

INTRODUCTION TO THE SCOR-JRI SPECIAL ISSUE ON NEW FORMS OF RISK FINANCING AND RISK ENGINEERING

The world's insurance markets face growing exposure to catastrophic risk as well as rising loss exposure from legal liability, marine, aircraft, and other risk exposures. In response, global reinsurers have raised significant amounts of new capital, and the financial markets have responded with the development of innovative alternative financing techniques. The special issue examines many relevant aspects of these dynamic changes in risk financing and risk engineering.

The articles in the special issue fall into two primary categories. The first category of articles focuses on risk financing by insurers and reinsurers and the relative importance of various sources of new risk capital. This group of articles analyzes the financing of catastrophic risk and the relationship between reinsurance and capital market solutions. The discussion considers innovative sources of risk capital including industry loss warranties, multiperil and multitrigger contracts, sidecars, and risk-linked securities, such as catastrophe bonds, options, and swaps. Theoretical articles consider alternative securitization designs that may be able to expand the market for insurance-linked securities, and a comparative analysis is provided of alternative regulatory approaches to catastrophe risk finance in the United States and the European Union. The second category of articles in the special issue focuses on risk engineering and modeling, with particular emphasis on methodologies that can be utilized in solvency measurement and risk management. Articles in this category consider the theory and application of copulas as well as the impact of linear and nonlinear dependencies among risks. Also considered are optimal reinsurance strategies under regulatory constraints, the modeling of mortality risk and securitization with stochastic jumps, and the economic relationship between insurance premiums and financial markets. The remainder of this introduction provides a brief overview of the articles published in the special issue.

RISK FINANCING BY INSURERS AND REINSURERS

J. David Cummins and Philippe Trainar consider strengths and weaknesses of reinsurance and securitization in managing insurable risks. Traditional reinsurance operates efficiently in managing relatively small, uncorrelated risks and in facilitating efficient information sharing between cedants and reinsurers. However, when the magnitude of potential losses and the correlation of risks increase, the efficiency of the reinsurance model breaks down, and the cost of capital may become uneconomical. At this

juncture, securitization has a role to play by passing the risks along to broader capital markets. Securitization also serves as a complement for reinsurance in other ways such as facilitating regulatory arbitrage and collateralizing low-frequency risks.

J. David Cummins and Mary A. Weiss conduct a broad analysis of the convergence of insurance and financial markets in transferring risk. Convergence has been driven by the increase in the frequency and severity of catastrophic risk, market inefficiencies created by (re)insurance underwriting cycles, advances in computing and communications technologies, and the emergence of enterprise risk management, among other factors. These developments have led to the creation of hybrid insurance-financial instruments that blend elements of financial contracts with traditional reinsurance as well as new financial instruments patterned on asset-backed securities, futures, and options that provide direct access to capital markets. Cummins and Weiss also provide new information on the pricing and returns on contracts such as industry loss warranties and catastrophe (cat) bonds. The results show that cat bond returns have low correlations with returns on alternative investments such as stocks and bonds.

Pauline Barrieu and Henri Loubergé analyze diversification issues related to cat bonds. Insurance-linked securities, such as cat bonds, have been issued to complete the international risk transfer process, but so far they account for only a small proportion of the overall market for insurance risk transfer. Cat bonds represent idiosyncratic risks, diversifiable at the world level. For various reasons, reinsurance markets are unable to cope with this risk completely. The authors argue that downside risk aversion and ambiguity aversion explain the limited success of cat bonds. Hybrid cat bonds, combining the transfer of cat risk with protection against a stock market crash, are proposed to complete the market and thereby increase market volume.

Silke Finken and Christian Laux investigate the link between catastrophe bonds and reinsurance by studying the competitive effect of information-insensitive triggers. They identify a new benefit of index or parametric triggers. Asymmetric information between reinsurers regarding an insurer's risk affects competition in the reinsurance market: reinsurers are subject to adverse selection because only high-risk insurers may find it optimal to change reinsurers. The consequence is the presence of high reinsurance premiums and cross-subsidization of high-risk insurers by low-risk insurers. A contract with a parametric or index trigger (such as a cat bond) is insensitive to information asymmetry and therefore alters the equilibrium in the reinsurance market. Provided that basis risk is not too high, the introduction of contracts with parametric or index triggers provides low-risk insurers with an alternative to reinsurance contracts and therefore leads to less cross-subsidization in the reinsurance market.

Robert W. Klein and Shaun Wang conduct a comparative analysis of alternative regulatory approaches for catastrophe risk financing in the United States and the European Union. The regulation of insurance companies continues to evolve in response to market forces and the changing nature of risk. One important area where both economic realities and markets are changing is catastrophe risk and its financing. This article examines and compares regulatory and other government policies in both economic regions and analyzes their approaches to the regulation of catastrophe risk financing. The authors analyze the fundamental differences between the U.S. and EU systems to gain insights into their disparate treatment of catastrophe risk finance. Although policies could be improved in both jurisdictions, the authors argue that much greater

reform is needed in the United States relative to the European Union. They offer recommendations on how U.S. policies could be significantly improved and also comment on issues facing the European Union.

RISK ENGINEERING AND MODELING

Paul Embrechts discusses the role of copulas, which have become increasingly important in finance and insurance risk modeling. Embrechts reviews the origins of copulas; discusses some important current research, mainly from an applications point of view; and comments on potential future developments. Finally, he discusses in detail the popular and controversial question: "Which copula to use?"

Martin Eling and Denis Toplek propose an application of copulas by considering the influence of nonlinear dependencies on a non-life insurer's risk and return profile. To achieve this, they integrate several copula models in a dynamic financial analysis framework and conduct numerical tests. They also test risk management strategies in response to adverse outcomes. They find that extreme events are especially relevant because nonlinear dependencies significantly impact both the insurer's ruin probability and the expected policyholder deficit (EPD). In the presence of nonlinear dependencies, increasing equity capital reduces the ruin probability but does not necessarily reduce the EPD. They also find that simple risk-reduction strategies such as reinsurance reduce the ruin probability but not the EPD. Hence, modeling nonlinear dependencies is important for insurers, regulators, and rating agencies that use these measures as a foundation for internal risk models, capital standards, and ratings.

Christian Gourieroux and Wei Liu are concerned with the control and out-of-sample validation of dependent risks. They introduce a framework to determine and allocate capital reserves to multiple dependent business lines, with or without overall reserve level constraints. The proposed methodology emphasizes the role of the loss function in the validation criterion and its conditional interpretation. Univariate and multivariate examples are discussed in detail. The methodology can be employed to address some limitations of the Solvency II capital regulations.

Carole Bernard and Weidong Tian consider optimal reinsurance arrangements under tail risk measures. It is well known that regulatory authorities require insurance companies to control their risk exposure by imposing stringent risk management policies. This article investigates the optimal risk management strategy of an insurance company subject to regulatory constraints. The authors provide optimal reinsurance contracts under different tail risk measures and analyze the impact of regulators' requirements on risk sharing in the reinsurance market. Their results underpin adverse incentives for the insurer when compulsory value-at-risk risk management requirements are imposed. But economic effects may vary when regulatory constraints involve other risk measures. Finally, they compare the obtained optimal designs to existing reinsurance contracts and alternative capital market risk transfer mechanisms.

Hua Chen and Samuel H. Cox model mortality risk with jumps and apply their model to mortality securitization. They incorporate a jump process into the original Lee-Carter model and use it to forecast mortality rates and analyze mortality securitization. They explore alternative models with transitory versus permanent jump

effects and find that modeling mortality via transitory jump effects may be more appropriate in mortality securitization. They use the Swiss Re mortality bond as an example to show how to apply their model together with the distortion measure approach to value mortality-linked securities. Pricing the Swiss Re mortality bond is challenging because the mortality index is correlated across countries and over time. They show how to account for the correlations of the mortality index over time by simulating the mortality index and changing the measure on paths.

Fredj Jawadi, Catherine Bruneau, and Nadia Sghaier study the adjustment dynamics of the non-life insurance premium (NLIP) and test its relationship with the financial markets in five countries (Canada, France, Japan, the United Kingdom, and the United States). They justify the linkage between insurance markets and financial markets using underwriting cycles theory and financial models of insurance pricing. They then examine the relationship between the NLIP, interest rates, and stock prices using recent developments from nonlinear econometrics. Their empirical results show that the adjustment of the NLIP in France, Japan, and the United States is rather discontinuous, asymmetric, and nonlinear. Their results provide strong evidence of significant linkages between insurance and financial markets. They also isolate two regimes for the NLIP and show that the NLIP adjustment toward equilibrium is time varying with a convergence speed that varies according to the magnitude of insurance disequilibrium.

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