



2023 年金融数学与精算保险研讨会（福州）

会议手册

福建师范大学数学与统计学院
分析数学及应用教育部重点实验室
统计学与人工智能福建省高校重点实验室

2023 年 11 月 17-20 日

福建·福州

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主 题 2023 年金融数学与精算保险研讨会（福州）

时 间 2023 年 11 月 17-20 日

会议地点 奥体梅园酒店（地址：福州市仓山区建新镇盘屿路 3 号）

主办单位 福建师范大学数学与统计学院

承办单位 福建师范大学数学与统计学院

学术委员会（按姓氏字母顺序）

薄立军（西安电子科技大学）

王 健（福建师范大学）

郭军义（南开大学）

汪荣明（上海对外经贸大学）

胡太忠（中国科技大学）

许左权（香港理工大学）

胡亦钧（武汉大学）

杨静平（北京大学）

梁宗霞（清华大学）

尹传存（曲阜师范大学）

林火南（福建师范大学）

刘国欣（河北工业大学）

马敬堂（西南财经大学）

荣喜民（天津大学）

王过京（苏州大学）

组织委员会

陈密 梁克龙（学院办公室主任） 王文元

会议联系人

陈密 13306933674 苏毅明（硕士生） 15159226669 王文元 18859256122

为加强国内金融数学与精算保险的学术交流及该分支与其他数学分支的交叉融合，促进概率统计学科建设，将于2023年11月17日-20日在福州举办“金融数学与精算保险”研讨会。会议由福建师范大学数学与统计学院主办。本次会议将邀请国内金融数学与精算保险领域的学者参加并做学术报告，就该领域相关问题开展深入讨论。会议将推进福建师范大学概率统计学科团队的发展，助力福建师范大学数学与统计学院的学科建设和人才培养。

本次会议不收取注册费，往返差旅费和食宿费用请自理。如有任何问题请联系会务组。感谢您的支持，您的参与将有助于本次会议取得圆满成功，将推进福建师范大学概率统计学科团队的发展，助力福建师范大学数学与统计学院的学科建设和人才培养。期待您的参与和支持！

03 学术报告日程安排

| | |
|-------------------------------|--|
| 11月17日 11:00-20:00 | 会议报到注册 （奥体梅园酒店大堂；地址： 福州市仓山区建新镇盘屿路3号） |
| 11月17日 18:00-20:00 | 晚餐 （奥体梅园酒店） |

| | 日期 | 报告人 | 主持人 | |
|------------------------------|-------------|--|-------------------|--|
| 11 月 18 日 | 08:00-08:20 | 开幕式致辞：王健 (福建师范大学数学与统计学院院长) 合影留念 | 林火南 | |
| | 08:20-08:50 | 汪荣明（上海对外经贸大学）TBA | 郭军义 (南开大学) | |
| | 08:50-09:20 | 许左权（香港理工大学）Two optimal dividend payout problems under path-dependent constraints | | |
| | 09:20-09:50 | 柏立华（南开大学）Reinforcement learning for optimal dividend problem under diffusion model | | |
| | 09:50-10:20 | 危佳钦（华东师范大学）Variance minimizing portfolio selection under increasing convex and concave orders constraints | | |
| | 10:20-10:30 | 茶歇 | | |
| | 10:30-11:00 | 郭军义（南开大学）TBA | 汪荣明 (上海对外经贸大学) | |
| | 11:00-11:30 | 张志民（重庆大学）A consensus-based parallel ADMM algorithm for high-dimensional regression with application in stock market predictive modeling | | |
| | 11:30-12:00 | 高光远（中国人民大学）Fitting additive models to incomplete data via the EB algorithm | | |
| | 12:00-12:30 | 徐冉（西交利物浦大学）LSTM-based coherent mortality forecasting for less developed countries | | |
| | 12:30-14:00 | 用餐、休息 | | |
| | 14:00-14:30 | 刘国欣（河北工业大学）TBA | 胡亦钧 (武汉大学) | |
| | 14:30-15:00 | 周明（中国人民大学）Equilibrium reinsurance strategy for an insurer with alpha-robust mean-variance criterion and mean-conditional Value at Risk principle | | |
| | 15:00-15:30 | 池义春（中央财经大学）Optimal risk management with reinsurance and its counterparty risk hedging | | |
| | 15:30-16:00 | 孟辉（中央财经大学）Optimal reinsurance strategy with heterogeneous beliefs: a geometric approach | | |
| 16:00-16:20 | 茶歇 | | | |

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|--|--------------------|---|-----------------|
| | 16:20-16:50 | 胡亦钧 (武汉大学) Risk measurement of joint risk of portfolios: a liquidity shortfall aspect | 刘国欣 (河北工业大学) |
| | 16:50-17:30 | 杨洋 (南京审计大学) Portfolio default losses driven by idiosyncratic risk | |
| | 17:30-18:00 | 李津竹 (南开大学) Asymptotic results on tail moment for light-tailed risks | |
| | 18:00-18:30 | 张艺赢 (南方科技大学) Optimal reinsurance design under distortion risk measures and reinsurer's default risk with partial recovery | |
| | 18:30-21:00 | 晚宴 | |

| | 日期 | 报告人 | 主持人 |
|------------------------------|-------------|--|-----------------|
| 11 月 19 日 | 08:10-08:40 | 杨静平 (北京大学) Asymptotic subadditivity/superadditivity of Value-at-Risk under tail dependence | 尹传存 (曲阜师范大学) |
| | 08:40-09:10 | 梁志彬 (南京师范大学) Two-sided optimal stopping problems for diffusion process and application to insurance contract | |
| | 09:10-09:40 | 姚经 (苏州大学) A generalized tail mean-variance model for optimal capital allocation | |
| | 09:40-10:10 | 赵慧 (天津大学) Time-consistent investment and contribution adjustment strategies for collective DC pension plans | |
| | 10:10-10:30 | 茶歇 | |
| | 10:30-11:00 | 尹传存 (曲阜师范大学) 多元分布随机序的某些新进展 | 杨静平 (北京大学) |
| | 11:00-11:30 | 王过京 (苏州大学) CDS index tranches pricing under thinning dependence structure with regime switching | |
| | 11:30-12:00 | 魏晓利 (哈尔滨工业大学) Continuous time q learning for McKean-Vlasov control problems | |
| | 12:00-12:30 | 彭旻宇 (天津大学) Time-consistent reinsurance strategy with self-protection under the mean standard deviation premium principle | |
| | 12:30-14:00 | 用餐、休息 | |
| | 14:00-18:10 | 自由讨论 | |

04 学术报告题目及摘要

(按姓氏字母顺序排列)

Reinforcement Learning for optimal dividend problem under diffusion model

柏立华 南开大学

In this paper, we study the optimal dividend problem under the continuous time diffusion model with the dividend rate being restricted in a given interval $[0, a]$. Unlike the standard literature, we shall particularly be interested in the case when the parameters (e.g. drift and diffusion coefficients) of the model are not specified so that the optimal control cannot be explicitly determined. We therefore follow the recently developed method via the Reinforcement Learning (RL) to find the optimal strategy. Specifically, we shall design a corresponding RL-type entropy-regularized exploratory control problem, which randomize the control actions, and balance the exploitation and exploration. We shall first carry out a theoretical analysis of the new relaxed control problem and prove that the value function is the unique bounded classical solution to the corresponding HJB equation. We will then use a policy improvement argument, along with policy evaluation devices (e.g., Temporal Difference (TD)-based algorithm and Martingale Loss (ML)-algorithms) to construct approximating sequences of the optimal strategy. We present some numerical results using different parametrization families for the cost functional to illustrate the effectiveness of the approximation schemes.

Optimal risk management with reinsurance and its counterparty risk hedging

池义春 中央财经大学

In this talk, we revisit the study of an optimal risk management strategy for an insurer who wants to maximize the expected utility by purchasing reinsurance and managing reinsurance counterparty risk with a default-free hedging instrument, where the reinsurance premium is calculated by the expected value principle and the price of the hedging instrument equals the expected payoff plus a proportional loading. Different to previous studies, we exclude ex post moral hazard by imposing the no-sabotage condition on reinsurance contracts and derive the optimal strategy analytically. We find that the stop-loss reinsurance is always optimal, but the form of the optimal hedging payoff depends on the cost difference between reinsurance and hedging instrument. We further show that full risk transfer is optimal if and only if both reinsurance pricing and the hedging price are fair. Finally, numerical analyses are conducted to illustrate the effects of some interesting factors on the optimal risk management strategy.

Fitting additive models to incomplete data via the EB algorithm

高光远 中国人民大学

In actuarial science, models for incomplete data are of interest such as Tweedie's compound Poisson models for total claim amount, finite mixture of regression models for claim size. The EM algorithm is a standard model-fitting method for incomplete data. However, the EM algorithm is problematic to fit additive models. We propose the Expectation-Boosting (EB) algorithm to fit the additive models to incomplete data. The EB algorithm trains only one weak learner at each iteration in a stagewise fashion. Theory shows the monotone behavior of the likelihood in the EB algorithm. A simulated data example and two real data examples are studied.

TBA

郭军义 南开大学

To be added.

Risk measurement of joint risk of portfolios: a liquidity shortfall aspect

胡亦钧 武汉大学

In this talk, I will present a novel axiomatic framework of measuring the joint risk of a portfolio consisting of several financial positions. Precisely, from the liquidity shortfall aspect, we first construct a distortion-type risk measure to measure the joint risk of portfolios, which we refer to as multivariate distortion joint risk measure, representing the liquidity shortfall caused by the joint risk of portfolios. After its fundamental properties have been studied, then we axiomatically characterize it by proposing a novel set of axioms. Furthermore, we also propose a new class of vector-valued multivariate distortion joint risk measures, as well as with sensible financial interpretation. It turns out that this new class is rich enough, as it can not only induce new vector-valued multivariate risk measures, but also recover some popular vector-valued multivariate risk measures known in the literature with alternative financial interpretation. This talk mainly gives some theoretical results, helping one to have an insight look at the measurement of joint risk of portfolios. (This talk is based on a joint work with Shuo Gong and Linxiao Wei.)

Asymptotic results on tail moment for light-tailed risks

李津竹 南开大学

In this talk, we focus on the asymptotic behavior of a recently popular risk measure called the tail moment (TM), which has been extensively applied in the field of risk theory. We conduct the study under the framework in which the individual risks of a financial or insurance system follow convolution equivalent or Gamma-like distributions. Precise asymptotic results are obtained for the TM when the individual risks are mutually independent or have a dependence structure of the Farlie-Gumbel-Morgenstern type. Moreover, based on some specific scenarios, we give an asymptotic analysis on the relative errors between our asymptotic results and the corresponding exact values. Since the model settings in this paper are not covered by traditional ones, our work fills in some gaps of the asymptotic study on the TM for light-tailed risks.

Two-sided optimal stopping problems for diffusion process and application to insurance contract

梁志彬 南京师范大学

In this paper, we discuss a two-sided optimal stopping problem with two different terminal conditions in an infinite time horizon. The corresponding dynamic programming principle and the variational inequality are given, and we also prove that the value function of this optimal problem is the unique viscosity solution of the variational inequality. Moreover, we present two examples which investigate the application of this two-sided optimal stopping problem to an insurance contract with cancellation feature. In the first example, we assume that the insured is the decision-maker for both sides of the stopping times; and the second one studies the optimal problem in a Dynkin game framework where the insured and the insurer are the decision-makers to choose the different optimal stopping time, respectively. Some interesting results are obtained, and two numerical examples are also provided to show the impact of some important parameters on the optimal results.

TBA

刘国欣 河北工业大学

To be added.

Optimal reinsurance strategy with heterogeneous beliefs: a geometric approach

孟辉 中央财经大学

In this paper, we investigate the optimal reinsurance problem for an insurer who has different belief about claims with the reinsurer basing on the perspective of risk control. Inspired by the exponential upper bound of ruin probability in Cramer-Lundberg model, we take Lundberg exponent maximization as the value function. Within the setting of general belief heterogeneity, we firstly show that a specific form of reinsurance with finite parameters is the optimal strategy satisfying incentive compatibility condition and principle of indemnity as well, in terms of a so-called relaxation and modification approach. It is worth to mention that the approach used here has good applicability for modifying reinsurance candidate to satisfy the incentive compatibility condition. As examples, we lastly present explicit reinsurance structures under a few important belief heterogeneity environments. (This a joint work with Yeshunying Wang, Ming Zhou.)

Time-consistent reinsurance strategy with self-protection under the mean standard deviation premium principle

彭旻宇 天津大学

In this paper, we propose and solve an optimal self-insurance and self-protection problem under the mean-variance criterion. Suppose that the insurer can purchase per-loss reinsurance to reduce the claim risk. In addition to the self-insurance protection, the insurance company can also reduce the intensity of the claims by self-protection. Under the time-consistent meanvariance criterion, the optimal self-insurance and self-protection strategies as well as the value function are derived explicitly by solving the extended Hamilton-Jacobi-Bellman system in a game framework. Considering the difficulty of estimating the intensity function for insurer, we construct the martingale loss function and apply stochastic gradient decent to estimate the parameters in intensity function. Finally, we illustrate the influence of model parameters on the optimal results for both the light-tailed and heavy-tailed risk, and reveal the importance of the self-insurance/self-protection.

CDS index tranches pricing under thinning dependence structure with regime switching

王过京 苏州大学

In this paper, we present the copulas for the default time based on a reduced form credit risk model with thinning-dependence structure with regime switching. We present some closed-form expressions for CDS index tranche pricing formula under the proposed copulas and marginal distribution functions of the default times. As an empirical example, we consider the pricing of the CDX NA IG series 25. We demonstrate how the model parameter can be calibrated based on market data and how the numerical results can be calculated via the proposed pricing formulas. In terms of the aggregate loss to be protected, we conclude that the proposed pricing model with regime switching might nicely predict the market quotes for the CDX NA IG series 25.

TBA

汪荣明 上海对外经贸大学

To be added.

Variance minimizing portfolio selection under increasing convex and concave orders constraints

危佳钦 华东师范大学

In this talk I shall present some results on the variance minimizing portfolio selection problem with increasing convex and concave orders constraints. The increasing convex order is an extension of the expectation, so that the variance minimization with increasing convex order constraint is a generalization of the classical mean-variance problem. To control the left tail risk, we also consider the increasing concave order (or second order stochastic dominance) constraint. The optimal solution is characterized by using convex optimization method.

Continuous Time q Learning for McKean-Vlasov Control Problems

魏晓利 哈尔滨工业大学

This paper studies the q-learning, recently coined as the continuous time counterpart of Q-learning by Jia and Zhou (2023), for continuous time McKean-Vlasov control problems in the setting of entropy-regularized reinforcement learning. In contrast to the single agent's control problem in Jia and Zhou (2023), the mean-field interaction of agents renders the definition of the q-function more subtle, for which we reveal that two distinct q-functions naturally arise: (i) the integrated q-function (denoted by q) as the first-order approximation of the integrated Q-function introduced in Gu, Guo, Wei and Xu (2023), which can be learnt by a weak martingale condition involving test policies; and (ii) the essential q-function (denoted by q_e) that is employed in the policy improvement iterations. We show that two q-functions are related via an integral representation under all test policies. Based on the weak martingale condition and our proposed searching method of test policies, some model-free learning algorithms are devised. In two examples, one in LQ control framework and one beyond LQ control framework, we can obtain the exact parameterization of the optimal value function and q-functions and illustrate our algorithms with simulation experiments. (This is based on a joint work with Xiang Yu.)

LSTM-based coherent mortality forecasting for less developed countries

徐冉 西交利物浦大学

In this paper, a Long short-term memory (LSTM) based coherent mortality forecasting method is proposed for less developed countries. Most of such countries have experienced rapid declines in mortality over the past few decades. However, their recent trend in mortality development is only a short-term behavior, which will tend to converge to that of developed countries in the long-run. Hence, we propose a neural network model (i.e. LSTM) that controls the trend of mortality convergence in target countries by predicting difference of life expectancy/lifespan disparity with benchmark countries, and embed such mortality convergence into a time-varying Lee-Carter mortality forecasting method. We apply this method to six less developed countries or regions, where the empirical results show a significant improvement in forecasting accuracy and robustness for long-term projections of mortality for less developed countries/regions.

Two optimal dividend payout problems under path-dependent constraints

许左权 香港理工大学

We study two long-standing dividend payout open problems in risk theory. In the first problem, the strategy is subject to the so-called ratcheting constraint, that is, the dividend payout rate shall be non-decreasing over time; whereas in the second one, the payout cannot be lower than a proportion of the historical maximum payout. To overcome the difficulty, we first introduce regime-switching problems --- a sequence of single-obstacle problems in ODE --- to approximate the original two-dimensional HJB equations and then take limit. We express the optimal strategies in terms of one or two free boundaries whose properties are well established.

Asymptotic subadditivity/superadditivity of Value-at-Risk under tail dependence

杨静平 北京大学

We consider the asymptotic subadditivity and superadditivity properties of Value-at-Risk for multiple risks whose copula admits a stable tail dependence function (STDF). For the purpose, a marginal region is defined by the marginal distributions of the multiple risks, and a stochastic order named tail concave order is presented for comparing individual tail risks. We prove that asymptotic subadditivity of VaR holds when individual risks are smaller than regularly varying random variables with index -1 under the tail concave order. We also provide sufficient conditions for VaR being asymptotically superadditive. For two multiple risks sharing the same copula function and satisfying the tail concave order, a comparison result on the asymptotic subadditivity/superadditivity of VaR is given. Asymptotic diversification ratios for regularly varying and log regularly varying margins with specific copula structures are obtained. Empirical analysis on financial data is provided for highlighting our results. (It is a joint work with Wenhao Zhu, Lujun Li, Jiehua Xie and Liulei Sun.)

Portfolio default losses driven by idiosyncratic risk

杨洋 南京审计大学

We consider a general portfolio of assets with low individual default risk and study the probability of the portfolio default loss exceeding an arbitrary threshold. The latent variables driving defaults are modeled by a mixture structure, which combines common shock, systematic risk, and idiosyncratic risk factors. While common shocks and systematic risk have been found by many studies to contribute significantly to portfolio losses, the role of idiosyncratic risk is often neglected, despite its high relevance for unbalanced or under-diversified portfolios. This study focuses on heavy-tailed idiosyncratic risk factors and explores two distinct scenarios among them: an independence scenario and an asymptotic dependence scenario. The former is standard in the literature, while the latter is motivated by some recent studies that have found the inadequacy of relying solely on common factors to capture default clustering or sovereign default spreads. This consideration also reflects the possibility that idiosyncratic reasons can trigger contagion among firms with liabilities in each other. Our main results establish asymptotic equivalences for the exceedance probability of the portfolio loss as the representative default probability approaches zero. These results highlight the significance of dominant idiosyncratic risk factors and their dependence in portfolio losses.

A generalized tail mean-variance model for optimal capital allocation

姚经 苏州大学

Capital allocation is a core task in financial and actuarial risk management. Some well-known capital allocation principles, such as the “Euler principle” and the “haircut principle”, have been widely used in the banking and insurance industry. The partitions of allocated capital not only serve as the buffer against the potential loss but also provide certain risk pricing and performance measurement to the underlying risks. Dhaene et al. (2012) proposed a unified capital allocation framework, which can be understood as a distance-minimizing allocation principle. Their objective function in the optimization only considers the magnitude of the loss function but not the variability. In this paper, we use the tail mean-variance model, which takes both the magnitude and the variability into account, to derive the optimal capital allocation for risks following the multivariate generalized hyperbolic distribution and the multivariate log-generalized hyperbolic distribution. We propose a general tail mean-variance model and derive explicit solutions for multivariate generalized hyperbolic distributed risks, which covers many existing results as special cases. For multivariate log-generalized hyperbolic distributed risks, we use the convex

approximation method to solve the explicit solutions. We present two numerical examples showing the good performance of our optimal capital allocation rules. The first one analyzes the market risk of S&P 500 industry sector indices. We show that our optimal capital allocation framework is applicable for various scenario analyses and provides a performance measure for the indices and financial market. The other example is based on insurance claims from an Australian insurance company, showing our approximate formulas are both robust and accurate.

多元分布随机序的某些新进展

尹传存 曲阜师范大学

本报告主要回顾近期有关多元分布随机序的一些最新结果。分布包括多元正态分布，椭圆分布，多元斜正态分布，多元斜椭圆分布以及矩阵值斜正态分布等。随机序包括凸序，分量凸序，超模序，方向凸序，上象限凸序，Copositive 和 completely positive orders等，并提出了若干个进一步研究的问题。特别介绍，对于两个n维随机向量X和Y，关于 $E[f(X)]-E[f(Y)]$ 的积分表达式，其中f为n元函数且满足一些正则条件。

Optimal reinsurance design under distortion risk measures and reinsurer's default risk with partial recovery

张艺赢 南方科技大学

It is not uncommon that reinsurers are exposed to default risk when they have to pay large claims to insurers who are unable to fulfill their obligations due to various reasons such as catastrophic events, underwriting losses, inadequate capitalization, or financial mismanagement. This paper studies the problem of optimal reinsurance design from a dual perspective of both parties and explores it through distortion risk measures when the insurer faces the potential default risk originating from the reinsurer. Firstly, if the insurer minimizes some convex distortion risk measure of his retained loss, we prove the optimality of a stop-loss treaty when the promised ceded loss function is charged by the expected-value premium principle and the reinsurer offers partial recovery in the event of default. For any fixed premium loading set by the reinsurer, we derive the explicit expressions of optimal deductible levels for three special distortion functions, including the TVaR, Gini, and proportional hazard distortion functions. Secondly, under the above three explicit distortion risk measures adopted by the insurer, we seek the optimal safety loading for the reinsurer by maximizing the net profit where the reserve capital is determined by the TVaR measure and the cost is governed by the proportional expectation of the compensation. This procedure ultimately leads to the Bowley solution under distortion risk measures between the insurer and the reinsurer in the presence of default risk. We provide abundant numerical examples to implement sensitivity analyses on demonstrating how different settings of default probability, recovery rate, and safety loading affect the optimal deductibles as well as the Bowley optima.

A consensus-based parallel ADMM algorithm for high-dimensional regression with application in stock market predictive modeling

张志民 重庆大学

The complexity and high-frequency nature of financial market data pose new challenges for statistical methods and computational algorithms. Combined (composite) regularization models such as elastic net, sparse group lasso, and sparse fused lasso can effectively handle complex variable relationships in datasets due to their use of multiple regularization terms. Therefore, this paper proposes the use of composite regularization models to track stock market indices. However, due to the high-frequency nature of stock market data with updates occurring every minute, traditional algorithms face challenges in handling massive amounts of data. To overcome this challenge, this paper proposes the use of a parallel ADMM algorithm to solve these combined regularized regression models. The proposed parallel ADMM algorithm offers high computational efficiency as each iteration has a closed-form solution. Furthermore, we prove that the proposed algorithm not only has global convergence but also exhibits linear convergence rate. Data experiments demonstrate the reliability, stability, and scalability of our algorithm. The R package for implementing the proposed algorithms can be obtained at <https://github.com/xfwu1016/CPADMM>.

Time-consistent investment and contribution adjustment strategies for collective DC pension plans

赵慧 天津大学

We study the optimal investment and benefit adjustment problem for collective DC (CDC) pension plans with parameter uncertainty and longevity trend, respectively. First, a smooth ambiguity framework is proposed to model the pension trustee's preferences towards risk and ambiguity. Since the pension trustee is ambiguous about the risky assets, she/he decides to invest in a risk-free asset, a purely risky asset and an ambiguous risky asset whose return is uncertain. Furthermore, we take the stochastic salary into account. The objective is to maximize the expectation of the accumulated benefit payment and terminal wealth under a smooth ambiguity utility which is the double power form. The utility function makes the problem time-inconsistent and we establish the extended HJB equation via game theoretic formulation. The equilibrium strategy and equilibrium value function are derived under smooth ambiguity. Next, we consider the longevity trend and assume that the mortality hazard rate is a function of age and time, which extend the Makeham's Law. The pension fund is allowed to invest in a risk-free asset and a risky asset whose price process satisfies the CEV model. The objective is expected utility maximization of terminal wealth and cumulative benefit. By applying dynamic programming approach, we establish the corresponding Hamilton-Jacobi-Bellman equation and obtain the optimal investment and benefit strategies for CARA and CRRA utilities, respectively. Finally, sensitivity analyses of optimal strategies are provided to demonstrate the effects of model parameters on optimal strategies.

Equilibrium reinsurance strategy for an insurer with alpha-robust mean-variance criterion and mean-conditional Value at Risk principle

周明 中国人民大学

This paper investigates the equilibrium reinsurance strategy for an insurer with the α -robust mean-variance criterion when the reinsurance premium is calculated by the mean-conditional Value at Risk (Mean-CVaR) premium principle. With the constraint of indemnity principle and incentive compatibility condition, the equilibrium reinsurance strategy is explicitly derived in the infinite reinsurance space for $\alpha=0$, $\alpha \in \left(0, \frac{1}{2}\right) \cup \left(1 - \frac{1}{\sqrt{3}}, 1\right)$ and $\alpha \in \left[\frac{1}{2}, 1\right)$ respectively. Generally speaking,

the auxiliary reinsurance strategy derived by the point-wise optimization approach might fail to satisfy the incentive compatibility condition. By taking a given arbitrary admissible reinsurance strategy as a reference, we propose a modification approach and then show that the equilibrium reinsurance strategy belongs to the set of combination of excess-of-loss reinsurance with at most 5 parameters. Notice that the objective integrand function in this optimization problem possesses either convexity or concavity piecewise. By the modification approach, we can overcome the moral hazard challenge. Most importantly, this approach has good applicability for modifying reinsurance candidate to satisfy the incentive compatibility condition.

| 序号 | 姓名 | 单位 | 职称/职务 | 邮箱 |
|----|-----|----------|-------|------------------------------|
| 1 | 柏立华 | 南开大学 | 教授 | lhbai@nankai.edu.cn |
| 2 | 薄立军 | 西安电子科技大学 | 教授 | lijunbo@xidian.edu.cn |
| 3 | 池义春 | 中央财经大学 | 教授 | yichun@cufe.edu.cn |
| 4 | 郭军义 | 南开大学 | 教授 | jyguo@nankai.edu.cn |
| 5 | 高光远 | 中国人民大学 | 副教授 | guangyuan.gao@ruc.edu.cn |
| 6 | 胡太忠 | 中国科学技术大学 | 教授 | thu@ustc.edu.cn |
| 7 | 胡亦钧 | 武汉大学 | 教授 | yjhu.math@whu.edu.cn |
| 8 | 李津竹 | 南开大学 | 教授 | lijinzhu@nankai.edu.cn |
| 9 | 梁宗霞 | 清华大学 | 教授 | liangzongxia@tsinghua.edu.cn |
| 10 | 梁志斌 | 南京师范大学 | 教授 | liangzhibin111@hotmail.com |
| 11 | 刘国欣 | 河北工业大学 | 教授 | gxliu@hebut.edu.cn |
| 12 | 马敬堂 | 西南财经大学 | 教授 | mjt@swufe.edu.cn |
| 13 | 孟辉 | 中央财经大学 | 教授 | menghuidragon@126.com |
| 14 | 钱林义 | 华东师范大学 | 教授 | lyqian@stat.ecnu.edu.cn |
| 15 | 荣喜民 | 天津大学 | 教授 | rongximin@tju.edu.cn |
| 16 | 王过京 | 苏州大学 | 教授 | wanguojing@hotmail.com |
| 17 | 汪荣明 | 上海对外经贸大学 | 教授 | rmwang@stat.ecnu.edu.cn |
| 18 | 危佳钦 | 华东师范大学 | 教授 | jqwei@stat.ecnu.edu.cn |
| 19 | 魏晓利 | 哈尔滨工业大学 | 副教授 | xiaoli.wei@hit.edu.cn |
| 20 | 许左权 | 香港理工大学 | 副教授 | rmwang@stat.ecnu.edu.cn |
| 21 | 徐林 | 安徽师范大学 | 教授 | xlwgl11@ahnu.edu.cn |
| 22 | 徐冉 | 西交利物浦大学 | 副教授 | ranx.2018@outlook.com |
| 23 | 杨静平 | 北京大学 | 教授 | yangjp@math.pku.edu.cn |
| 24 | 杨洋 | 南京审计大学 | 教授 | yyang@nau.edu.cn |
| 25 | 姚定俊 | 南京财经大学 | 教授 | yaodj@nufe.edu.cn |
| 26 | 姚经 | 苏州大学 | 教授 | yyang@nau.edu.cn |
| 27 | 尹传存 | 曲阜师范大学 | 教授 | yangjp@math.pku.edu.cn |
| 28 | 曾燕 | 中山大学 | 教授 | zengy36@mail.sysu.edu.cn |

| | | | | |
|----|-----|--------|-------|-------------------------|
| 29 | 赵慧 | 天津大学 | 副教授 | zhaohuimath@tju.edu.cn |
| 30 | 张鑫 | 东南大学 | 教授 | xzhangseu@seu.edu.cn |
| 31 | 张艺赢 | 南方科技大学 | 副教授 | zhangyy3@sustech.edu.cn |
| 32 | 张志民 | 重庆大学 | 教授 | zmzhang@cqu.edu.cn |
| 33 | 周明 | 中国人民大学 | 教授 | mingzhou@ruc.edu.cn |
| 34 | 彭旻宇 | 天津大学 | 博士研究生 | 2891250700@qq.com |
| 35 | 吴晨曦 | 天津大学 | 博士研究生 | |
| 36 | 林火南 | 福建师范大学 | 教授 | |
| 37 | 王健 | 福建师范大学 | 教授 | |
| 38 | 陈密 | 福建师范大学 | 副教授 | |
| 39 | 王文元 | 福建师范大学 | 副教授 | |
| 40 | 高宇 | 福建师范大学 | 硕士研究生 | |
| 41 | 苏毅明 | 福建师范大学 | 硕士研究生 | |
| 42 | 颜炳文 | 福建师范大学 | 硕士研究生 | |
| 43 | 陈雅婷 | 福建师范大学 | 硕士研究生 | |
| 44 | 俞晴 | 福建师范大学 | 硕士研究生 | |
| 45 | | | 硕士研究生 | |
| 46 | | | 硕士研究生 | |
| 47 | | | 硕士研究生 | |
| 48 | | | 硕士研究生 | |
| 49 | | | 硕士研究生 | |
| 50 | | | 硕士研究生 | |

06 福建师范大学简介

福建师范大学坐落于素有“海滨邹鲁”之誉的历史文化名城福州，是一所历史悠久、声誉斐然的百年省属高等学府。学校肇始于1907年清朝帝师陈宝琛先生创办的“福建优级师范学堂”，后由华南女子文理学院、福建协和大学、福建省立师范专科学校等单位几经调整合并，于1953年成立福建师范学院，1972年易名为福建师范大学并沿用至今。2012年，福建省人民政府与教育部共建福建师范大学。2014年被确定为福建省重点建设的高水平大学。2018年被确定为福建省一流大学建设高校。2022年被确定为福建省第二轮“双一流”建设A类高校。

百载春秋，薪火相传。叶圣陶、郭绍虞、董作宾、林兰英、郑作新、黄维垣、唐仲璋、唐崇惕、姚建年等诸多蜚声海内外的大师巨匠曾在学校任教。经过一代又一代师大人的传承创新，学校砥砺出“**知行笃，立诚致广**”的校训精神，孕育了“**重教、勤学、求实、创新**”的优良校风，着力推动各项事业不断向前发展，荣获“全国文明单位”“全国文明校园”等一大批高级别荣誉称号。滋兰树蕙，桃李芬芳。建校以来，学校向社会培养输送各级各类人才近60万名，为国家和福建经济社会发展作出了突出贡献。

学校本部共有旗山、仓山两个校区，占地面积4000多亩。现有本科专业84个（2023年全日制普通本科招生专业78个），全日制普通本科学学生2.4万多人，各类研究生近1万人。拥有专任教师2012人，其中，高级职称人员占62.62%、具有博士学位教师占64.31%，加拿大皇家科学院院士、欧洲科学院院士、国际欧亚科学院院士、双聘院士各1人，国家高层次特殊人才支持计划9人、青年拔尖人才人选6人，“长江学者奖励计划”特聘教授6人、青年项目2人，国家杰出青年科学基金获得者（含海外）9人，国家自然科学基金优秀青年科学基金资助者（含海外）10人，国务院学位委员会学科评议组成员3人，国务院学位委员会学科发展战略咨询委员会委员1人，全国博士后管委会专家评审组召集人1人，国家级有突出贡献中青年专家7人，国家级百千万人才工程人选7人，国家级教学名师2人，全国文化名家暨“四个一批”人才6人，科技部中青年科技创新领军人才2人，教育部“新世纪优秀人才支持计划”入选者14人，全国高校黄大年式教师团队2个，教育部创新团队2个，国家级教学团队3个，历年享受国务院政府特殊津贴专家134人。

学校深入落实立德树人根本任务，坚持以人才培养为中心，不断深化教育教学改革，着力提升人才培养质量。本科教学工作水平被教育部评为优秀，先后获评国家级教学成果一、二等奖17项，获批教育部基础学科拔尖学生培养计划2.0基地1

个、国家一流本科专业建设点 36 个、国家级专业综合改革试点 2 个、特色专业建设点 10 个，国家级精品课程 9 门、精品资源共享课程 13 门、精品视频公开课 1 门、双语教学示范课程 1 门、一流本科课程 54 门，国家级课程思政示范课程 2 门、课程思政示范课程案例 2 个。30 部教材入选国家级重点规划建设教材，获评全国优秀教材奖特等奖 1 项、二等奖 2 项、先进集体 1 个。现有国家级实验教学示范中心（含虚拟仿真实验教学中心）5 个，国家级新文科研究与改革实践项目 2 项，国家级新工科研究与改革实践项目 1 项，国家级人才培养模式创新实验区 4 个，国家级卓越教师教育计划 1 项，入选教育部卓越中学教师培养计划实施院校，17 个师范专业完成师范类专业二级认证，生物工程专业通过教育部工程教育专业认证。入选全国重点马克思主义学院，拥有 4 个国家人才培养基地和教育部高校辅导员培训和研修基地、教育部思政课教师教学研修基地、教育部全国重点建设职教师资培养培训基地。学生在“挑战杯”“互联网+”等国家级赛事中屡获特等奖、金奖、一等奖，入选全国百篇优秀博士学位论文 3 篇。

学校充分发挥学科龙头带动作用，着力构建一流文科、高水平理科、有特色工科的学科体系，基本形成了综合性大学的学科布局。拥有国家重点学科 1 个、福建省第二轮“双一流”建设主干学科 3 个、省高峰学科 9 个和高原学科 13 个，博士后科研流动站 17 个，博士学位授权一级学科 21 个，硕士学位授权一级学科 34 个，硕士专业学位类别 22 个。化学、工程学、材料科学、计算机科学、环境科学与生态学、农学 6 个学科进入 ESI 全球排名前 1%，其中化学、工程学进入 ESI 前 5%。

学校始终坚持“四个面向”，服务“国之大者”，主动融入国家战略和地方经济社会发展，强化有组织的科研。获批建设全国中国特色社会主义政治经济学研究中心（全国仅 7 个），拥有国家级野外科学观测研究站、国家级重点实验室培育基地、国家地方联合工程研究中心、国家级“2011”协同创新中心（核心协同单位之一）、高等学校学科创新引智基地各 1 个，教育部重点实验室、工程研究中心、人文社科重点研究基地等部省级科研平台 114 个。先后获部省级以上科研成果奖 1000 余项，其中独立或合作获国家三大奖（国家自然科学奖、国家技术发明奖、国家科学技术进步奖）18 项、教育部高等学校科学研究优秀成果奖人文社会科学一等奖 4 项、自然科学一等奖 1 项。近 5 年来，承担各类国家级课题 630 多项，其他各类课题 3800 多项，其中获国家重点研发计划重点专项 2 项、国家社会科学基金重大项目和教育部哲学社会科学重大课题攻关项目 16 项，2 部专著入选国家社科基金中华学术外译项目。围绕福建建设 21 世纪海上丝绸之路核心区、自由贸易试验区、国家生态文明试验区等生动实践，深入开展产学研用合作，多措并举促进科技成果转化及产业化。聚焦

重大现实问题，打造一批富有区域和学校特色的新型智库，努力发挥“智囊团”和“思想库”作用。

学校积极发挥地处 21 世纪海上丝绸之路核心区、毗邻台港澳等区位优势，着力深化对外交流与合作。目前已与美国、英国、意大利、澳大利亚、日本等国家和地区的 130 多所高校、科研机构及联合国教科文组织建立友好合作关系，与台湾 40 多所高校建立实质性合作关系。现有 1 个非独立法人中外合作办学机构—福建师范大学哈德斯菲尔德学院，6 个本科层次、1 个研究生层次中外合作办学项目，3 个国家留学基金委“创新型人才国际合作培养项目”。印尼研究中心入选教育部国别和区域研究备案中心，菲律宾研究中心入选国家民委“一带一路”国别和区域研究中心。海外华文教育初具规模、特色彰显，迄今已向菲律宾、印度尼西亚、泰国、美国等 28 个国家派出志愿者共 21 批近 1000 人（次），与菲律宾红溪礼示大学、印尼阿拉扎大学合作创办 2 所孔子学院，在海内外产生了良好影响。

学校主办多种学术期刊，《福建师范大学学报》哲学社会科学版和自然科学版均为全国中文核心期刊，哲学社会科学版被评为教育部名栏建设学报、中文社科引文索引（CSSCI）来源期刊，自然科学版被列为中国科技核心期刊、中国科学引文数据库（CSCD）来源期刊。图书馆为全国古籍重点保护单位，现有纸质图书近 500 万册、电子图书 560 多万册，在全国高师院校中名列前茅，其中尤以丰富的古籍、善本、碑刻、字画、地方文献、早期外文原版书籍和“五四”前后代表性报刊的收藏享誉海内外。校园网络设备完善、应用广泛，实现无线网络校园全覆盖。拥有一批高水平体育场馆，运动设施完备，较好满足各类赛事、训练、健身运动的需求。设有附中、附小、实验幼儿园等附属学校，附中是福建省获国际奥林匹克学科竞赛奖最多的学校。

走过 116 年光荣历程的福建师范大学，不忘立德树人初心，牢记为党育人、为国育才使命，全面深化综合改革，全面推进内涵发展，全面提高办学质量，正朝着加快建成富有鲜明特色的综合性全国一流大学的奋斗目标大踏步前进，努力为谱写全面建设社会主义现代化国家福建篇章、实现中华民族伟大复兴的中国梦作出新的更大贡献。

（以上数据截至 2023 年 5 月）

07 福建师范大学数学与统计学院简介

百载春秋，薪火相传。数学与统计学院肇始于1907年陈宝琛先生创办的“福建优级师范学堂”的数学科。后由华南女子文理学院、福建协和大学、福建省立师范专科学校等院校几经调整合并，于1953年成立福建师范学院，保留和发展了数学系。1972年，改名为福建师范大学数学系。1996年，成立计算机科学系，与数学系合称为福建师范大学数学系、计算机科学系。2002年，成立数学与计算机科学学院。2017年6月，数学与计算机科学学院、软件学院整合成立数学与信息学院。2021年6月，数学与信息学院分设数学与统计学院、计算机与网络空间安全学院（软件学院）。

数学与统计学院现设数学系和统计学系，拥有数学与应用数学（师范类）、统计学、数据科学3个本科专业。数学与应用数学专业是国家级特色专业、入选国家级一流本科专业建设点、通过教育部师范类专业二级认证；统计学专业入选国家级一流本科专业建设点。近年来，学院获得国家级教学成果二等奖1项，福建省教学成果奖特等奖1项，一等奖2项；获批国家级一流课程2门、省级一流课程4门，国家级资源共享课程1门，省级教育教学改革项目5项（重点项目1项、一般项目4项），省级人才培养模式创新实验区1个，省级研究生教育创新基地1个。现有在读学生1625人，其中研究生398人、本科生1227人。

现有，数学、统计学2个一级学科博士学位授权点，数学、统计学2个博士后科研流动站，数学、统计学2个一级学科硕士学位授权点，学科教学（数学）、应用统计2个专业学位硕士点。数学是福建省高峰学科，统计学是福建省重点学科。现有分析数学及应用教育部重点实验室、福建省分析数学及应用重点实验室、统计学与人工智能福建省高校重点实验室、福建省应用数学中心、福建师范大学数学研究中心和福建数学基础教育研究中心等科研平台。学院主办《福建中学数学》杂志，同时学院是福建省中小学数学学科教学带头人培养基地。

近年来，学院主动融入国家战略和地方经济社会发展，强化有组织的科研。学院教师获国家自然科学基金等国家级项目30多项；其中，国家自然科学基金杰出青年项目1项、国家自然科学基金优秀青年项目1项、国家自然科学基金重点项目3项（含参加）；获教育部自然科学奖一等奖1项、福建省自然科学奖一等奖、二等奖、三等奖各1项以及福建省社会科学奖二等奖1项、三等奖1项。

学院高度重视高层次人才队伍建设，师资力量雄厚。学院现有在职教职工112人，其中教授28人，副教授46人，博士生导师16人；其中，长江学者特聘教授1

人，国家杰出青年科学基金获得者2人，国家优秀青年科学基金获得者1人，国务院政府特殊津贴2人，闽江学者7人，入选福建省“百人计划”2人，福建省“雏鹰计划”青年拔尖人才2人，福建省“百千万人才工程”3人，福建省优秀教师1人，福建省“运盛”青年科技奖2人，建有“随机分析及相关领域”福建省高校科技创新团队、“非线性分析及应用”福建省博士生导师团队。学院已为党和国家培养了许多优秀的人才，他们积极工作，奋发向上，成为各行业的骨干，为教育发展、经济建设和社会进步做出了重要的贡献。江文哉、张远南、王毓泉、李必成、刘金星、林凤、林群、叶青柏、林顺来、郑一平、李迅、林燎、邵东生、徐明杰、周灵、黄金德、赵祥枝、王奇南、林亚南、李海北等校友荣获“福建省杰出人民教师”荣誉称号。广大校友爱国爱校，慷慨解囊，捐资助学。2006年，福建师范大学数学系61级学生、香港知名企业家、福建师范大学客座教授吴维新先生捐资设立“吴维新教育基金”；2015年，吴维新先生再次捐资设立“吴维新研究生奖学金”。

学院党委认真履行党建工作主体责任，汇聚人心，凝聚力量，推动学院各项工作不断取得新的成绩。学院党委被福建省委教育工委评为“福建省学校创先争优先进基层党组织”、1个学生党支部被福建省委教育工委评为“先进基层党组织”。学院工会被中华全国总工会评为“模范职工小家”、被福建省总工会评为“五一先锋号”。学院团委获得“全国五四红旗团委创建单位”“福建省新长征突击手”“福建省五四红旗团委标兵”“福建省五四红旗团委”“福建省基层团建示范单位”等荣誉称号。学院教师还获得“福建青年五四奖章”“福建省优秀共青团干部”“福州市青年五四奖章”“校五一劳动奖章”等荣誉称号。

（以上数据截至2023年8月）

知行笃 云诚致广

