. But by careful preparation, we can be prepared, not only to respond to these risks as they arise, but to structure our affairs so that we can be more robust in the face of unknowable shocks. As Louis Pasteur famously said, “chance favors only the prepared mind”. This is a book of surprising substance and, in the changing world of risk, it will prepare us well.

Philadelphia *Neil A. Doherty*

Preface

This book is dedicated to the memory of Wolfgang Müller (†1993), who made the two authors join him for performing a critical review of insurance regulation as envisaged by the European Union at the time. The three of us soon noticed that there did not seem to exist a textbook on insurance economics we could refer to. It would have to be at the crossroads of insurance as one way to cope with risk and insurance as an industry with its own peculiarities. We therefore planned to write a textbook that would be quantitative enough to permit its readers to understand a concept such as "ex-ante moral hazard" while being accessible to (future) practitioners who also want to know "how insurance works". The two survivors finally realized this plan in 2000, when a first edition of the textbook was published in German. Its success suggested that it indeed filled a gap.

Since then, important works have appeared, notably Risk Management and Insurance by Harold W. Skipper and W. Jean Kwon (2007) and Economic and Financial Decisions under Risk by Louis Eeckhoudt, Christan Gollier, and Harris Schlesinger (2005). The first covers a very wide range of topics but in turn avoids all those mathematical formulations and graphical illustrations that are so heavily used in the pertinent scientific literature. The other goes to the other extreme by providing a great deal of advanced theory without ever saying anything about the insurance industry. There still seems to be a gap to be closed.

This volume is unique in at least three ways. First, it clearly distinguishes between the demand for insurance by individuals who lack other alternatives of risk diversification and by those who also have diversification possibilities through the capital market. Accordingly, the reader is made familiar not only with the conventional theory pioneered by Arrow and Borch but with the Capital Asset Pricing and the Option Pricing models developed by Doherty as well. Second, the supply of insurance is given due attention. Analysis of the decision-making problems facing the management of an insurance company are of importance not only to students of Business Administration but also to policy makers inside and outside government who are confronted with initiatives of deregulation and re-regulation and wish to predict the likely consequences of these initiatives. And third, the book devotes an entire chapter to social insurance, whose importance exceeds that of private insurance by far, at least in industrial countries. To this topic, economic analysis is brought to bear and tested against empirical evidence in precisely the same way as in the remainder of the book.

This text is designed for advanced MBA, MSc Fin, and MSc Econ and beginning PhD students. It can be taught as a two-semester course, with the first term devoted to Chaps. 1–4. Chapters 5–9 are recommended for the second term. Chapter 10 (on future challenges confronting insurance) provides not only "food for thought" but also many linkages with the body of the book.

The transition from the original to the present English version called for many modifications, hopefully also resulting in improvements. It required the continuous and concentrated effort of Philippe Widmer, our project coordinator. Without him, the book would not be in existence! We also owe a great deal to Susan Danuser, who transformed hours of voice recording into a raw text. At that point, our two formatting specialists took over. For weeks and months, Christian Elsasser and Alexander Ziegenbein homogenized text, drew graphs, and perfected the layout of tables. Finally, George Elias, Maurus Rischatsch, Johannes Schoder, Michle Sennhauser, Maria Trottmann, Philippe Widmer, and Alexander Ziegenbein read parts of the manuscript. They went far beyond pointing out typos, suggesting many clarifications in exposition. To all of them, we would like to express our gratitude.

Last but not least, there are several generations of students who were exposed to the original German and precursors of the present English text. We are very thankful for their queries and comments. And now we hope that a few more generations of readers will be stimulated by the arguments and insights of the pages that follow. At a minimum, they should not be bored; better still, they may at times even find pleasure reading!

Zurich and Munich

Peter Zweifel
Roland Eisen

Contents

1 Introduction: Insurance and Its Economic Role 1
1.1 Basics and Definitions 1
1.2 Risks and Their Development Over Time 3
1.3 Macroeconomic Importance of Insurance 6
1.4 Functions of Insurance 11
1.5 Major Determinants of the Demand for Insurance 15
1.5.1 The Effects of Wealth and Income 15
1.5.2 The Effect of Price 18
1.6 System Analysis and Organization of the Book 21
1.E Exercises 23

2 Risk: Measurement, Perception, and Management 25
2.1 Definition and Measurement of Risk 26
2.1.1 Definition of Risk 26
2.1.2 Measurement of Risk 27
2.2 Subjective Perception of Risk, Risk Aversion, and the Risk Utility Function 32
2.2.1 Risk Perception as a Subjective and Cultural Phenomenon 32
2.2.2 Risk Aversion and the Risk Utility Function 34
2.3 Willingness to Pay for Certainty, Risk Aversion, and Prudence ... 43
2.3.1 Willingness to Pay for Certainty, Certainty Equivalent, and Risk Premium 43
2.3.2 Risk Premium and Coefficients of Risk Aversion 46
2.3.3 Prudence and Higher-Order Derivatives of the Risk Utility Function 51
2.4 Estimates of Risk Aversion 53
2.4.1 Microeconomic Evidence 54
2.4.2 Macroeconomic Evidence 55
2.5 Instruments of Risk Management 57
2.6 Effectiveness of Risk Management and Risk Policy Measures 60
2.A Appendix: Stochastic Dominance 65
2.A.1 First-Degree Stochastic Dominance 65
2.A.2 Second-Degree Stochastic Dominance 67
2.E Exercises 69

3 Insurance Demand I: Decisions Under Risk Without Diversification Possibilities 71
- 3.1 The Expected Utility Maximization Hypothesis 71
- 3.2 Theory of Insurance Demand 76
  - 3.2.1 The Basic Model 76
  - 3.2.2 Insurance Demand in the Presence of Irreplaceable Assets 81
- 3.3 Demand for Insurance Without Fair Premiums 84
  - 3.3.1 Optimal Degree of Coverage Without Fair Premiums 84
  - 3.3.2 Risk Aversion as a Determinant of Insurance Demand 88
  - 3.3.3 Premium Rate and Wealth as Determinants of Insurance Demand 89
  - 3.3.4 Pareto-Optimal Insurance Contracts 94
- 3.4 Demand for Insurance with Multiple Risks 96
- 3.5 Relation Between Insurance Demand and Prevention 100
- 3.6 Critique of the Expected Utility Hypothesis and Alternatives 105
  - 3.6.1 Anomalies of Expected Utility Theory 105
  - 3.6.2 Alternatives to Expected Utility Theory 108
- 3.E Exercises 109

4 Insurance Demand II: Decisions Under Risk with Diversification Possibilities 111
- 4.1 Risk Management and Diversification 112
  - 4.1.1 Risk Management and Internal Diversification 112
  - 4.1.2 Risk Diversification Through the Capital Market 116
  - 4.1.3 The Capital Asset Pricing Model (CAPM) 124
  - 4.1.4 Arbitrage Pricing Theory (APT) 130
- 4.2 Risk Management, Forward Contracts, Futures, and Options 132
  - 4.2.1 Hedging Through Forward Contracts and Options 132
  - 4.2.2 Hedging Through Stock Options 135
- 4.3 Corporate Demand for Insurance 139
  - 4.3.1 Demand for Insurance in the Light of Capital Market Theory 139
  - 4.3.2 Empirical Studies of Corporate Demand for Insurance 143
  - 4.3.3 Reasons for Corporate Demand for Insurance Not Related to the Capital Market 146
- 4.E Exercises 148

5 The Insurance Company and Its Insurance Technology 151
- 5.1 Financial Statements of an Insurance Company 152
  - 5.1.1 The Balance Sheet 152
  - 5.1.2 Operational Statement 156

5.2 Objectives of the IC ... 160
5.2.1 Theoretical Considerations ... 160
5.2.2 Empirical Evidence Concerning the Importance of IC Objectives ... 163
5.3 Survey of Insurance Technology of an IC ... 167
5.3.1 What is the Output of an IC? ... 167
5.3.2 Instruments of Insurance Technology ... 169
5.4 Choice of Distribution Channel ... 170
5.4.1 Main Distribution Channels for Insurance Products ... 170
5.4.2 The Principal-Agent Relationship as the Underlying Problem ... 171
5.4.3 A Comparison of Cost of Distribution Channels Using U.S. Data ... 173
5.4.4 A Study Relating Performance to Incentives ... 175
5.5 Underwriting Policy ... 177
5.5.1 Instruments of Underwriting Policy ... 177
5.5.2 A Simple Model of Risk Selection ... 178
5.6 Controlling Moral Hazard Effects ... 180
5.7 Reinsurance ... 184
5.7.1 Functions of Reinsurance ... 184
5.7.2 Types of Reinsurance ... 186
5.7.3 A Model of Demand for Reinsurance Based on Option Pricing Theory ... 188
5.7.4 Empirical Testing of the Model ... 194
5.8 Capital Investment Policy ... 197
5.E Exercises ... 203

6 The Supply of Insurance ... 205
6.1 Traditional Premium Calculation ... 206
6.1.1 Claims Process and Loss Distribution ... 206
6.1.2 Basics of Probability Theory and Insurer's Risk ... 215
6.1.3 Premium Principles ... 219
6.2 Financial Models of Insurance Pricing ... 222
6.2.1 Portfolio Optimization by the IC ... 223
6.2.2 Pricing According to Insurance CAPM ... 223
6.2.3 Pricing According to Option Pricing Theory ... 229
6.2.4 Empirical Evidence on the Actual Behavior of IC ... 233
6.3 Economies of Scope ... 241
6.3.1 Economies of Scope and Properties of the Cost Function ... 241
6.3.2 Empirical Relevance of Economies of Scope ... 243
6.3.3 Stochastic Economies of Scope ... 245

6.4 Economies of Scale 246
6.4.1 Definitional Issues 246
6.4.2 Empirical Relevance of Economies of Scale in Life Insurance 249
6.4.3 Empirical Relevance of Economies of Scale in Non-life Insurance 253
6.4.4 Alternatives and Extensions 254
6.4.5 Scale Economies and Size of Market 257
6.E Exercises 259

7 Insurance Markets and Asymmetric Information 265
7.1 Asymmetric Information and Its Consequences 265
7.2 Moral Hazard 268
7.2.1 Definition and Importance of Moral Hazard 268
7.2.2 Ex-Ante Moral Hazard 270
7.2.3 Market Equilibrium with Ex-Ante Moral Hazard 277
7.2.4 Empirical Evidence on Ex-Ante Moral Hazard 281
7.2.5 Ex-Post Moral Hazard in Short-Term Disability Insurance 284
7.3 Adverse Selection 291
7.3.1 Adverse Selection in a Single-Period Framework 291
7.3.2 Empirical Relevance of Adverse Selection 299
7.3.3 Adverse Selection in a Multi-Period Context 303
7.3.4 Empirical Evidence Regarding the Experience-Rating Model 309
7.4 Adverse Selection and Moral Hazard in Combination 311
7.E Exercises 313

8 Regulation of Insurance 315
8.1 Objectives and Types of Insurance Regulation 315
8.1.1 Objectives of Insurance Regulation 315
8.1.2 Avoidance of Negative Externalities 316
8.1.3 Material Regulation 316
8.1.4 Regulation Limited to Formal Requirements 320
8.1.5 Historical Differences in Insurance Regulation Between Countries 322
8.2 Three Competing Theories of Regulation 323
8.2.1 Public Interest Theory 323
8.2.2 Capture Theory 324
8.2.3 Market for Regulation Theory 324
8.2.4 Empirically Testable Implications for Insurance 326

8.3 Effects of Insurance Regulation 328
8.3.1 Evidence from the United States 328
8.3.2 Risk-Based Capital as the U.S. Regulatory Response 335
8.3.3 Evidence from Europe 336
8.4 Recent Trends in Insurance Regulation 341
8.4.1 The Financial Crisis of 2007–2009 341
8.4.2 The Convergence of Banking and Insurance and Regulation 343
8.4.3 Systemic Risk in Insurance Markets? 343
8.4.4 Characterization of Recent Regulatory Initiatives 345
8.E Exercises 347

9 Social Insurance 349
9.1 Importance of Social Insurance 350
9.2 Why Social Insurance? 351
9.2.1 Social Insurance as an Efficiency-Enhancing Institution 352
9.2.2 Social Insurance as an Instrument Wielded by Political Decision Makers 359
9.3 Overview of the Branches of Social Insurance 361
9.3.1 Structural Characteristics of Social Insurance 361
9.3.2 Importance of Branches of Social Insurance 363
9.4 Requirements for Efficient Social Insurance 363
9.4.1 Comparing the Efficiency of Provision for Old Age 364
9.4.2 Efficiency Assessment from a Portfolio Theory Perspective 367
9.5 Macroeconomic Impacts of Social Insurance 371
9.5.1 Impacts of Provision for Old Age 373
9.5.2 Impacts of Social Health Insurance 381
9.5.3 Impacts of Unemployment Insurance 385
9.5.4 Optimal Amount of Social Insurance 386
9.E Exercises 391

10 Challenges Confronting Insurance 393
10.1 Globalization of International Economic Relations 394
10.1.1 Globalization and Corporate Insurance 394
10.1.2 Globalization and Individual Insurance 395
10.2 Changes in Science and Technology 396
10.2.1 Genetic Information 396
10.2.2 Advances in Information Technology 402
10.3 Changes in Legal Norms 405
10.3.1 Principal Elements of Insurance Contract Law 405
10.3.2 Consequences of Deregulation 406

10.4 Increased Frequency and Severity of Catastrophic Events 407
10.4.1 New Elements of Insurance Technology 408
10.4.2 Issues Linked to Reinsurance of Catastrophic Risks 413
10.4.3 Alternative Risk Transfer Through Capital Markets 413
10.5 Demographic Change 416
10.5.1 Aging of Population 416
10.5.2 Increasing Share of One-Person Households 418
10.6 Final Remarks 419

References 423

Author Index 435

Subject Index 439