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Dissertation Defense

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Under the Supervision of Dr. Vytaras Brazauskas

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Smoothed Quantiles for Claim Frequency Models, with Applications to Risk Measurement

Statistical models for the claim severity and claim frequency variables are routinely constructed and utilized by actuaries.Typical applications of such models include identification of optimal deductibles for selected loss elimination ratios, pricing of contract layers, determining credibility factors, risk and economic capital measures, and evaluation of effects of inflation, market trends and other quantities arising in insurance. While the actuarial literature on the severity models is extensive and rapidly growing, that for the claim frequency models lags behind. One of the reasons for such a gap is that various actuarial metrics do not possess "nice" statistical properties at the discrete models whilst their counterparts at the continuous models do. The contribution of this dissertation to addressing the issue described above is three-fold:

1. It introduces "smoothed quantiles" for samples and populations of claim counts.
2. It investigates large- and small-sample properties of smoothed quantile estimators.
3. It demonstrates the relevance of such tools to actuarial practice.

Smoothed quantiles are defined using the theory of fractional or imaginary order statistics, which was originated by Stigler (1977). To prove consistency and asymptotic normality of sample estimators of smoothed quantiles, we utilize the results of Wang and Hutson (2011) and generalize them to vectors of smoothed quantiles. Further, we thoroughly investigate extensions of this methodology to discrete populations with infinite support (e.g., Poisson and zero-inflated Poisson distributions). Furthermore, large- and small-sample properties of the newly designed estimators are investigated theoretically and through Monte Carlo simulations. Finally, applications of smoothed quantiles to risk measurement (e.g., estimation of distortion risk measures such as value-at-risk, conditional tail expectation, and proportional hazards transform) are discussed and illustrated using actual insurance data.

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