Modeling, Measuring, and Managing Catastrophe Risks

Second-Year Progress Report

This is the second-year progress report for our three-year CAE research grant titled "Modeling, Measuring, and Managing Catastrophe Risks" on the following three areas:

(a) Modeling Catastrophe Risks
(b) Measuring Catastrophe Risks
(c) Managing Catastrophe Risks

Publications in Scientific Journals

As stated in the agreement, we were expected to produce at least five research papers and present the results in at least two conferences during 06/01/2019–05/31/2020.

We begin by listing nine papers dealing with the three areas of study. Among these nine papers, two have been published, two have been revised and resubmitted, three have been submitted, and two will be submitted by 04/30/2020. All of these papers will appear in reputable journals in actuarial science or related broader fields.

(1) Chen, Y. A Kesten-type bound for sums of randomly weighted subexponential random variables. *Statistics and Probability Letters* **158** (2019), 108661.
(2) Chen, Y. A renewal shot noise process with subexponential shot marks. *Risks* **7** (2019), no. **2**, 63.
(3) Chen, Y. Precise large deviations of aggregate claims with an arbitrary dependence between claim sizes and their interarrival times. To be submitted to *European Actuarial Journal* by the end of March 2020.
(4) Chen, Y.; Yang, F. Risk measurement based on available information. To be submitted to a top actuarial journal listed in the contract by 04/30/2020.
(5) Li, H.; Tang, Q. Joint extremes in temperature and mortality: A bivariate POT approach. *North American Actuarial Journal*, submitted in original version in November 2019 and in revised version in March 2020.
(6) Li, X.; Liu, H.; Tang, Q.; Zhu, J. Liquidation risk in insurance under contemporary regulatory frameworks. *Insurance: Mathematics and Economics*, submitted in original version in October 2019, in first revised version in February 2020, and the second revised version in March 2020.
(7) Lo, A. Invited discussion on "Optimal reinsurance designs based on risk measures: A review." To be submitted to *Statistical Theory and Related Fields* in April 2020.
(8) Lo, A.; Tang, Q.; Tang, Z. Universally marketable insurance under multivariate mixtures. *ASTIN Bulletin*, submitted in March 2020.
(9) Tang, Q.; Tong, Z.; Yang, Y. Large portfolio losses in a chaotic market. *European Journal of Operational Research*, submitted in March 2020.

Two doctoral students, Haibo Liu and Zhaofeng Tang, both co-supervised by Professors Qihe Tang and Ambrose Lo, graduated in Summer 2019. Their theses, entitled "Pricing, Bankruptcy, and

Liquidation under Insurance and Financial Risks in a Markovian Framework" and "Quantitative Risk Management under Systematic and Systemic Risks," respectively, are motivated by problems related to modeling, measuring, and managing catastrophe risks.

Another doctoral student, Jin Meng, who is supervised by Professor Kung-Sik Chan, is working on a thesis entitled "Topics in High Dimensional Statistical Learning with Applications in Property-Casualty Insurance." His research work draws on tools in extreme value theory and predictive analytic vehicles such as generalized linear models and decision trees, and has practical applications to insurance practice. He is expected to graduate in Summer 2020.

In all of the publications above, we have duly acknowledged the financial support of the CAE research grant.

The following seven papers, which were listed among the main contributions in our first year report, have recently been published:

(1) Chen, Y. Comment on the work of Zhang et al. (2017). *Journal of Inequalities and Applications* (2019). Available from: https://link.springer.com/article/10.1186/s13660-019-2142-3.
(2) Chen, Y.; Yang, Y. Bivariate regular variation among randomly weighted sums in general insurance. *European Actuarial Journal* **9** (2019), no. **1**, 301–322.
(3) Cheung, K.C.; Chong W.F.; Lo, A. Budget-constrained optimal reinsurance design under coherent risk measures. *Scandinavian Actuarial Journal* **2019** (2019), no. **9**, 729–751.
(4) Cheung, K.C.; Ling, H.K.; Tang, Q.; Yam, S.C.P.; Yuen, F.L. On cardinality of tail comonotonic risks. *Scandinavian Actuarial Journal* **2019** (2019), no. **10**, 837–866.
(5) Li, H.; Tang, Q. Analyzing mortality bond indexes via hierarchical forecast reconciliation. *ASTIN Bulletin* **49** (2019), no. **3**, 823–846.
(6) Lo, A. Demystifying the integrated tail probability expectation formula. *The American Statistician* **73** (2019), no. **4**, 367–374.
(7) Tang, Q.; Yang, Y. Interplay of insurance and financial risks in a stochastic environment. *Scandinavian Actuarial Journal* **2019** (2019), no. **5**, 432–451.

Dissemination of Research Results in Conferences and Seminars

During 06/01/2019–05/31/2020, we presented our research results at several conferences, workshops, and seminars. Financial support of the research grant facilitated our participation in these events.

Professor Yiqing Chen gave the following talk:

- "*Bivariate regular variation among randomly weighted sums in general insurance*" at the 2019 Symposium on Actuarial Science and Applications, East China Normal University, China, May 18–19, 2019

Professor Ambrose Lo gave the following talk:

- (Invited talk) "*Universally Marketable Insurance under a Multivariate Mixture Model*" at the Actuarial Science Seminar, Department of Mathematics, University of Connecticut, February 24, 2020

Professor Qihe Tang gave the following talks:

- "*Indifference pricing of insurance-linked securities*" at The 23rd International Congress on Insurance: Mathematics and Economics (IME), Technical University of Munich, Germany, July 10–12, 2019
- (Invited talk) "*Catastrophe risk management*" at The 54th Actuarial Research Conference (ARC), Indianapolis, USA, August 14–17, 2019
- (Invited talk) "*Liquidation Risk in Insurance under Contemporary Regulatory Frameworks*" at Now We r_{60}: Conference in Honor of Professor David Dickson, University of Melbourne, Australia, December 5–6, 2019
- (Invited talk) "*CAT Bond Pricing under a Product Probability Measure with POT Risk Characterization*" at Risk Workshop 2019, UNSW – Macquarie University, Sydney, Australia, December 12–13, 2019

Graduate student Haibo Liu gave the following talk:

- "*Risk-neutral pricing of insurance-linked securities*" at The 23rd International Congress on Insurance: Mathematics and Economics (IME), Technical University of Munich, Germany, July 10–12, 2019

Grant Webpage

We have updated our grant webpage http://www.stat.uiowa.edu/cae-grant/cae-grant-university-iowa with manuscripts for papers published in the second grant year. This webpage is available to the general public and will be updated on an ongoing basis.