Undergraduate Honors Theses

in

Actuarial Science

John A. Beekman

Ball State University

Abstract

The purpose of this paper is to discuss some of the undergraduate research in actuarial science at Ball State University. Abstracts of twenty-three Honors Theses, with brief comments about the students' careers, are given. Common characteristics of the theses are described. Helpful techniques for advising thesis writing students are provided.

I.   Introduction

For many years, actuarial educators have asked themselves how they could get their students to start a habit of reading actuarial journals and other non-exam oriented materials, to develop research skills, and to communicate their findings.

Cecil Nesbitt has shared experiences and jointly authored results which developed in National Science Foundation supported research programs for undergraduates at The University of Michigan in [19], [20], and [21]. Bryan Hearsey has reported on "Undergraduate Student Research at Lebanon Valley College" in [9].

The purpose of this paper is to discuss some of the undergraduate research in actuarial science done at Ball State University over the past twenty years. To graduate from our Honors College, a student takes special courses, colloquia, seminars, and writes an Honors Thesis. In the Fall Semester of 1994-95, thirty-two of the ninety-three majors in actuarial science were enrolled in the Honors College. As their years unfold, some of those students may not complete the requirements to graduate with honors. This paper will provide abstracts of twenty-three Honors Theses, with brief remarks about the students' careers. The present author was the thesis advisor to these twenty-three students. In addition to this author, several other Ball State professors are now directing the writing of such theses.

There are some common characteristics of these theses. First, exposition was the major part of each work. Secondly, most theses contained some actuarial formulas, with explanations. Thirdly, the writings relied on actuarial journals, insurance periodicals, other periodicals and journals, and appropriate books. These included: Transactions, Society of Actuaries; Proceedings, Casualty Actuarial Society; Journal, Institute of Actuaries; Record, American Institute of Actuaries; National Underwriter; Best's Review; Insurance Week; Insurance Review; Social Security Bulletin; Journal, American Statistical Association; Harvard Business Review; and

"Report of Surgeon General on Environmental Tobacco Smoke." Fourthly, the topics of the theses were current at the times of writing (indeed, most topics are still current.) In about half of the theses, the topics related to the authors' summer internships or overseas study. Because of the fourth and fifth characteristics, some originality occurred in every thesis.

Certain techniques were found helpful in advising thesis writing students. In April of the student's junior year, a topic was suggested. The student was asked to do some work on the topic during the summer. Several advising sessions occurred in the Fall Semester of the student's senior year. Then, starting in January, the writers of the theses and this author met weekly. Such friendly deadlines for the respective sections helped, and the students aided each other. In the second semesters of 1992-93, 1993-94, and 1994-95 there were three students writing Honors Theses each year. Students were encouraged to use all of the library collections, including those in the Government Publications Section.

The finished theses are permanently housed in the Special Collections Area, Bracken Library, Ball State University. They are catalogued under author, and advisor.

II.   Abstracts of the Theses, and Career Comments about the Writers

Jack E. Bruner was the first student to complete a thesis. Jack spent a term at Ball State's London Center, and managed to spend some time at Staple Hall Inn. His thesis [3] was entitled "The Institute of Actuaries," and was completed in 1976. He learned about and reported on the starting of actuarial exams, the establishment of the Institute's library, the starting of regular actuarial meetings, the beginning of the Journal, Institute of Actuaries, and the creation of the designations Fellow, Institute of Actuaries, and Associate, Institute of Actuaries. Jack became a F.S.A. in 1984, and is with Hewitt and Associates.

Gail D. Price completed the second Honors Thesis. It was titled "U.S. Pension Plans and

Retirement Systems," and completed in 1978, [25]. Its history reported on the first public employee retirement system (1859; New York City policemen), the first general state employee system (Massachusetts), the Social Security Act of 1935, and the Employment Retirement Income Security Act of 1974. Gail took a position with Metropolitan Life Insurance Company in Aurora.

Robert J. Leone completed his thesis in 1979. It is titled "The Variable Annuity," [15]. His thesis described these annuities which can protect consumers from inflation, and contained charts of the cost of living index, and the purchasing power of the dollar. Bob became a F.S.A. in 1982, and is with Hewitt and Associates.

Sharon O'Meara's 1984 thesis "A Mathematical Model for a Group Pension Program," [23] grew out of her 1983 summer internship. She provided an outline of the structure of a pension plan, implying the need for immunization. Later sections discussed theories of immunization, projections of pension plan cashflows, and a computer system to produce future cashflows, and the first two moments of the assets. Upon graduation, Sharon took a position in Denver. She became an A.S.A. in 1988, and is now with Hewitt and Associates.

Charla J. Swinney's 1984 thesis was entitled "An Actuarial Analysis of Two Variable Life Products," [27]. For the one product, the benefits were adjusted each year; thus, the investment risk was assumed by the policyholder. In the second product, the inflation risk was handled by the insurance company. Charla became a F.S.A. in 1993, and is with the Union Central Life Insurance Company in Cincinnati.

A third thesis completed in 1984 was titled "Social Security, Demographic Changes, and Intergenerational Transfers: The French Example." This was written by John R. Wilmoth after spending a year in France, [29]. His thesis discussed the French Social Security system, population projections, the financial evolution of the system, and intergenerational transfers. John earned a Ph.D. in demography at Princeton University, spent two years in a post-doctoral position

at the Population Studies Institute, University of Michigan, and now is an Assistant Professor, Department of Demography, University of California-Berkeley.

Karen J. Devoy completed her Honors Thesis "Effects of AIDS on the Insurance Industry" in 1988, [4]. She wrote about the history of AIDS, projections of its mortality, impacts on insurance underwriting procedures, the prevalence of HIV+ in insureds, and resulting financial concerns. Karen became an A.S.A. in 1990, and works for the Lincoln National Life Insurance Company.

Anju Gupta wrote on "Unisex Rating in Insurance," and finished her thesis in 1989, [7]. She investigated the history of using unisex tables in the insurance industry, and included an actuarial analysis of the use of such tables. For life insurance, premiums for females would increase, while premiums for males would decrease. For pensions, benefits for females would increase, whereas benefits for males would decrease. Anju took a position with Time Insurance Company, and became an A.S.A. in 1992.

"Asset/Liability Management: An Overview of Immunization Theory" was the 1989 thesis of Greg Johnston, [12]. He studied and reported on investment options for immunizing a fund, Redington's theory of immunization, McCutcheon's theory, and software packages to help in the immunization process. Greg became an A.S.A. in 1992, and works for the Time Insurance Company.

Teresa K. Holmes studied California's Proposition 103. It called for a twenty percent reduction in bodily injury and uninsured motorist insurance rates, with no lessening of benefits, followed by a one year rate freeze. The California insurance commissioner stated that Proposition 103 could drive thirty-five insurers into insolvency in two years. Because of lawsuits, the roll-backs were not actuated. Theresa's thesis was titled "California's Proposition 103; An Overview and Analysis," [11]. She works for Blue Cross-Blue Shield in Indianapolis,

and became an A.S.A. in 1994.

Our undergraduates study risk theory in the last semester of their B.S. program, if at all. Thus, it was unusual when Patricia A. Warder was able to work on a risk theory topic. Her thesis was titled "Application of Collective Risk Theory to Certain Reinsurance Contracts," and was finished in 1990, [28]. She discussed reinsurance, stop loss contracts, and risk theory applications. Patricia's 1989 summer internship experience was with stop-loss reinsurance. Patty works for American United Life Insurance Company, and achieved her F.S.A. in 1994.

Steven P. Habegger's 1991 thesis was titled "Interest Rates and Their Forecasting," [8]. Steve studied and discussed random interest rates, four stochastic models for interest rates, historical interest rates, inflation, and appropriate statistical analysis. Steve became a F.S.A. in 1994, and is an actuary with the Lincoln National Reinsurance Companies.

Sharyn E. Oliver's 1992 Honors Thesis, [22], was devoted to the subject of long-term care. Sharyn discussed the growth in our elderly population, the increased need for LTC, the cost of LTC, the history of LTC insurance, and a projection of numbers of future LTC policyholders. Her research was aided by a summer internship at the Lincoln National Corporation. Sharyn works for Conseco, in Indianapolis.

"Similarities in the Mathematics of Demography and the Theory of Interest" was the theme and title of Edward L. Pyle's 1992 thesis, [26]. Ed compared models of population growth with the growth of a fund over time due to interest, and other mathematical similarities. Ed is in the Actuarial Department of Nationwide Insurance Company.

The expansion of the theory of interest to include stochastic models has provided a rich field for undergraduate learning and writing. Gary A. Gorrell's 1993 thesis, [6], was entitled "Stochastic Approaches to Interest Rates." Gary discussed independent and dependent interest rates, the capital asset pricing model, an option pricing model, a random walk model for security

prices, and scenario testing for future interest rates. Gary works for the Lincoln National Life Insurance Company.

Dominic J. Moster wrote a 1993 thesis titled "Interest Rate Fluctuations: Why They Occur and How to Minimize Your Risk," [16]. Dominic considered the effects of inflation, risks and uncertainties, and lengths of investments on interest rates. He also investigated yield curves, spot rates, expected present values, forward rates, government policies which influence interest rates, duration, volatility, and immunization theory. Dominic became an Associate of the SOA in 1994. He works for Jackson National Life Insurance Company in Lansing, Michigan.

Karen L. Appleby was interested in becoming a casualty actuary. This was the stimulus for her 1993 thesis, "The Subjects Studied and Exams Passed to Become an Associate of the Casualty Actuarial Society," [1]. Karen included some interesting examples from some of the subjects studies by a CAS student. Karen works for Allstate Insurance Company.

"The Effects of Environmental Tobacco Smoke on the Insurance Industry" was the topic of Angela D. Kemerly's 1994 thesis, [13]. In her work, she discusses the hazards of second-hand smoke, actions an insurance company can take to reduce ETS in the workplaces of its policyholders, and the subject of ETS and noncancer respiratory diseases. Angela works for Management Information Disciplines in Indianapolis.

Michelle Ford wrote on time series models for yield rates of bonds classified by Moody's Bond Classifications, the estimation of the model parameters, and forecasting future yield rates. Her thesis was entitled "Statistical Models for Corporate Bond Rates," and was completed in 1994, [5]. Michelle started her actuarial career with Associated Group, Indianapolis,

Brad Hoagland's 1994 thesis "Parametric Estimation of Storm Incurred But Not Reported Claims," [10], was given a good start with his 1993 summer internship with American States Insurance Company, Indianapolis. Based on that experience, and further study, Brad wrote on

the need to accurately estimate IBNR claims in order to properly adjust reserve amounts, the maximum likelihood estimation of parameters in truncated distributions, the use of the steepest descent numerical analysis algorithm, and use of the Kolmogorov-Smirnov nonparametric statistical test. After graduation, Brad accepted a regular position with American States Insurance Company.

The 1995 theses all drew from the subject of demography. Brett Bade's thesis, [2], was entitled "Population Projections for Allen County, Indiana". Brett made projections from 1990 to 2045. He used the logistic curve model, and the census data for the Fort Wayne Metropolitan Statistical Area. Brett considered several methods for estimating the parameters in the logistic curves. He prepared tables for the years 1990, 2000, 2005, 2015, 2025, 2035, and 2045 which showed the projected populations for each of the age and sex population subgroups. Different growth rates were observed for the various subgroups, with implications for the need for day care facilities, new schools, parks, nursing homes, and hospitals. Projections of the aged dependency ratios, the youth dependency ratios, the total dependency ratios, and the expenditure dependency ratios were included in the tables. Brett is doing actuarial work with Lincoln National Life Insurance Company, Fort Wayne.

Jeff Lane pursued the important topic "The United States Social Security Retirement Benefit: Are We Getting Our Money's Worth?", [14]. His thesis drew upon the papers [17] and [18] by Robert J. Myers and Bruce D. Schobel. Jeff made certain assumptions and then approximated benefit/tax ratios. For his analysis, only the employee payroll tax was considered. He carefully considered what interest rates should be used in the accumulation of preretirement taxes paid, and the discounting of postretirement benefits. It was assumed that all workers retire at the Normal Retirement Age, (NRA) and that they live exactly their expected lifetime at NRA. Projected decreases in mortality were used in the expectations of life. Seven tables were devoted

to interest rates, annual wages and tax amounts, monthly benefit awards, life expectancies at retirement, accumulated tax values, value of future benefits at time of retirement, and benefit/tax return ratios for the single years 1960 through 2000, and quinquennial years 2005 through 2070. The tables were for males and females, both average earning and maximum earning. An interpretation of the results concludes the thesis.

Brad Peckinpaugh's thesis, [24], was entitled "Population Projection for the Denver-Boulder Standard Metropolitan Statistical Area." A key component in his projection method was an appropriate Leslie matrix. In order to create this, Brad used mortality and fertility data for Colorado from the National Center for Health Statistics. His estimates of migration were made from material from the Bureau of the Census. Brad used the 1980 census count as his baseline population, but with the nonquinquennial age group data split into quinquennial age groups. His Leslie matrix was used to project the population to the years 1990, 2020, 2050, and 2080. Aged, youth, and total dependency ratios for those years were computed. Brad concludes his thesis with some insightful remarks about the consequences of such dependency ratios in future years.

References

[1]   Appleby, Karen L. "The Subjects Studied and Exams Passed to Become an Associate of the Casualty Actuarial Society." B. S. Honors Thesis, Ball State University, 1993, Muncie, Indiana.

[2]   Bade, Brett S. "Population Projections for Allen County, Indiana." B.S. Honors Thesis, Ball State University, 1995, Muncie, Indiana.

[3]   Bruner, Jack E. "The Institute of Actuaries." B.S. Honors Thesis, Ball State University, 1976, Muncie, Indiana.

[4]   Devoy, Karen J. "Effects of AIDS on the Insurance Industry." B.S. Honors Thesis, Ball State University, 1988, Muncie, Indiana.

[5]   Ford, Michelle. "Statistical Models for Corporate Bond Rates." B.S. Honors Thesis, Ball State University, 1994, Muncie, Indiana.

|6| Gorrell, Gary A. "Stochastic Approaches to Interest Rates." B.S. Honors Thesis, Ball
       State University, 1993, Muncie, Indiana.

|7| Gupta, Anju. "Unisex Rating in Insurance." B.S. Honors Thesis, Ball State University,
       1989, Muncie, Indiana.

|8| Habegger, Steven P. "Interest Rates and Their Forecasting." B.S. Honors Thesis, Ball
       State University, 1991, Muncie, Indiana.

|9| Hearsey, Bryan V. "Undergraduate Student Research at Lebanon Valley College."
       Actuarial Research Clearing House, Issue 1994.1, pp. 81-87, Schaumburg, Illinois.

|10| Hoagland, Brad. "Parametric Estimation of Storm Incurred But Not Reported Claims."
       B.S. Honors Thesis, Ball State University, 1994, Muncie, Indiana.

|11| Holmes, Teresa K. "California's Proposition 103: An Overview and Analysis." B.S.
       Honors Thesis, Ball State University, 1990, Muncie, Indiana.

|12| Johnston, Greg. "Asset/Liability Management: An Overview of Immunization Theory."
       B.S. Honors Thesis, Ball State University, 1989, Muncie, Indiana.

|13| Kemerly, Angela D. "The Effects of Environmental Tobacco Smoke on the Insurance
       Industry." B.S. Honors Thesis, Ball State University, 1994, Muncie, Indiana.

|14| Lane, Jeffrey J. "The United States Social Security Retirement Benefit: Are We Getting
       Our Money's Worth?" B.S. Honors Thesis, Ball State University, 1995, Muncie,
       Indiana.

|15| Leone, Robert J. "The Variable Annuity." B.S. Honors Thesis, Ball State University,
       1979, Muncie, Indiana.

|16| Moster, Dominic J. "Interest Rate Fluctuations: Why They Occur and How to Minimize
       Your Risk." B.S. Honors Thesis, Ball State University, 1993, Muncie, Indiana.

|17| Myers, Robert J. and Bruce D. Schobel (1985). "A Money's Worth Analysis of Social
       Security Retirement Benefits." Trans., Society of Actuaries, 35, 533-545.

|18| Myers, Robert J. and Bruce D. Schobel (1993). "An Updated Money's Worth Analysis
       of Social Security Retirement Benefits." Trans., Society of Actuaries, 44, 247-270.

|19| Nesbitt, Cecil, Felicity Messner, Aaron Robertson. "Review of Social Security Financing
       and Related Matters," Actuarial Research Clearing House, Issue 1993.1, pp. 249 -
       282, Schaumburg, Illinois.

|20| Nesbitt, Cecil, Andrew Cohen, David Gallers, Brett Houghton, Angela Myler, Paul Weiss.
       "n-Year Roll-Forward Reserve Financing of Social Security." Actuarial Research
       Clearing House, Issue 1994.1, pp. 30-80, Schaumburg, Illinois.

|21| Nesbitt, Cecil, Marjorie Rosenberg, Lee Berger, Marc Levinsky, Alexa Nerdrum, Suzy O'Donnell, David Samaniego, Amy Trendel. "Some Financing Options for Social Security." Actuarial Research Clearing House, Issue 1995.1, pp. 381-417, Schaumburg, Illinois.

|22| Oliver, Sharyn E. "Long-Term Care: A Growing Concern." B.S. Honors Thesis, Ball State University, 1992, Muncie, Indiana.

|23| O'Meara, Sharon M. "A Mathematical Model for a Group Pension Program." B.S. Honors Thesis, Ball State University, 1984, Muncie, Indiana.

|24| Peckinpaugh, Bradley D. "Population Projection for the Denver-Boulder Standard Metropolitan Statistical Area." B. S. Honors Thesis, Ball State University, 1995, Muncie, Indiana.

|25| Price, Gail D. "U.S. Pension Plans and Retirement Systems," B.S. Honors Thesis, Ball State University, 1978, Muncie, Indiana.

|26| Pyle, Edward L. "Similarities in the Mathematics of Demography and the Theory of Interest." B.S. Honors Thesis, Ball State University, 1992, Muncie, Indiana.

|27| Swinney, Charla J. "An Actuarial Analysis of Two Variable Life Products." B.S. Honors Thesis, Ball State University, 1984, Muncie, Indiana.

|28| Warder, Patricia A. "Application of Collective Risk Theory to Certain Reinsurance Contracts." B.S. Honors Thesis, Ball State University, 1990, Muncie, Indiana.

|29| Wilmoth, John R. "Social Security, Demographic Change, and Intergenerational Transfers: The French Example." B.S. Honors Thesis, Ball State University, 1984, Muncie, Indiana.