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2016 ERM Seminar

Predictive Modeling and Pricing: How Does it all Fit Within an ERM Framework?

Peter Wu, FCAS, ASA, MAAA, Deloitte Consulting LLP
Hsiu-Mei Chang, FCAS, AIG
Rita Zona, ACAS, MAAA, Deloitte Consulting LLP

Agenda

Topic	Speaker	Timing
Introduction	Moderator	5 minutes
Pricing and Advanced Modeling Trends and Challenges in the P&C Industry	Peter Wu	20 minutes
Model Risk Management	Hsiu-Mei Chang	25 minutes
Pricing Risk Governance	Rita Zona	15 minutes
Questions	All	10 minutes

Pricing and Advanced Modeling Trends and Challenges in the P&C Industry

Peter Wu, FCAS, ASA, MAAA, Deloitte Consulting LLP

The Evolution of P&C Insurance

Advanced Pricing and Modeling

Advanced pricing and predictive modeling have become mainstream over the last 15 years in several industries within financial services. Property and Casualty insurance has been one of the leading industries in the integration of advanced analytics into core operations.

1990

- Credit Scoring – An early bellwether of the disruptive power of data in insurance.

2000s

- Predictive modeling transformation of the P&C industry and actuarial profession.
- Analytics-powered key operations such as underwriting, claim triage, and marketing

Today and Future

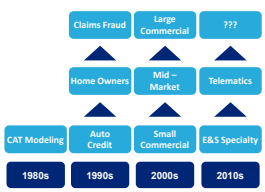
- From predictive modeling to broad based analytics and big data
- Increasingly and granular applications on every aspect of insurance operations and customer service.
- A core strategic capability
- Actuaries and data scientists

Continued Acceleration

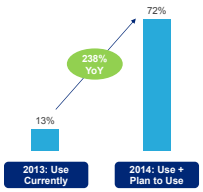
Advanced Pricing and Modeling will Continue to Accelerate

P&C adoption took 20+ years to institutionalize modeling; Specialty Lines has taken 12 months

P&C Advanced Modeling Adoption

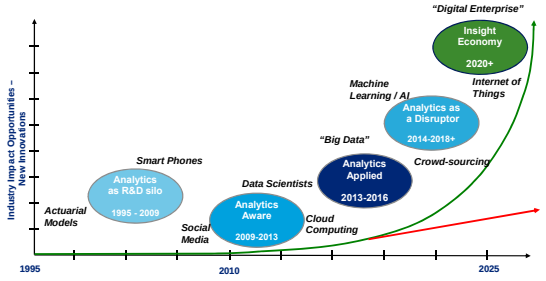


Future Trend



Continued Acceleration

Perception: Analytics evolving **LINEARLY**. Reality: Occurring **EXPONENTIALLY**

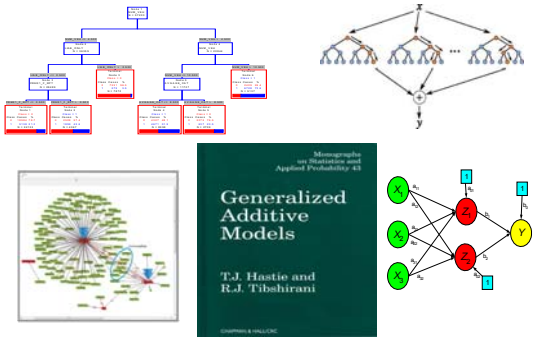


The Role of Technology

Advanced Pricing and Modeling will Continue to be Shaped by Technology

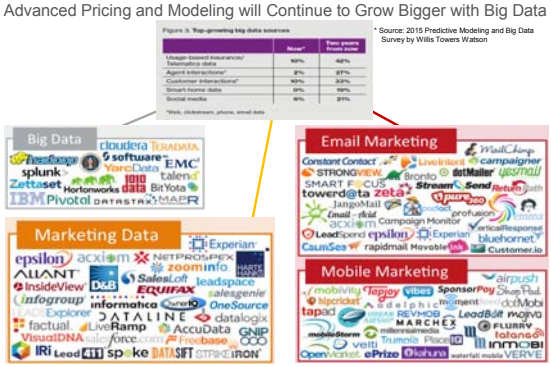
Sophistication

Advanced Pricing and Modeling will Continue to be More Sophisticated



The Impact of Big Data

Advanced Pricing and Modeling will Continue to Grow Bigger with Big Data



* Source: 2015 Predictive Modeling and Big Data Survey by Willis Towers Watson

Increased Modeling Applications

Advanced Pricing and Modeling will Continue to Spread Wider

Increasingly Modeling Applications on Every Aspect of Insurance Operations and Customer Service

- **Claim Modeling**
- **Fraud Detection**
- **Litigation Analytics**
- Salvage Rate Modeling
- Loss Control Modeling
- Warranty Modeling

- Demand Modeling
- **Cross Sale and Upsale Modeling**
- **Marketing Mix Modeling**
- Customer Segmentation and Retention Modeling
- Lifestyle Base Analytics
- Customer Lifetime Value Analytics

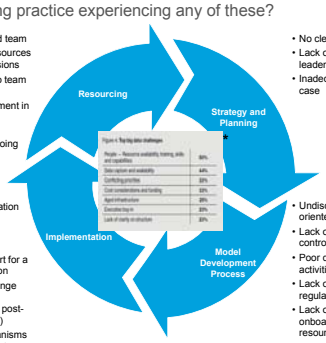
- Workforce Analytics
- Workers Safety analytics
- **Business Information Analytics**
- Competitive Analysis

- Underwriting Modeling
- Pricing Modeling
- Account Modeling
- **Premium Audit and Leakage Modeling**

Predictive Modeling Challenges

Is your modeling practice experiencing any of these?

- Heavily modeling focused team
- Improper allocation of resources to support business decisions
- Loss of knowledge due to team member turnover
- Lack of end-user involvement in end-to-end process (e.g., underwriter)
- Lack of ownership of ongoing model maintenance
- Lack of IT involvement



- No clear analytical strategy
- Lack of buy-in, support from leadership
- Inadequate or absent business case

- No long-term implementation strategy
- Lack of ownership for implementation tasks
- Underestimating the effort for a successful implementation
- Inadequate focus on change management (e.g., communication, training, post-implementation activities)
- Lacking feedback mechanisms (i.e., performance metrics)

- Undisciplined research-oriented development process
- Lack of, or inadequate, quality control
- Poor documentation of activities and decisions
- Lack of business, legal, regulatory and peer reviews
- Lack of training materials to onboard new analytics resources

* Source: 2015 Predictive Modeling and Big Data Survey by Willis Towers Watson

Three Lines of Defense in Guarding the Risk

Enterprise Business Units and Modeling Teams

- Self control and self regulations
- Wok papers and documentations
- Code standards and management
- Modeling process and standards
- Peer review

Enterprise Risk Management Team

- Enterprise risk management framework
- Risk management and governance committee by CRO, General Counsel, actuaries, underwriters, product management, etc.
- Risk governance standards and process
- Compliance review

Assurance and Regulations

- Insurance regulations by Fed and insurance departments on model risks, rate filings and financial reporting
- Internal and external audit reviews
- State insurance department market conduct examinations
- Public interest groups

Professional Standards and Regulation on Modeling

Federal Reserve Letter SR 11-7

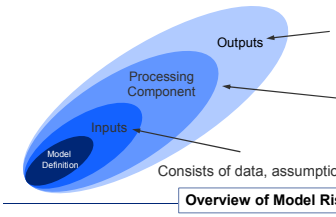
- Financial institutions should be attentive to possible adverse consequences (including financial loss) of decisions based on models that are incorrect or misused, and should address those consequences through active model risk management
- Core model validation include evaluation of conceptual soundness, ongoing monitoring and outcome analysis

ASB – Standards for Modeling

- Existing ASB standards:
  - ASOP No. 38: Models outside the Actuary's Area of Expertise
  - ASOP No. 36 and 43 for Reserving
  - ASOPs for Ratemaking
  - Should the existing ASOPs apply to insurance predictive modeling work?
- Working on Modeling Exposure Drafts that apply to all practice areas and all forms of models and clarifies actuary's use of professional judgment to determine whether full application of guidance in the standard is warranted
- Ongoing debates on various key considerations for actuarial standards for modeling

Models and Model Risk for SR 11-7

What is a model according to SR 11-7?



Produces mathematical representations of reality used to inform business decisions

Transforms input components into estimates using quantitative methods

Consists of data, assumptions and parameters

Overview of Model Risk

Model Risk → Fundamental Error Risk

Model Risk → Incorrect Use Risk

Financial institutions should be attentive to possible adverse consequences (including financial loss) of decisions based on models that are incorrect or misused, and should address those consequences through active model risk management.

ASB Proposed Standard on Modeling

- ASOP No. 38 of "Using Models outside the Actuary's Area of Expertise" was approved in 2000 for actuaries working with CAT models.
- ASB feels the need to provide actuaries new standards on modeling as the number of modeling applications in actuarial science has significantly increased in recent years. A task force was form in 2010 to begin the work:
  - The First Exposure Draft on modeling standards was released in June 2013.
  - The Second Exposure Draft on modeling standards was released in Nov 2014.
  - The Third Exposure Draft of Proposed Actuarial Standard of Practice on Modeling was released in June 2016 with a deadline of Oct 31, 2016 for soliciting feedbacks.
- The proposed standard provides detailed guidance to actuaries on model assumptions, usage, development, variables, data, validation, disclosure, etc.
- Ongoing debates for the proposed actuarial standard include:
  - Should there be a single standard applicable to all areas?
  - Should the standard be applied more broadly or narrowly?
  - Can we appropriately define "model"?
  - How much judgment that actuaries can apply regarding the applicability of the standard?
  - Should actuaries be accountable for meeting the standard if other modeling team members are not actuaries?

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Model Risk Management

2016 CAS ERM Seminar
October 6, 2016

Hsiu-Mei Chang, FCAS
AIG – Risk Director, ERM/ Model Risk Management
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Disclaimer

The information, opinions, and recommendations contained in this presentation are my own and do not necessarily reflect the policies, procedures, or opinions of AIG.

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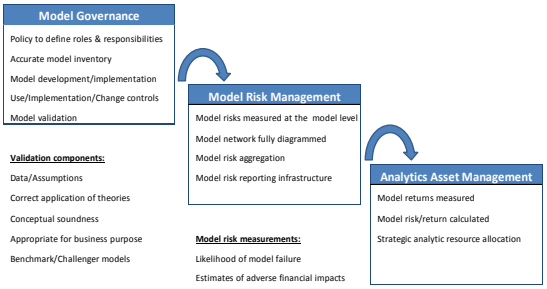
Discussion Points

1. A comprehensive model management framework
2. Model governance
3. Model risk measurement
4. Analytic asset management

3

A Comprehensive Model Management Framework
Three phases of evolution



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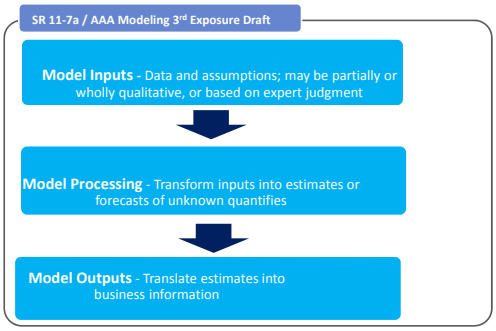
Model Governance
Model Definition & Components



Model Use Examples

1. Asset/Liability valuation
   - Financial reporting
   - Budget/Business Planning
   - Baseline scenario analysis - systemic insurance risk drivers (e.g., underwriting cycles, mortality, morbidity, and catastrophe risks), macroeconomic risk drivers (e.g., Interest rate, currency, commodity price risk)
2. Products pricing
   - Overall profitability
   - Effective risk segmentation
   - Marketing strategies, product (re)designs
3. Capital management
   - Cost effective financing and risk transfer/hedging strategies
   - Aggregation/concentration risk mitigation
   - Stress scenario analysis – liquidity risk management
   - Portfolio optimization reflecting efficient capital use/allocation

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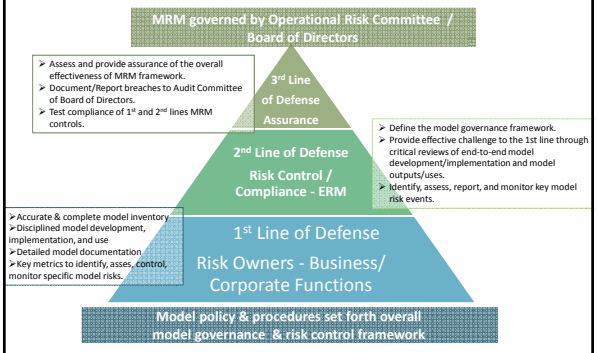
Model Governance
3 Lines of Defense



Model Risk Management
Model Risk & Causes

1. Model risk - Potential adverse consequences from decisions based on incorrect models or misuse of model outputs.
2. Causes of model risk
   - Intrinsic – data deficiencies, estimation uncertainty, complexity of model process, business applications, new models, inadequate testing
   - Extrinsic – model implementation/use controls, systematic risk drivers (e.g., (e.g., uncertainty in volatility / correlation, unexpected movements in interest rates).

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Model Risk Management
Costly Model Risk Events

Examples of costly model errors

- Model-related errors
  - Bank of America (2014) – data/process error causes $4B reduction in reported capital
  - London Whale (2012) – models error caused $5.8B of trading losses
  - Banamex (2002) Modeling teams destroy approximately 5 years worth of default data due to faulty data processing. Computer literature suggests that the value of 100 megabytes of data is valued at approximately $1 million,
  - Between 2001 and 2012 SEC public registrants announced over 12,000 financial restatements, most due to data processing and/or model errors

Other costly model errors with Model tie-ins

- Operational errors
  - S&P and Moody's (2008) – errors in models for rating complex debt products. Huge reputational damage
  - Knight Capital Group (2012) – trading software malfunction led to more than $450M losses
  - Goldman Sachs (2013) – software glitch caused erroneous flood of stock option orders, creating significant trading losses
- Basic model errors
  - Long Term Capital Management (1998) – over reliance on short term history to calibrate models, use of VaR. Resulted in bankruptcy
  - 2008-2009 financial crisis – CDO default models ignored dependence on rising national housing prices

The revenue loss from other undiscovered and unreported models deficiencies cannot be estimated, but must be huge

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Model Risk Management
Model Risk Quantification - Challenges

1. All risk measurement is hard
2. Model "failure" criteria hard to fully define
3. Apples & oranges problems
4. Direct and indirect effects

But we can take inspiration from some (unlikely) heroes:

- Simon Kuznets – inventor of GDP
- Frank Knight – "If you can't measure it, measure it anyway", Economic Freedom; Toward a Theory of Measurement, Walter Block, 1991

Practitioners need to maintain an inventor/entrepreneurial attitude. Read Frank Knight's "Risk, Uncertainty, & Profit".

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Model Risk Management
Model Risk Quantification - Challenges

1. Risk is a psychic concept, i.e. it is "perceived"
2. Technical risk analytics requires assumptions about underlying preferences – typically expressed through a utility function. Such analysis is usually used to:
   - Rationalize behavior we observe
   - Provide guidance/control over our own behavior
3. The theoretical foundation for the existence of utility functions is the ability of the agent to rank order preferences over a choice set

Thus, we do not necessarily need utility functions to create an institutional model risk framework – but we *do* need preference ordering

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Model Risk Management
Model Risk Quantification - Framework

1. Enumerate bad outcomes
2. Identify preference rank ordering
3. Associate models with bad outcomes
4. Enumerate modes of failure by model type
5. Associate failure modes with bad outcome likelihood

Risk must be based on somebody's preferences

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Model Risk Management
Model Risk Quantification - Framework

1. Enumerate bad outcomes
   - Any model failure that could impact revenue, profitability, market share, stock price, reputation, or survival
2. Identify preference rank ordering
   - No ranking is necessary, the only bad outcome is a negative impact on stock price
3. Associate models with bad outcome potential
   - For different model classes, how likely are failures to affect stock prices?
5. Associate failure modes with bad outcome likelihood
   - For each model class, how likely are different failure modes to affect stock prices?

With enough data such a framework may be feasible, but it still must reflect somebody's preferences

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Model Risk Management
Model Risk Quantification - Framework

1. Enumerate bad outcomes
   - Losses (of different types), revenue drag, reputational damage, regulatory censure, etc.
2. Identify preference rank ordering, e.g.
   - Don't fail CCAR
   - Prevent headline "OpRisk" losses
   - Enhance margins
   - Additional criteria
3. Associate models with bad outcome potential
4. Enumerate modes of failure for model types
5. Associate failure modes with bad outcome likelihood

Management/BU developed

Risk Analytics developed

These components, along with their probability measures and weightings comprise the framework

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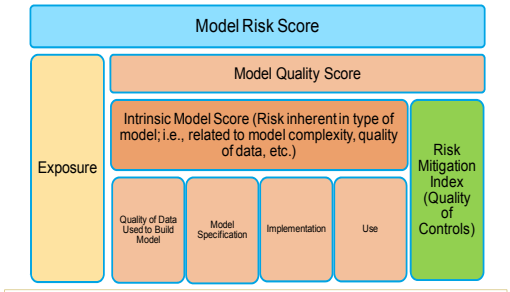
Model Risk Management
Model Risk Quantification - Framework



To harvest risk component data from the validation process requires that process to be highly structured

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Model Risk Management
Model Risk Quantification - Limitations

1. Model-to-model effects
   - Risk propagation (amplification, neutral transmission, or mitigation) within a system
2. Exposure attribution
3. Weak link to financial metrics
4. Redundant analyses/findings
5. Poor subject matter expertise matching
   - All validators need to be data quality experts?

All of these issues are significantly ameliorated by elevating the unit of observation to the model stream level

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Analytic Asset Management
Why is this important?

1. Profitability and market share (and ultimately firm survival) will depend critically on it
2. Regulatory expectations (requirements) in this area continue to grow*
3. They are essential for a comprehensive and integrated model management framework

"Model risk should be managed like other types of risk. Banks should identify the sources of risk and assess the magnitude… Banks should consider risk from individual models and in the aggregate.",
SR Letter 11-7 Model Risk, page 4.

*In rare but actual cases, failure to meet regulatory expectations and survival can become intertwined.

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Analytic Asset Management
What is a model stream?

1. A group of models ***and their infrastructure*** related by
   - Function
   - Dependence (nesting)
   - Common data sources
   - Common platform
2. The stream includes all movements of data and calculated values
3. It includes data transfer/processing/transformation components as well as models
4. It is wing-to-wing: data sources to final use/reporting

Risk measurement at the stream level can directly embed data quality risks and model risks adjusted for interdependencies

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Analytic Asset Management
Considerations of a model stream

1. Product outlook
   - Core/non-core, growth/stable/shrinking
   - Profitability, competitive positions
   - Performance volatility
   - Product evolution (dynamism, segmentation)
2. Tactical objectives
   - Improve risk segmentation, predictive accuracy
   - improve implementation infrastructure - more controlled production application, ease of use, more automated data capture
   - Interconnectivity of related models
3. Economic assessments
   - Known deficiencies
   - Key costs and effected margins
   - Tail loss avoidance
   - Product differentiation, pricing power, demand elasticity, client services
   - Potential impact – risk/reward trade offs, combined ratio effect, etc.

Strategic and tactical action based on this information *is* model risk management

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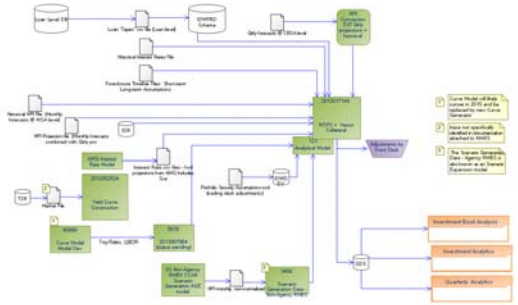
Analytic Asset Management
A Diagram View of an Illustrative Stream



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Analytic Asset Management
A Strategic View of the Overall Information Processing Complex

1. **Model based view**
   - Wing-to-wing independent validation (data, performance, controllership, technology)
   - Risk score (based on comprehensive model risk assessment framework)

   Basic underlying analysis
2. **Stream based view**
   - Assessment based on use/scope/corporate function
   - Clear executive ownership
   - Includes an appropriate measurable definition of model exposure alternatives

   Supports the development of a strategy
3. **Meta view**
   - Explicit mapping of all system components: data, applications, models, reports & other uses
   - Typically will lie between "model" and "block" based views
   - Assessment throws off - aggregated model risk measure, risk-based data quality measure, explicit tactical remediation plans

   Enables the implementation of the strategy

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Analytic Asset Management
Concept of an Integrated Objective Environment (IOE)

1. Models are typically embedded in systems/processes that include data sources, inter-related models, platforms, and other model-delivery systems – *they all contribute to risk and to return*
2. Effective model validation requires some consideration of this broader context/infrastructure anyway – putting structure on this part of the process will increase efficiency
3. Business strategic planning to enhance analytic capabilities is typically done at the stream level – this planning is also critical contextual input for the validators
4. Model risk measures aggregated to the stream level will be more meaningful and more actionable

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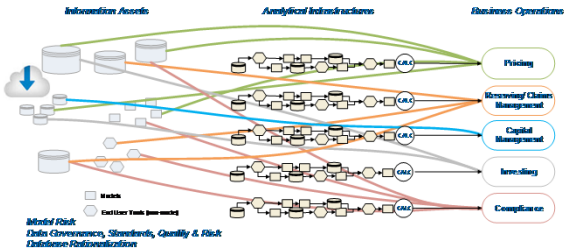
Analytic Asset Management
IOE Framework

1. Each business line has its own infrastructure, sometimes linked, but not explicit or visible.
2. Development of calculations are soloed and independently managed.
3. Data & calc lineages are not easily determined.
4. Analytic infrastructures require forensic analysis to determine components and assess
5. controllership, performance gaps and outputs.



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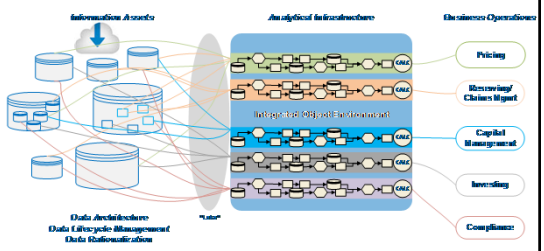
Analytic Asset Management
IOE Framework - The Analytics "Supply Chain and Factory"

1. Analytical linkages established and maintained data, models, platforms, end uses.
2. Makes the infrastructure "streams" visible with insight into cost, controls, and profitability.
3. Contains its own embedded analytic & reporting capabilities for management.
4. Surgical approach to scale and to extension.



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Thank
You
25

Pricing Risk Governance

Rita Zona, ACAS, MAAA, Deloitte Consulting LLP

Pricing Cycle

The importance of controls

Weak control programs relating to pricing functions often contributes to uncontrolled and inefficient processes.

Importance of Controls on Pricing Strategy

- Pricing Strategy
- Establishes
- Processes, Authorities and Benchmarking
- Informs
- Tool and Model Development
- Feed
- Data and Reporting Capabilities
- Support
- Planning and Strategic Decision Making
- Advise
- Next Year's Pricing Strategy

Issues that can Arise Without Proper Controls

Lack of Monitoring that processes and authorities are being followed

- Leads to unpredictable pricing
- Re-work needed during Quality Assurance
- Difficult to find relevant outputs for reporting

Tools and Models are not integrated into the planning process

- Requires manual review of pricing documents to gather inputs into reporting process. Data is stored in several platforms with numerous versions
- Errors occur in the process of transferring data across several sources

Data is not sufficient to support Planning and Strategic Decision Making

- Reports have not been socialized across the organization to ensure that outputs are relevant and actionable to key stakeholders
- Data can not be collected in a timely manner to make the information insightful

Lack of a sound Model Risk Governance Framework that could lead to model errors and misinterpretation of results

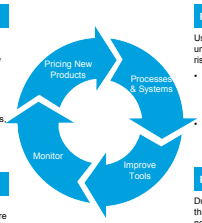
Pricing Process

Risks identified at various stages

Pricing New Products

With the market constantly changing, this area is more important than ever before:

- Is there a robust process to support new product pricing in a constantly changing environment?
- Is the organization ready to support emerging products such as telematics, smart home product, self-driving vehicles, etc.



Processes & Systems

Using outdated technology systems or unsophisticated pricing practices presents a risk to the organization:

- Is there a need to modernize pricing and rating with emerging technologies, systems transformation e.g. mobile application, social media?
- Is competitive analysis information and customer behavior information/pricing optimization incorporated in pricing and rating?

Monitoring Performance

Monitoring past changes and identifying drivers of performance helps to inform future strategic decisions:

- Is the pricing and rating process following actuarial standards and regulation requirements?
- How can an organization quickly decide which products, geographies, customer segments are adequately priced?

Pricing Tools

Due to the competitive nature of the industry, the most accurate pricing tools are necessary to avoid adverse selection:

- Does the organization have all the necessary pricing methodologies and tools at its disposal? Are the pricing methodologies and tools up to speed with development in predictive modeling and advanced analytics?
- How will Big Data impact insurance pricing and ratemaking?

Does the organization have a sound model risk governance framework in place in order to understand the key risks that the company face and the mitigation controls around the key risks?

Pricing Challenges and Opportunities

Evaluating risk in each area of pricing support

Non-uniform and irregularly updated pricing models as well as unstandardized processes lead to rate inconsistencies and potentially inadequacy. Lack of model validation results in overlooked model errors

Using outdated or non-integrated technology systems limits data availability for analytics and uniformity in pricing

Lack of specialized expertise and inadequately documented practices could lead to a resource crunch

Lack of internal reporting standards and processes can lead to difficulties information management and rate monitoring

Impacts

- Pricing New Products
- Processes and Systems
- Pricing Tool Improvement
- Performance Monitoring

Modeling Risk Governance Framework Illustration

Overview

A modeling risk governance framework is developed to follow the model development lifecycle, and provide a clear indication to all stakeholders that the model is usable

Model Lifecycle

Planning → Model Development → Model Implementation → Model Use → Model Maintenance

Model Validation

Framework Considerations

Considerations and Factors

- Common Pitfalls and Associated Risks
- Industry Best Practices
- Integration of Modelling with Pricing and Operation

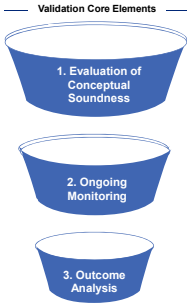
Modeling Risk Governance Framework Illustration

What constitutes a strong model governance framework?

- **Senior management oversight and tone** to instil the appropriate behaviours and culture around the effective management of model risk
- **Understanding of key risks** and their potential impacts within key areas (e.g. data and assumptions) but also in the hand-offs between such areas. In addition, u**nderstanding of mitigating controls** in place around the key risks
- Adherence to comprehensive and well understood **procedures and governance** around key stages of the results production process
- Clearly defined **policies and standards** relating to documentation, data quality, assumptions setting and other aspects of the production of results
- Clarity of roles and responsibilities across the **3 lines of defence model** – doing / validation and reviewing adherence to policies and standards / reviewing on-going effectiveness
- Structured **model development lifecycle** (from specification through to transition to BAU) with documentary evidence of approval of model changes. This includes greater **automation of processes** thereby reducing risk of errors
- Conduct **model validation** exercises on a regular basis to ensure the appropriateness and accuracy of the model. Documentation and understanding of the **limitations of the models** by the users of the model results for decision making

Pricing Model Validation

Effective validation helps to ensure that pricing models are sound, identifying potential limitations and assumptions, and assessing their possible impact.



Validation Objectives

- To assess the quality of the model design and construction
- To review the documentation and empirical evidence supporting the methods used and variables selected for the model
- To confirm that the model is appropriately implemented and performing as intended
- To verify that any extension of the model beyond its original scope is valid
- To evaluate whether changes in the model, the products that it represents, or macro/micro-economic factors necessitate adjustment, redevelopment, or replacement of the model
- To compare model outputs with the corresponding actual outcomes

Integration within the Organization

Having a sound model risk governance framework in place which includes model validation does not only apply to pricing but other parts of the organization as well and forms part of the enterprise-wide risk management framework

- Pricing is closely linked to other parts of the organization:
  - Reserving
  - Product management
  - Reinsurance
  - Capital allocation
  - Business and strategic planning, and other functions
- The increasing and accelerated trend in using advanced pricing and modeling techniques within P&C insurance companies increases the need for a sound model risk governance framework
- This will help companies to improve their top-line growth and to effectively manage their bottom-line results

Questions