Math 5194: Casualty Actuarial Mathematics
Spring Semester, 2027

Instructor: Prof. John Holmes
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Office Hours: Monday, Wednesday and Friday, 9:00 - 10:00 AM
Lecture: Monday, Wednesday and Friday, 10:20 - 11:15 AM
Textbooks: Friedland, J.F., Estimating Unpaid Claims Using Basic Techniques, Casualty Actuarial Society, Third Version, July 2010.
Available at: *http://www.casact.org/library/studynotes/friedland_estimating.pdf*
Werner, G, and Modlin, C., Basic Ratemaking, Casualty Actuarial Society, Fourth Edition, October 2010;
Available at: *http://www.casact.org/library/studynotes/Werner_Modlin_Ratemaking.pdf*
Prerequisites: A grade of C- or above in Math 4530 or 5530H, or Stat 4201 or 6301, and a grade of C- or above in Math 3618; or graduate standing.
Description: This course provides an introduction to Property & Casualty ratemaking and reserving techniques, from an actuarial perspective. Ratemaking and loss reserving are the two fundamental functions performed by actuaries, and are necessary for satisfying an organizations strategic, operational, and regulatory goals and requirements. Specific topics covered in this course include the core loss reserving techniques (loss development, expected loss ratio, and Bornhuetter-Ferguson), the essential concepts and methods involved in the ratemaking process (on-level premiums and losses, pure premiums, and classification), and an assortment, as time permits, of advanced topics associated with the casualty actuarial function.
Grades: Cutoffs for letter grades will be determined at the end of the semester, and will be based upon a students earned points out of a possible 700 points, available in the following three areas.

1. Homework and participation: (100 points) Homework will be assigned weekly.
2. Midterms: (200 points) There will be two in class midterm.
3. Final exam: (200 points) The final exam is will be comprehensive.

Schedule and detailed Objectives:
Werner and Modline Chapter 1 Introduction (2 hours) Chapter 1 provides an overview of P&C insurance ratemaking, highlighting the unique relationship between price, cost, and profit. This overview includes basic P&C insurance terms and commonly used insurance ratios. This chapter also introduces the fundamental insurance equation, a key concept that is referenced frequently in other chapters. This concept states that premium charged for policies written during a future time period should be appropriate to cover the losses and expenses expected for those policies while achieving the targeted profit.
Werner and Modline Chapter 3 Ratemaking data (3 hours) Chapter 3 discusses ratemaking data, both internal and external to the insurance company, and introduces methods of data organization.
Werner and Modline Chapter 4 Exposures (3 hours) Chapter 4 discusses insurance exposures, the basic unit that measures a policys exposure to loss and therefore serves as the basis for the calculation of premium. The chapter outlines criteria for selecting exposure bases, methods and quantitative examples for defining and aggregating exposures, and circumstances requiring a measurement of exposure trend.

Friedland Basic techniques for estimating unpaid claims (6 hours) Chapters 7, 8 and 9 cover the development technique, expected claims technique, Bornhuetter-Ferguson technique, frequency-severity technique, case outstanding development technique, Berquist-Sherman techniques, Recoveries: salvage and subrogation and reinsurance, etc.

Werner and Modline Chapter 5 Premium (6 hours) Chapter 5 focuses on premium, the price the insured pays for the insurance product and one of the key elements of the fundamental insurance equation. The chapter discusses different ways to define and aggregate premium (including quantitative examples) and introduces standard techniques to adjust historical premium data to make it relevant for estimating future premium in the context of ratemaking. These adjustments include current rate level, premium development in consideration of premium audits, and premium trend. These adjustments to premium are relevant in loss ratio analysis.

Werner and Modline Chapter 6: Losses and Loss Adjustment Expenses (3 hours) Chapter 6 is dedicated to losses and loss adjustment expenses. Losses are amounts paid or owed to claimants under the provisions of the insurance contract. This chapter outlines the different types of insurance losses, reviews how loss data is aggregated for ratemaking analysis, and defines common metrics involving losses. This chapter also describes the various adjustments to historical loss data to make it relevant for estimating future losses. These include adjustments for extraordinary events, changes in benefit levels, changes in loss estimates as claims mature, and changes in cost levels over time.

Werner and Modline Chapter 9: Traditional Risk Classification (3 hours) Chapter 9 covers rate adequacy at the individual risk (or risk segment) level. The chapter discusses the concept of risk segmentation via rating variables and outlines criteria to consider when using a certain risk characteristic as a rating variable. The chapter also reviews the application of univariate methods to historical data to calculate rate differentials (or changes to existing rate differentials) for each rating variable. This process is known as classification ratemaking.

Werner and Modline Chapter 10: Multivariate Classification (3 hours) Chapter 10 is an extension of Chapter 9 that specifically addresses multivariate classification ratemaking techniques. The chapter discusses the benefits of multivariate approaches and provides a basic explanation of the mathematical foundation of one commonly used multivariate method, generalized linear models (GLMs). Sample output with explanation is provided for GLM results as well as associated statistical diagnostics. The chapter also reviews some commonly used data mining techniques.

Werner and Modline Chapter 11: Special Classification (2 hours) Chapter 11 addresses additional classification ratemaking techniques that were developed to address the unique qualities of some rating variables or risk characteristics. These include territory boundary analysis, increased limits factors, deductibles, size of risk for workers compensation insurance, and the concept of insurance to value and how it affects the adequacy of rates.

Werner and Modline Chapter 12 Credibility (6 hours) Chapter 12 provides a broad overview of the credibility procedures used in ratemaking. This includes methods for incorporating credibility in an actuarial estimate, desirable qualities for the complement of credibility (the related data that is blended with the original actuarial estimate), and methods and examples for determining the complement of credibility.

Werner and Modline Chapter 14 Implementation (2 hours) Chapter 14 discusses non-pricing and pricing solutions to an imbalanced fundamental insurance equation (i.e., current rates do not produce an average premium that is equivalent to the sum of expected costs and target underwriting profit). In regards to pricing solutions, the chapter discusses how to calculate final rates for an existing product, as well as how to develop rates for a new product by referencing other data sources. The chapter concludes with comments regarding the importance of communicating

expected rate change results to key stakeholders and monitoring results after implementation.
Werner and Modline Chapter 16 Claims-made ratemaking (2 hours) Chapter 16 discusses the adoption of claims-made policies, with particular attention to the medical malpractice line of business. This alternative to occurrence policies shortens the time period from coverage inception to claim settlement. For the ratemaking actuary, this translates to a shorter forecast period and therefore reduced pricing risk.