Integration of Insurance Mathematics and Economics Through Application Driven Theory

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For Educational Purposes Only

Insurance: Mathematics and Economics Conference
CEAR Lecture July 26, 2016
Agenda

- Historical Linkages of Insurance Mathematics and Economics.

- What is Application Driven Theory?

- Basic versus Non-Basic Research and Pure versus Applied Research.

- Examples of Application Driven Theory in Insurance Mathematics and Insurance Economics.

- Research Directions in IME for Application Driven Theory.
Risk Management Is Ancient

- “Avoid the danger that has not yet arisen” (Heyam Dukham Anagatam in Sanskrit), Vedic literature from 6,000 years ago.

- Hammurabi Code 1750 BC
  - Laws on ancient obelisk
  - Describes how a lender gets an additional fee in exchange for the loan being forgiven if a loss at sea occurs (insurance).
Insurance Began in Ancient Times

- Insurance and annuities existed in practice long before the mathematics and economics of risk made pricing rational.

- Insurance in early barter economies involved agreements of mutual aid.

- Risk transfer and pooling were practiced by Chinese and Babylonian traders in the 3rd and 2nd millennia BC.
Ancient Insurance

- Insurance was sold in spite of people not believing in chance occurrences or accidents—God controlled every detail of the Universe deterministically.

- Cost of a $100/month life annuity was the same at age 30 and age 70--per annuities offered by William III of England.

Risk Assessment Is A Matter Of Perspective

The Hallucinogenic Toreador painting by Salvador Dali
Risk Assessment Is A Matter Of Perspective

"I prefer these imported cigarettes — they don’t have a health warning."
Why The Delay In Quantifying Risk?

- The development of measures of frequency of occurrence of uncertain events did not occur until the mid 1600s.

- The development of economics did not occur until about the same time.

- Why?

- Statistician M. G. Kendall: “Mathematics never leads thought, but only expresses it.”
  - The same can be said about economics.
The Plague Changed Everything

- Economic power shifted with the plague
  - Rise of middle class
  - Set the ball rolling for
    - Industrial revolution
    - Reformation of the church
      - Reevaluation of the role of God in earthly activities.

- These changes led, through several Application Driven Theories, to a whole new intellectual environment.
What is Application Driven Theory?

- “Application Driven Theory” is theory developed to address a concrete problem.

- Basic research motivated by an application and resulting in theoretical development.
  
  - Theory developed in one field can apply to others.
  
  - Example: Fluid flow dynamics theory can inform not only airplane and ship construction but also building protections for hurricanes.
    
    - Has applications far beyond the original motivating topic area (airfoil, fluid viscosity, etc.).
Texas Coast Before Hurricane Ike, 2008
After Ike: Last House Left Standing
Theory Development Important to IME

- Quantification of uncertainty and chance (probability) of future outcomes (1654 by Pascal and Fermat). A major philosophical breakthrough.

- Historically chance was not accepted as existing, much less worthy of being quantified. Uncertainty was human, but not nature.

- Omnipotence of God made discussions of chance or randomness unthinkable (or blasphemous).
Quotes On Chance Reflecting Determinism

- St. Augustine: “We say that those causes that are said to be by chance are not nonexistent but are hidden, and we attribute them to the will of the true God…”

- La Jardin d’Epicure 1894, “Chance is perhaps the pseudonym God uses when He did not want to sign.”
John Wesley (founder of Methodist Church) describes how he used the drawing of lots to decide whether or not to marry (*Journal*, Vol. 1 1737, Friday, 4 March).
Even in Science God Often Entered

“I think you should be more explicit here in step two.”
Recognizing Human Predictability

- A major breakthrough was recognition that human events were subject to regularity which could, in the aggregate, be predicted and explained via quantitative reasoning.

- John Graunt’s publication *Natural and Political Observations* based upon the *Bills of Mortality*. Published in 1662, with commentary and extensions by William Petty (sometimes called the Father of Modern Economics).
### Bills of Mortality Analyzed by Graunt 1662

#### The Diseases and Casualties this Week.

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#### The Price of Bread set forth by Order of the Lord Mayor and Court of Aldermen

A penny Wheaten Loaf to contain Nine Quinces and a half, and three half-penny White Loaves the like weight.
Birth of Statistics, Actuarial Science and Economics

- First lifetable giving rise to statistics.
- Purpose was Applied and Practical --Example of Application Driven Theory

King Charles II told the Royal Society "that if they found any more such tradesmen, they should be sure to admit them all, without any more ado."
Basic, Pure and Applied Research

- In the USA, the National Science Foundation Act of 1950 formalized the familiar one dimensional characterization of research as “basic” or “applied”.

- In discussing Application Driven Theory it is convenient to replace this with a two-dimensional matrix where “Non-basic” and “Basic” research are the columns and “Applied” and “Pure” are the rows.
Distinction Between “Pure” and “Applied”

- Pure, oriented toward **understanding**
- Applied, directed to **use**
Distinction of “Basic” and “Non-Basic”

Basic research is aimed at foundations.

- **Basic Research:**
  1. Opens new avenues of research
     - Relatively easy to give examples of this in IME.
  2. Closes off previous research
     - Example: Hilbert called for a program to find a complete and consistent set of axioms for all of mathematics. Gödel's incompleteness theorems showed this is impossible.
"Putting a box around it, I'm afraid, does not make it a unified theory."
In Mathematics

“IT'S AN EXCELLENT PROOF, BUT IT LACKS WARMTH AND FEELING.”
Doing Both Basic And Applied Research Can Be Difficult!!

"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."

McCombs School of Business
Something's just not right -- our air is clean, our water is pure, we all get plenty of exercise, everything we eat is organic and free-range, and yet nobody lives past thirty.

We’ve Come A Long Way But Still Have Challenges
Where Are We Going?

- **Big Applications Needing Theory:**
  - Big Data and Data Mining
  - Cyber Risk Insurance
  - Man-Made Catastrophe
  - Risk Sharing/Insurance
  - Political Risk (Including Terrorism)
A Call for Application
Driven Theory

We have many problems to solve that can lead to theory development to help solve new problems.
Thank you! Now for the peer review – Questions?