Georges Dionne *Editor*

Handbook of Insurance

Second Edition

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Springer

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To:
My family,
for their continuous support

Claire Boisvert
for her excellent collaboration

My students
for their hunger for learning

Preface

What a pleasure it is to discover the second edition of the Handbook of Insurance, edited by Georges Dionne, 12 years after the first! Almost all original basic texts are there, for the most part updated to incorporate the scientific foundations of insurance, and have been re-explored through 15 new contributions of great relevance. The field of insurance economics is indeed expanding every year, and it is fascinating to see the depth and breadth of this growth. Old problems are revisited, reformulated, and remodeled, bringing new conclusions and solutions. And through a process of germination, these fruitful developments generate a new stream of highly interesting research.

Many key concepts at the core of risk, uncertainty, and insurance economics have been further refined, reassessed, and reanalyzed over the past 12 years—for example moral hazard, adverse selection, the symmetry and asymmetry of information, and risk aversion. Traditional issues have been re-explored, such as underwriting cycles, the performance of insurance companies, risk management, distribution networks, regulation, recourse to reinsurance, coexistence between private and public insurance, health insurance, and fraud. New issues have emerged or have grown in importance, including systemic risk, longevity risk, long-term care, interactions and dependencies between variables, the corporate governance of insurance companies, capital allocation within insurance companies, and alternative risk transfer devices such as industry loss warranty (ILW), sidecars, cat bonds, swaps, and securitization.

What is striking when reading these various contributions is the recurring issue of optimization. How do you design an optimal insurance contract to minimize moral hazard, whether ex ante or ex post, and reduce or eliminate adverse selection? What is the optimal demand for insurance from a corporation and for reinsurance from an insurance company? How do you draft an optimal regulation, allowing market forces to operate and competition to function, while minimizing costly failures? How do you optimize capital allocation within a company between the various branches, lines of business, and markets? How do you optimize a portfolio of risks by minimizing dependencies? How do you optimize the amount of capital for a given insurance company, while maximizing the rate of return, yet respecting the solvency level corresponding to the chosen risk appetite?

These 37 new contributions and updates provide answers—sometimes straightforward, sometimes more complex—to all of these questions, and provide highly useful tools for a greater understanding of the markets and institutions transferring and sharing risks. This handbook contains a wealth of ideas, insights, models, data and empirical tests, providing food for thought for academics, policy makers, and last but not least, managers of insurance and reinsurance companies. I am convinced that careful reading of this handbook will help researchers to detect new fields and hypotheses to explore, policy makers to draw up regulations based on solid grounds, and managers of insurance companies to innovate, redesign contract policies, improve the use of capital, reorient distribution networks, protect against fraud, and so on. In an ever-expanding risk universe, increased sophistication is the only way to

push back the frontiers of insurability and therefore maintain, or even improve, the level of protection offered to individuals and corporations throughout the world.

May I take the opportunity of this preface to congratulate Georges Dionne for his outstanding contribution to the science of risk and uncertainty. His capacity to develop theories and models, while validating them through empirical work, and to deal with the real issues at the core of insurance industry practice, is unique. May I also thank each of the authors of this new handbook, for providing contributions of such high quality.

I have a simple wish that this handbook be diffused to as wide an audience as possible, both in academic and professional spheres. It will help to improve understanding in terms of the demand and supply of insurance and reinsurance and to promote market solutions for more efficient risk trading. The development of insurance—both for P&C and Life lines—is undoubtedly of benefit to the welfare of society as a whole.

Chairman and CEO of SCOR Denis Kessler

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Introduction

It was the article "Uncertainty and the Welfare Economics of Medical Care" by Kenneth Arrow (*American Economic Review*, 1963) that first drew my research attention to risk, uncertainty, insurance, and information problems. This article proposed the first theorem showing that full insurance above a deductible is optimal when the premium contains a fixed-percentage loading, provided there are no information problems. It also suggests economic definitions of moral hazard and adverse selection. It generated many doctoral dissertations, my own included.

During the 1970s, researchers proposed theorems regarding optimal insurance coverage, security design, moral hazard, adverse selection, and equilibrium concepts for markets with imperfect information. The 1980s were characterized by several theoretical developments such as the consideration of more than one contracting period; commitment; many contracting agents; multiple risks; non-expected utility; and several information problems simultaneously. Other economic and financial issues such as underwriting cycles, financial pricing of insurance, insurance distribution, liability insurance crisis, and retention capacity were addressed by academics and practitioners during that period. Hierarchical relationships in firms and organizations and organizational forms were also studied, along with the measurement of efficiency and the pricing and design of insurance contracts in the presence of many risks.

The empirical study of information problems became a real issue in the 1990s and advanced rapidly in the 2000s. These years were also marked by the development of financial derivative products and large losses due to catastrophic events. Alternatives to insurance and reinsurance coverage for these losses are currently emerging in financial markets. Also, during this period, new forms of risk financing and risk engineering were proposed by the financial markets to cover the growing exposure to catastrophic risk as well as the rising loss exposure from legal liability and other dependent and significant risk exposures. New sources of risk capital were developed, including loss warranties, sidecars, and risk-linked securities, such as catastrophe bonds, options, and swaps. Alternative securitization designs were proposed to expand the market for insurance-linked securities. Risk engineering and modeling techniques were developed to improve solvency measurement and risk management.

New theoretical developments were also published to better understand decision making under risk and uncertainty. Today, higher-order risk attitudes play a central role in understanding how decisions are made by consumers and managers. Portfolio and insurance models that integrate background risk have been put forth to solve different puzzles, partially explained by inadequate standard models for complex risky situations. Longevity risk, long-term care insurance, and corporate governance are now challenging researchers and managers in the insurance industry. Finally, the 2000s have seen the rapid growth of liquidity and operational risks and the second major financial crisis of modern society marked not only by systemic risk in financial markets but also by speculation and lack of transparency in different markets, including the insurance industry.

The aim of this new version of the *Handbook of Insurance* is to update this reference work on risk and insurance for professors, researchers, graduate students, regulators, consultants, and practitioners. It proposes an overview of current research with references to the main contributions in different fields. Fifteen new chapters were added. Many of them cover new research subjects developed since 2000 such as higher-order risk attitude (Chap. 2), statistical dependence (Chap. 6), precaution (Chap. 8), securitization (Chap. 20), corporate governance (Chap. 26), systemic risk (Chap. 27), modern capital allocation (Chap. 29), new insurance market regulation (Chap. 31), longevity risk (Chap. 34), long-term care insurance (Chap. 35), and new life insurance financial products (Chap. 36).

The new version contains 37 chapters written by 59 contributors, who have produced significant research in their respective domains of expertise. Almost all chapters of the 2000 version were rewritten either by the original authors or by new authors: Six are not included in this new edition. This handbook can be considered as a complement to the previous books published by the S.S. Huebner Foundation of Insurance Education in 1992 (*Foundations of Insurance Economics—Readings in Economics and Finance*, G. Dionne and S. Harrington; *Contributions to Insurance Economics*, G. Dionne) and to the two more recent books of readings edited by G. Niehaus, *Insurance and Risk Management* (vol. I: *Economics of Insurance Markets*; vol II: *Corporate Risk Management*).

Each chapter begins with an abstract and can be read independently of the others. They were (with very few exceptions) reviewed by at least two anonymous referees. Below, the contents of this new edition are outlined.

History and Risk and Insurance Theory Without Information Problems

The first chapter is concerned with the history of research in insurance economics. H. Loubergé relates the evolution of insurance research since 1973. One important message from this contribution is that the significant developments of insurance economics during the last 40 years are exemplified by those in the economics of risk and uncertainty and in financial theory. Insurance economics now plays a central role in modern economics by proposing examples and new ideas for understanding the general economy, which is significantly exposed to various risks and uncertainties.

We next turn to the foundations of insurance theory in the absence of information problems. L. Eeckhoudt and H. Schlesinger propose an overview of higher-order risk attitudes, which play a central role in expected utility theory for examining decisions under risk and uncertainty. It is now well understood that risk aversion is not sufficient to explain many behaviors. The authors show how higher-order risk attitudes are consistent with preferences over moments of a statistical distribution even if higher-order attitudes are much more general than preferences over statistical moments.

M. Machina's chapter investigates whether some classical results of insurance theory remain robust despite departures from the expected utility hypothesis. His analysis covers insurance demand; deductible and coinsurance choices; optimal insurance contracts; bilateral and multilateral Pareto-efficient risk-sharing agreements; self-insurance vs. self-protection; and insurance decisions with ambiguity. The general answer to the above question is positive, although some restrictions are necessary given that the non-expected utility model is broader than the classical, linear expected utility model.

C. Gollier concentrates on the derivation of optimal insurance designs when insurers and policyholders have symmetric information about the distribution of potential damages. His chapter shows that the standard optimal result of full insurance coverage above a straight deductible can be obtained without the linear expected utility model. However, the hypothesis of linear expected utility still generates additional results when transaction costs are nonlinear.

The way in which changes in risk affect optimal-decision variables is a difficult and elusive research topic. The major problem is that risk aversion is not sufficient to predict that a decision maker will

reduce his optimal risky position (or increase his insurance coverage) when an exogenous increase in risk is made in the decision maker's environment. Usually, strong assumptions are needed regarding the variation of different measures of risk aversion or regarding distribution functions, to obtain intuitive comparative static results. C. Gollier and L. Eeckhoudt increase the level of difficulty by adding a background risk to the controllable risk. They propose restrictions on first- and second-order stochastic dominance to obtain unambiguous comparative statics results. They also consider restrictions on preferences. Their applications cover the standard portfolio problem and the demand for coinsurance.

P. Embrechts and M. Hofert propose a general overview on modeling risk in finance and insurance. Specifically, they cover interactions and dependencies between different risks. Well-known concepts to model risk are presented, and their advantages and weaknesses are analyzed. Their general approach is particularly useful for analyzing the total risk of complex portfolios containing many dependent risks such as those of insurers and reinsurers and for computing their optimal and regulated capital.

H. Schlesinger has contributed to many articles on market insurance demand. He first presents the classical results related to changes in optimal coinsurance and deductible insurance with respect to initial wealth, loading (price), and attitudes towards risks. The single-risk models are extended to account for multiple risks such as solvency and background risks. It is interesting to observe how many results in the single-risk models extend to the multiple-risk environments.

Prevention and precaution are risk management activities that are still very difficult to understand even in the context of symmetric information. Prevention is associated with self-protection and self-insurance activities introduced in the literature 40 years ago. The effect of risk preferences on optimal self-protection is still puzzling. The concept of precaution is more recent in the economics literature. It is a risk management activity for risky situations that are imperfectly known by decision makers, such as a new pandemic. C. Courbage, B. Rey and N. Treich show how this concept is strongly linked to the effect of the arrival of information over time and to situations where probability distributions are ambiguous.

Asymmetric Information

The book then moves on to asymmetric information problems, which have often been introduced into economics and finance literatures through examples of insurance allocation problems. Two sections of the book are devoted to this subject. The first reviews the main theoretical results related to ex ante and ex post moral hazard (insurance fraud), adverse selection, liability insurance, and risk classification. The second studies the empirical significance of these resource allocation problems.

R. Winter extends his 2000 survey by presenting the development of optimal insurance under moral hazard since the beginning of the 1970s. Ex ante and ex post moral hazard is analyzed. He shows how the insurance context manages to introduce general results in the hidden-action principal-agent problem. Particular attention is paid to the endogenous forms of the insurance contracts and to the factors that influence the design of such contracts. For example, when noncontractible effort affects the frequency but not the severity of accidents, a deductible is optimal whereas when effort affects only the severity, coinsurance above a deductible is optimal. The author also discusses the implications of repeated contracts on the design of optimal insurance policies.

The chapter by G. Dionne, N. Fombaron, and N. Doherty proposes a detailed analysis of adverse selection in insurance markets. Many new subjects are added to the classical one-period models of Stiglitz (Monopoly) and Rothschild and Stiglitz (Competition). Much more attention is paid to the recent developments of multi-period contracting with emphasis on commitment issues and renegotiation between contracting parties. A section is devoted to the endogenous choice of types before contracting, and another one treats moral hazard and adverse selection simultaneously.

Finally, the last section covers various new subjects related to adverse selection: risk categorization and residual adverse selection; multidimensional adverse selection; asymmetric information on risk aversion; symmetric imperfect information; double-side adverse selection; principals better informed than agents; *uberrima fides* and participating contracts.

The risk classification literature was strongly influenced by K. Crocker and A. Snow. Risk classification may not only increase efficiency when certain conditions are met, but it may also introduce adverse equity in some risk classes. The authors revise the theory of risk classification in insurance markets and discuss its implications for efficiency and equity in detail. They show that the economic efficiency of categorical discrimination depends on the informational structure of the environment. They also discuss the empirical literature on risk classification.

J. Ambrose, A. Carroll, and L. Regan study the basic relationships between liability system, liability insurance, and incentives for loss control. They extend the survey of S. Harrington and P. Danzon published in the 2000 version of the handbook. They cover many aspects of liability insurance and its application in the USA: the role of liability rules in providing incentives for loss control; the demand for liability insurance; the effect of correlated risks on liability insurance markets; the design of liability insurance contracts; and the efficiency of the US tort liability/liability insurance system. They also discuss directors' and officers' liability and the general liability insurance crises documented by many studies, including medical malpractice.

Insurance fraud is now a significant resource-allocation problem in many countries. It seems that traditional insurance contracts cannot control this problem efficiently. In fact, there is a commitment issue by the insurance industry because audit costs of claims may become quite substantial. P. Picard surveys the recent development of two types of models: costly state verification and costly state falsification. In the second type, the insured may use resources to modify the claims, whereas in the first he simply lies. In this case, the insurer can use deterministic or random claim auditing that can be conditioned on fraud signals perceived by insurers. Other subjects include adverse selection; credibility constraints on anti-fraud policies; and collusion between policyholders and insurers' agents or service providers when an accident occurs.

The empirical measure of information problems is a more recent research topic in the economics and financial literatures. Many issues are considered in the two chapters written by P.A. Chiappori and B. Salanié and by G. Dionne. P.A. Chiappori and B. Salanié put the emphasis on empirical models that test for or evaluate the scope of asymmetric information in the insurance relationship, whereas G. Dionne discusses insurance and other markets such as labor, used cars, slaves, and mergers and acquisitions. P.A. Chiappori and B. Salanié focus on the methodological aspect of measuring asymmetric information, while Dionne also reports empirical results. P.A. Chiappori and B. Salanié suggest that empirical estimation of theoretical models requires precise information on the contract: information on performance and transfers available to both parties. They underscore the testable consequences that can be derived from very general models of exclusive contracting. Both surveys cover how we can separate moral hazard from adverse selection and asymmetric learning and the recent tests available using dynamic data. G. Dionne concludes that observed efficient mechanisms seem to reduce the theoretical distortions due to information problems and even eliminate some residual information problems. However, this conclusion is stronger for adverse selection. One explanation is that adverse selection is related to exogenous characteristics, while moral hazard is due to endogenous actions that may change at any time. Finally, he shows how some insurance contract characteristics may induce insurance fraud!

R. Butler, H. Gardner, and N. Kleinman review the major contributions on workers' compensation, focusing on empirical measurement of the incentive responses of different indemnity benefits and medical reimbursements. They show how workers' compensation is more complex than other forms of social insurance having a system of diverse state-based laws funded through private, public, and self-insuring entities. Workers' compensation also overlaps with health insurance, unemployment insurance, and other benefits. They conclude by suggesting that more research is needed on the link

between workplace productivity and program characteristics based on worker-centric rather than on program-centric orientation.

The last chapter on the empirical measurement of information problems presents statistical models of experience rating in nonlife insurance. J. Pinquet discusses identification issues on the nature of the dynamics of nonlife insurance data. He shows how longitudinal data can be predicted via a heterogeneous model. Empirical results are presented. He offers consistent estimations for numbers and costs of claim distributions. Examples of predictions are given for count-data models with constant and time-varying random effects, for one and several equations and for cost-number models of events.

Risk Management and Insurance Pricing

The role of corporate insurance demand has not received the same attention as consumer insurance demand in the literature, although we observe that insurance contracts are regularly purchased by corporations and are fairly important in the management of corporate risk. In fact, insurance is simply another risk management tool, much like corporate hedging. The model developed by R. MacMinn and J. Garven focuses on the efficiency gains of corporate insurance to solve underinvestment and risk-shifting problems. Other determinants of the demand for corporate insurance are also reviewed: distress costs, agency costs, and tax costs. Finally, the authors analyze the role of management compensation on corporate insurance decisions and discuss the empirical implications of the theory, tests done and those still needed.

The chapter by H. Kunreuther and E. Michel-Kerjan examines the role of insurance in managing catastrophic risks from natural disasters, by linking insurance to cost-effective risk mitigation measures. This chapter outlines the roles that private markets and municipalities can play in encouraging the adoption of cost-effective risk mitigation measures. It discusses ways to reduce future losses by focusing on protection activities by homeowners and other decision makers. They develop proposals for risk management strategies that involve private–public partnerships.

The development of innovative risk-financing techniques in the insurance industry is one of the most significant advances since 2000. Risk-financing is another part of risk management. Recent innovations in the hybrid insurance and financial instruments have increased insurers' access to financial markets. D. Cummins and P. Barrieu propose an extensive overview of hybrid and pure financial market instruments, not only emphasizing CAT bonds but also presenting futures, options, industry loss warranties, and sidecars. They cover life insurance securitization to increase capital and hedge mortality and longevity risks.

The transfer of risks by insurers to reinsurers remains an important risk management activity in the insurance industry. C. Bernard describes the reinsurance market and analyzes the demand for reinsurance. She covers the design of reinsurance contracts from Arrow's contribution to more recent models with background risk, counterparty risk, regulatory constraints, and various risk measures. Moral hazard and securitization are also studied. Finally, the pricing of reinsurance contracts is analyzed.

The next topic is insurance contract pricing, treated in two complementary chapters: the first discusses financial-pricing models, while the second introduces underwriting cycles in the design of insurance pricing. D. Bauer, R. Phillips, and G. Zanjani propose a comprehensive survey of financial pricing for property–liability insurance and discuss extensions to existing models. The financial pricing of insurance products refers to asset pricing theory, actuarial science, and mathematical finance. The authors present different pricing approaches in a common framework highlighting differences and commonalties. These approaches yield values of insurance assets and liabilities in the setting of a securities market.

After reviewing evidence that market insurance prices follow a second-order autoregressive process in US property-casualty insurance market during the 1955–2009 period, S. Harrington, G. Niehaus, and T. Yu present different theories that try to explain the cyclical behavior of insurance prices and profits. They then provide evidence of whether underwriting results are stationary or cointegrated with macroeconomic factors. They also review theoretical and empirical work on the effects of shocks to capital on insurance supply and the research on the extent and causes of price reduction during soft markets.

Industrial Organization of Insurance Markets

The section on the industrial organization of insurance markets starts off with the two researchers who have influenced this area of research the most, D. Mayers and C. Smith. They first stress the association between the choice of organizational structure and the firm's contracting costs. They then analyze the incentives of individuals involved in the three major functions of insurance firms: the manager function, the owner function, and the customer function. They also examine evidence on corporate-policy choices by the alternative organizational forms: executive compensation policy; board composition; choice of distribution systems; reinsurance decisions; and the use of participating policies. The relative efficiency of different organizational forms is reviewed, and the product-specialization hypothesis in the insurance industry is examined.

Insurance distribution systems are analyzed by J. Hilliard, L. Regan, and S. Tennyson. They first highlight the theoretical arguments for the presence of various distribution systems. They also discuss public policy and regulation associated with insurance distribution. Their chapter focuses on three major economic issues: (1) insurers' choice of distributive system(s); (2) the nature of insurer–agent relationships; and (3) the regulation of insurance distribution activities. Both US and international markets are considered.

N. Boubakri offers a survey of the literature on the nature of corporate governance in the insurance industry. This new subject was covered extensively in a special issue of the *Journal of Risk and Insurance* in 2011. Here the focus is on several corporate governance mechanisms such as the Board of Directors, CEO compensation, and ownership structure. The impact of such mechanisms on insurers' performance and risk taking is also discussed. Several avenues of future research are identified.

The analysis of systemic risk is another new subject in the financial literature. D. Cummins and M. Weiss examine the privacy factors that identify whether institutions are systemically risky and the contributing factors that amplify vulnerability to systemic events. Their first conclusion is that the core activities of US insurers are not affected by systemic risk. However, both life and property–liability insurers are vulnerable to reinsurance crises. Noncore activities such as financial activities, including derivative trading, may cause systemic risk. Regulators need better mechanisms for insurance group provision.

Measuring the efficiency and productivity of financial firms is very difficult, because the definitions of output are multidimensional. D. Cummins and M. Weiss, who have significantly contributed to this research, review the modern frontier efficiency and productivity developed to analyze the performance of insurance firms. They focus on the two most prominent methodologies: stochastic frontier analysis using econometrics and nonparametric frontier analysis using mathematical programming. Methodologies and estimation techniques are covered in detail. Seventy-four insurance efficiency studies are identified by the authors from 1983 to 2011, and 37 papers published in upper tier journals from 2000 to 2011 are reviewed. There seems to be growing consensus among researchers on the definitions of inputs, outputs, and prices in the insurance sector.

Capital allocation concerns an assignment of the capital of a financial institution to the various sources of risk within the firm. Its necessity and feasibility are still discussed in the academic literature.

D. Bauer and G. Zanjani show how incomplete markets and frictional costs create conditions sufficient for capital allocation to play a role as either an input to or a by-product of the pricing process. They also review the various approaches to capital allocation, with particular attention paid to the theoretical foundations of the Euler approach to capital allocation. Finally, the chapter illustrates the application of the Euler method in life insurance.

E. Baranoff, T. Sager, and B. Shi's chapter summarizes the theory and empirical analysis of capital structure for life insurers and health insurers. The capital structure question is carefully adapted from the debt vs. equity theories used for nonfinancial firms to the risk vs. capital theories in insurance. The predictions of agency theory, transaction-cost economics, pecking order, debt-equity trade-off, bankruptcy cost, risk-subsidy, and other theories are developed and summarized in the "finite risk" and "excessive risk" hypotheses. They show that insurers have operated under the finite risk paradigm over the last two decades, even during the last financial crisis.

Insurance regulation has long been a subject of considerable interest to academics, policymakers, and other stakeholders in the insurance industry. R. Klein identifies three topics of particular importance that have significant implications for the regulation of insurance companies and markets: 1) catastrophe risk, 2) imperfect competition, and 3) systemic risk. The author provides an overview of insurance regulation and discusses key issues in this area. Over the last decade, catastrophe risk has increased significantly, and systemic risk in financial markets has had implications on insurance regulation.

Developing and emerging countries have considered financial stability as an essential element of their economic and political independence. However, reliance on foreign insurance and reinsurance has remained an important policy issue. J.F. Outreville presents two important features of insurance markets in developing and emerging economies. The first issue is the relationship between insurance development and economic development which has been assessed in many empirical studies. The second issue is to present some empirical tests of the relationship between the market structure and the retention capacity for some of these countries.

Health and Long-Term Care Insurance, Longevity Risk, Life Insurance, and Social Insurance

Health insurance in the USA continues to be a complex mix of private and public programs. The advent of health-care reform legislation, specifically the Patient Protection and Accountable Care Act (PPACA), introduces new challenges and research opportunities. M. Morrisey provides a historical overview of the US system and a summary of the key features of the PPACA that affect health insurance. Attention is then directed to the key issues in health insurance and an update on the research undertaken in the last decade. Key topics include adverse selection and moral hazard where the new research examines multidimensional selection, forward-looking behavior, prescription drug coverage, and utilization management as a mechanism to control moral hazard. The author also presents new research on important aspects of employer-sponsored health insurance, for instance premium sensitivity, compensating wage differentials, and the tax treatment of employer-sponsored coverage. Recent research has also examined the role of the employer as agent for its workers. Finally, the author examines the effects of risk adjustment in the Medicare Advantage program and the effects in the Medicare prescription drug program.

Longevity risk is analyzed by G. Coughlan, D. Blake, R. MacMinn, A. Cairns, and K. Dowd. This risk of unanticipated increases in life expectancy has only recently been recognized as a significant risk that has raised the costs of providing pensions and annuities. The authors discuss historical trends in the evolution of life expectancy and analyze the hedging solutions that have been developed to

manage longevity risk. One set of solutions has come directly from the insurance industry: pension buyouts, buy-ins, and bulk annuity transfers. Another complementary set of solutions has come from the capital markets: longevity swaps and q-forwards. The authors then review the evolution of the market for longevity risk transfer. An important theme in the development of the longevity market has been the innovation originating from the combined involvement of insurance, banking, and private equity participants.

T. Davidoff covers long-term care insurance. He discusses the considerable variation in limitations to "activities of daily living" and associated expenditures on long-term care. He then treats the question of why the market for private insurance against this large risk is small in the USA. Donated care from family, otherwise illiquid home equity, and the shortened life and diminished demand for other consumption associated with receiving care may all undermine demand for long-term care insurance. Information problems also affect the supply of public and private long-term care insurance.

N. Gatzert and H. Schmeiser provide an overview of new life insurance financial products. First, they identify the key developments and drivers for the life insurance industry. They then present different forms of traditional and innovative life insurance financial products and their main characteristics. They also review the basic aspects of the modeling, valuation, and risk management of unit-linked life insurance contracts with two forms of investment guarantees (interest rate and lookback guarantees). Variable annuities are discussed, with an emphasis on challenges for insurers concerning pricing and risk management of the various embedded options. Finally, they look from the customer's perspective regarding life insurance financial products.

The book ends with the division of labor between private and social insurance. P. Zweifel starts from the observation that the division of labor between private insurance (PI) and social insurance (SI) has changed substantially in the past decades, to the advantage of the latter. The efficiency view of SI explains the existence of SI along with the market failures of PI, namely moral hazard and adverse selection. A benevolent government is introduced that seeks to determine the optimal division of labor between PI and SI. The discussion thus supports the public choice view, which emphasizes the interests of risk-averse voters even with below-average wealth in redistribution through SI. This view predicts a crowding out of PI by SI even in markets without adverse selection. Normative issues are also discussed.

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Chapter 1
Developments in Risk and Insurance Economics: The Past 40 Years

Henri Loubergé

Abstract The chapter reviews the evolution in insurance economics over the past 40 years, by first recalling the situation in 1973, then presenting the developments and new approaches which flourished since then. The chapter argues that these developments were only possible because steady advances were made in the economics of risk and uncertainty and in financial theory. Insurance economics has grown in importance to become a central theme in modern economics, providing not only practical examples to illustrate new theories, but also inspiring new ideas of relevance for the general economy.

Keywords Insurance economics • Insurance pricing • Economics of risk and uncertainty • Financial economics • Risk management • Asymmetric information

1.1 Introduction

In the early 1970s, some 40 years ago, the economics of risk and insurance was still embryonic. Indeed, when the International Association for the Study of Insurance Economics (known as the "Geneva Association") was founded in 1973, one of the main goals of its promoters was to foster the development of risk and insurance education in economics curricula. In particular, there existed then a clear need to develop an understanding for risk and insurance issues among the future partners of the insurance industry. It seemed also necessary to attract the attention of economists to risk and insurance as a stimulating and promising research field.

At that time, some attempts to link insurance to general economic theory had already been made, but they were still scarce. The books written by Pfeffer (1956), Mahr (1964), Greene (1971), and Carter (1972), or the one edited by Hammond (1968), tried to bridge the gap. (Corporate) risk management started, at least in the USA, to be considered seriously as a branch of study—see Mehr and Hedges (1963) and Greene (1973) for early references. The main obstacle was obvious: traditional economic theory was based on the assumption of perfect knowledge—with some ad hoc departures from this assumption, as in the theory of imperfect competition or in Keynesian macroeconomics. In order to witness an integration of risk and insurance issues into general economics, the theory of risk had to develop and to gain a position at the heart of economic theory. The foundations were already at hand: the von Neumann and Morgenstern (1947) and Savage (1954) theory of behavior under uncertainty, the Friedman and Savage (1948) application to risk attitudes, Pratt's (1964) analysis of

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risk aversion, Rothschild and Stiglitz (1970) characterization of increases in risk, and the Arrow (1953) and Debreu (1959) model of general equilibrium under uncertainty. These approaches had already started to bring about a first revolution in the study of finance, with the Markowitz (1959) model of portfolio selection and the Sharpe (1964), Lintner (1965), and Mossin (1966) model of equilibrium capital asset pricing (the CAPM). With the benefit of hindsight, we know now that they did provide the starting point for the accomplishment of one of the Geneva Association's long-term objective: the integration of risk and insurance research into the mainstream of economic theory.

The purpose of this chapter is to remind the reader of the situation of insurance economics in 1973 (Sect. 1.2), and to summarize its main development since then in the three main areas of investigations that could be defined at that time: Optimal insurance and protection (Sect. 1.3); market equilibrium under asymmetric information (Sect. 1.4); and insurance market structure (Sect. 1.5). Section 1.6 introduces a personal bias toward financial economics by focussing on the new approaches which resulted from the growing integration of insurance and finance. Section 1.7 concludes. Due to limitations in space and time, two important related topics were omitted from this survey: health economics and social security. In addition, life insurance is only partially covered in Sect. 1.6. The discussion is mainly concentrated on risk and insurance economics issues as they relate to property–liability insurance.[1]

1.2 Insurance Economics in 1973

In 1973, the economic theory of insurance had already begun to develop on the basis of five seminal articles: Borch (1962), Arrow (1963a), Mossin (1968), Ehrlich and Becker (1972), and Joskow (1973).[2] All these articles were based on the expected utility paradigm. Following these articles, and more particularly the first two of them, a bunch of important articles were published. They were a signal that the elaboration of an economic theory of risk and insurance was under way.

1.2.1 Borch (1962)

In his 1962 *Econometrica* article "Equilibrium in Reinsurance Markets," Karl Borch showed how Arrow's (Arrow (1953)) model of general equilibrium under uncertainty could be applied to the problem of risk-sharing among reinsurers. But generations of economists later learned that this insurance application had far-reaching implications for the general economy.[3] In 1953, Arrow had shown that financial markets provide an efficient tool to reach a Pareto-optimal allocation of risks in the economy. Nine years later, Borch's theorem[4] was showing how the mechanism could be organized in practice.

[1] Note that all chapters appearing in the 2000 version of this *Handbook* are excluded from the reference list, on the expectations that the present version includes revised version of these surveys.

[2] Note that two of these six authors, Kenneth Arrow and Gary Becker, received later the highest distinction for economic research—the Nobel Prize in economics.

[3] See Gollier (1992) for a review of the economic theory of risk exchanges, Drèze (1979) for an application to human capital, and Drèze (1990) for an application to securities *and* labor markets.

[4] Actually, Borch's theorem was already present in Borch (1960), but the latter article was primarily written for actuaries, whereas the 1962 *Econometrica* article was addressed to economists.

The main argument is the following. In a population of risk-averse individuals, only social risks matter. Individual risks do not really matter, because they can be diversified away using insurance markets (the reinsurance pool of Borch's contribution). But social risks—those affecting the economy at large—cannot be diversified: they have to be shared among individuals. Borch's theorem on Pareto-optimal risk exchanges implies that the sharing rule is based on individual risk-tolerances (Wilson 1968). Each individual (reinsurer) gets a share in the social risk (the reinsurance pool) in proportion to its absolute risk-tolerance, the inverse of absolute risk-aversion. If all individual utility functions belong to a certain class (later known as the HARA[5] class, and including the most widely used utility functions), the sharing rule is linear. The above-mentioned CAPM, for long the dominant paradigm in finance theory, represents a special case of this general result.

In my view, Borch's contribution provides the corner stone of insurance economics. It may be conveniently used to show how the insurance mechanism of risk-pooling is part of a more global financial mechanism of risk-allocation, and how a distinction may nevertheless be made between insurance institutions and other financial institutions.[6] For this reason, it may be used to clarify ideas on a hotly debated issue: the links between finance and insurance (see Sect. 1.6 below).

In the years until 1973, Borch's seminal contribution found its main insurance economics extensions in the contributions by Arrow (1970) and Kihlstrom and Pauly (1971).[7] Arrow (1970) explicitly defined insurance contracts as conditional claims—an exchange of money now against conditional money in the future. Kihlstrom and Pauly (1971) introduced information costs in the risk-sharing model: they argued that economies of scale in the treatment of information explain why insurance companies exist. In 1974, Marshall extended further this analysis by introducing a distinction between two modes of insurance operations: reserves and mutualization (Marshall 1974). Under the reserve mode, aggregate risk is transferred to external risk-bearers (investors). With mutualization, external transfer does not apply, or cannot apply: aggregate losses are shared among insureds.

1.2.2 Arrow (1963a)

The article published in 1963 by Kenneth Arrow in *The American Economic Review* under the title "Uncertainty and the Welfare Economics of Medical Care" represents the second point of departure for risk and insurance economics. This work may be credited with at least three contributions. First, the article provided, for the first time, what has become now the most famous result in the theory of insurance demand: if the insurance premium is loaded, using a fixed-percentage loading above the actuarial value of the policy, then it is optimal for an expected utility maximizing insured to remain partially at risk, i.e., to purchase incomplete insurance coverage. More specifically, Arrow proved that full insurance coverage above a deductible is optimal in this case. Second, Arrow also proved that when the insured and insurer are both risk-averse expected utility maximizers, Borch's theorem applies: the Pareto-optimal contract involves both a deductible and coinsurance of the risk above the deductible—a result later extended by Moffet (1979) and Raviv (1979), and more recently generalized by Gollier and Schlesinger (1996) and by Schlesinger (1997) under the less restrictive assumption

[5]HARA = Hyperbolic Absolute Risk Aversion. As noted by Drèze (1990), the linearity of the sharing rule follows from the linearity of the absolute risk tolerance implied by hyperbolic absolute risk aversion.

[6]The question whether or not "institutions" are needed to allocate risks in the economy was tackled later in the finance literature.

[7]The applications of Borch's theorem in the actuarial literature are reviewed by Lemaire (1990).