Session 5

Leveraging Predictive Analytics for Enterprise Risk Management

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Leveraging Predictive Analytics in ERM

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Agenda

• What is Predictive Analytics

• Application in ERM:
  - Economic capital calculation
  - Digital ERM dashboard

• Look into future

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Education and Qualifications
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• Head of Advanced Analytics and a Consulting Actuary with Milliman in Taipei
What is Predictive Analytics?
What is Predictive Analytics?

- **Business Intelligence** — a set of technologies and tools to understand and analyze business performance
- **Analytics** — the extensive use of data, statistical and quantitative analysis, explanatory and predictive models
- **Predictive Analytics** — predicting the value of an outcome, given a number of input measures

- A wide range of statistical methods and approaches
  - e.g. random forest, neural network, generalized linear models
- Using large and granular data sets
  - Various types and sources
- To predict future patterns
  - Predictive vs. descriptive
- To obtain business insight and facilitate decision-making
Now comes its time…

Expanding Data

Computational power

Management interest

Competitive pressure

Predictive analytics

Entering a new era

Wherever Decisions are made, there is Opportunity for Predictive Analytics

Marketing
- Brand management
- Target marketing
- Cross sell
- Product design

Underwriting
- Underwriting requirements
- Exposure audits

Pricing
- Rate relativities

Claims
- Fast track
- High risk case management
- Fraud detection

Distribution
- Agency selection
- Agency management
Application in ERM:
Economic Capital Calculation

Economic Capital:
Sufficient surplus to cover potential losses at a given risk tolerance level over a specified time horizon

Applications of Economic Capital:
- Product Pricing
- Determine Risk Profile
- Capital Budgeting
- Applications of Economic Capital
- Managing and Limiting Risk
- Long Term Value
- ALM

Determine Risk Profile
Typical Risks

- **Market Risk**
  - Equity & Interest rate: performance of underlying investments
  - Volatility
  - Misestimation

- **Policyholder Behavior Risk**
  - Persistency/Lapse: Early termination
  - Catastrophe
  - Volatility
  - Misestimation

- **Insurance Risk**
  - Mortality/Longevity: Risk from misestimating mortality
  - Catastrophe
  - Volatility
  - Misestimation
  - Trend

- **Other Risks**
  - Counterparty: Risk of reinsurer failing to meet obligations
  - Operational: Risk from inadequate or failed internal processes
  - Expense: Risk of incurred expenses being higher than anticipated

**Evaluation of Behavioral Tail Risk**

**Types of Lapse Tail Risk**

- **Drift**
  - Risk that best estimate lapse rates vary under different market conditions
  - Captured by a dynamic lapse component

- **Diffusion**
  - Risk that estimates of the entire lapse function are off
  - Captured by simulation of lapse behaviour using predictive model

- **Extreme Event**
  - Risk that some unprecedented events may impact lapse in an extreme way
  - Resort to some manner of judgement call
Lapse Behavior Simulation

\[
\text{logodds} \sim a + b_1 \cdot \text{Variable1} + b_2 \cdot \text{Variable2} + b_3 \cdot \text{Variable3} + \varepsilon
\]

Model Assumptions:
- Each coefficient \( b_x \) is normally distributed
- The error term \( \varepsilon \) is normally distributed with a mean of 0
- Correlation between each predictive \( \text{VariableX} \) can be given by a correlation matrix
- The standard deviation of \( \varepsilon \) denoted by \( \mathbf{\Omega} \) can be determined from the correlation matrix using numerical methods such as Cholesky decomposition

Lapse Behavior Simulation – Determine Best Estimate

- Consider the following model, where the only predictive variable considered is In-The-Moneyness

\[
\text{logodds} \sim a + b_1 \cdot ITM + \varepsilon
\]

- After fitting your experience to the model, the following best estimate calibration is attained:

\[
\text{logodds} = 0.5 + (-2) \cdot ITM + 0
\]

Resulting best estimate lapse rate (\( \rho \)):

<table>
<thead>
<tr>
<th>ITM</th>
<th>( \rho )</th>
</tr>
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<tbody>
<tr>
<td>225%</td>
<td>1.8%</td>
</tr>
<tr>
<td>175%</td>
<td>4.7%</td>
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<td>125%</td>
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<td>25%</td>
<td>50.0%</td>
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</table>
Lapse Behavior Simulation – Simulating the Risk of Model Misestimation

- Alternatively, we can simulate lapse rates by allowing the coefficients to vary according to their standard deviation, assuming a multivariate normal distribution

\[ \text{logodds} = 0.5 + N_1(0, \Omega) + (-2 + N_2(0, \Omega)) \times \text{ITM} \]

<table>
<thead>
<tr>
<th>Best Estimate</th>
<th>ε = (0.2, 0.1)</th>
<th>ε = (-0.2, -0.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ε</td>
<td>ITM</td>
<td>p</td>
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<td>0</td>
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Application in ERM: Digital ERM Dashboard
Why (digital) ERM Dashboards?

Digital ERM dashboards go beyond static dashboards by enabling quick access to the unbiased data needed to support decisions.

**Convenience**
- Imagine going to a board meeting with a printout of 1-2 pages from a dashboard you're logged into that allows complete drilldown ability on the fly.
- Drill in to answer questions and provide data to come to informed decisions.

**Timing issues**
- Hooking into source data eliminates issues of prioritizing time by the business units to acquire the needed data.
- Analysis can be updated in real time as experience emerges and market conditions evolve.

**Reporting bias**
- Taking business units out of the update process also reduces bias in reporting without reducing their opportunity to add commentary.

**Customized**
- Can be set up with a traffic light or heat map approach.
- Can grow as you identify important data points to monitor.
Empowering Digital ERM Dashboard

- Real-time data and refreshed models
- Continuous monitoring

**Dashboard**

- Identify areas for further investigation
- Generate ideas for why things may be unfolding as they are.

**Predictive Modeling**

- Test theories and create a desired level of confidence in the answer.
- Use machine learning to investigate what drives risk events

Problems for analysis → Results reported back to dashboard

Market-Based Explanations

- A digital dashboard can connect straight to news feeds and to your admin system to put stats side by side
- Watch experience emerge next to changes in the economic environment, political environment, etc.
- Do spikes or drops in activity relate to the external world?

Hypothesis: lapse rates drop after a lag in response to a drop in the S&P, likely related to a rise in ITM
Actual vs Expected

- A dashboard can quickly and easily highlight which segments of business are performing as expected and which are diverging.
- This shows aggregate experience dipping into warning territory.

Note: Lapse rates have dropped recently relative to expectations.

Actual vs Expected

- Drilling deeper, you can identify segments of the block that are behaving closer to expectations, and some behaving even further from expected.

Note: Youngest ages are still lapsing as expected, older ages contribute to low lapses.
Economic Capital – Behavioral Sensitivities

- If we change our assumption, what’s the dollar impact?
- Adding a calculation possibly via Greeks, for the dollar impact of changes to policyholder behavior is a quick step to a traffic light indicator

Look into the (near) future
The use of Machine Learning and Artificial Intelligence (AI) adds value to every stage of ERM cycle

- Identify anomalies through structured and unstructured data
- Automate reports to deliver near real-time alerts and help generate business insights
- Predict exposure based on evolving business environment
- AI-based decision making in risk mitigation and control strategies

Illustration of Cyber Risk model

1. **Risk Profiling**
   - Identify and assess each risk
   - Cognitive mapping
   - Historical experience
   - Current indicators
   - Process, controls, and users

2. **Model Construction**
   - Establish causal chain between triggers and consequences
   - Performance of controls
   - Likelihood of cyber attacks after management actions
   - Potential outcomes (e.g. losses/reputation)

3. **AI Integration**
   - Model calibration with real-time data
   - Threat detection
   - Incorporation of unstructured data

4. **Reporting & Ongoing Monitoring**
   - Dynamic dashboard
   - Threat development
   - Establish learning process: predict, monitor, learn, predict again