Research Paper

Life Insurance Costing and Risk Analysis

Task Force on Life and Health Insurance Costing Products

June 2008

Document 208047

Ce document est disponible en français.
© 2008 Canadian Institute of Actuaries

Research papers do not necessarily represent the views of the Canadian Institute of Actuaries. Members should be familiar with research papers. Research papers do not constitute Standards of Practice and therefore are not binding. Research papers may or may not be in compliance with Standards of Practice. Responsibility for the manner of application of Standards of Practice in specific circumstances remains that of the members in the life insurance practice area.
Memorandum

To: All Life Insurance Practitioners
From: Jacques Tremblay, Chairperson
       Practice Council
       Jason Wiebe, Chairperson
       Task Force on Life and Health Insurance Costing Products
Date: June 23, 2008

Subject: Research Paper – Life Insurance Costing and Risk Analysis

In 2005, the Practice Standards Council of the CIA created a task force to develop a research paper on Life Insurance Costing. Its mandate was to:

   Develop a research paper that will describe accepted actuarial costing techniques for life insurance, health insurance and annuity products. The primary focus of the work would be on products with longer-term guarantees. The research paper would also cover considerations in establishing assumptions and provide illustrative examples of how to approach assumption setting when experience is not directly available.

The attached paper is the result of the task force’s work. While research papers do not represent the view of the CIA and are therefore not binding upon members, it is recommended that all members involved in the pricing of insurance products review the paper. We would also like to thank Josée Racette and Luc Bergeron for their work in translating this document.

JT, JW
# TABLE OF CONTENTS

1. INTRODUCTION ......................................................................................................5
2. PRINCIPLES OF COSTING......................................................................................5
3. DEFINITIONS OF RISKS .........................................................................................6
4. COSTING PROCESS.................................................................................................9
   4.1 Introduction..........................................................................................................9
   4.2 Establish a process for product development and costing ...................................9
   4.3 Discovery ...........................................................................................................10
   4.4 Scoping ..............................................................................................................10
   4.5 Business Case and Development .......................................................................11
   4.6 Testing and Validation.......................................................................................15
   4.7 Documentation and Approval ...........................................................................16
   4.8 Launch ................................................................................................................18
   4.9 Post-Launch .......................................................................................................18
5. PRICING METRICS ................................................................................................18
   5.1 Overview of Pricing Metrics..............................................................................19
   5.2 Presenting the Results........................................................................................23
6. NON-ECONOMIC ASSUMPTION SETTING.......................................................23
   6.1 Claims ................................................................................................................24
   6.2 Policyholder Options .........................................................................................24
   6.3 Business Mix......................................................................................................25
   6.4 Expense Assumptions ........................................................................................26
   6.5 Investment Assumptions....................................................................................27
   6.6 Reserves and Capital ........................................................................................27
   6.7 Taxes ..................................................................................................................27
   6.8 Reinsurance ........................................................................................................27
   6.9 Other Assumptions.............................................................................................28
7. MARKET RISK CONSIDERATIONS....................................................................28
   7.1 Projected Economic Scenarios...........................................................................29
   7.2 Portfolio Returns................................................................................................30
   7.3 Impact of Company’s ALM Strategies ..............................................................31
   7.4 Fixed Income Crediting Rate Setting Strategies................................................31
   7.5 Equity Based Investments..................................................................................32
   7.6 Guarantees..........................................................................................................32
   7.7 Other Considerations .........................................................................................33
8. POLICYHOLDER BEHAVIOUR AND PRODUCT FEATURES.........................33
   8.1 Contractual Guarantees......................................................................................33
   8.2 Penalties and Bonuses.......................................................................................34
   8.3 Plan Changes.......................................................................................................34
   8.4 Behaviour – Policyholder, Distribution, Underwriting......................................35
   8.5 Premium, Deposit and Pay-out Flexibility.........................................................36
   8.6 Advisor Behaviour ..............................................................................................36
8.7 Corporate Behaviour........................................................................................................37
9. STOCHASTIC MODELING..................................................................................................37
9.1 What is Stochastic Modeling........................................................................................37
9.2 When to use Stochastic Modeling.................................................................................37
9.3 Advantages and Challenges.........................................................................................38
9.4 Model Selection.............................................................................................................38
9.5 Model Development and Testing.................................................................................39
9.6 Assumption Selection....................................................................................................39
9.7 Communication of Results..........................................................................................41
9.8 Other Considerations....................................................................................................41
10. CONCLUSION...............................................................................................................43
1. INTRODUCTION

This research paper was commissioned by the Practice Standards Council (PSC) in 2005 to encourage greater consistency of practice among practising actuaries in the field of life insurance costing. The task force was given the following mandate:

- Develop a research paper that will describe accepted actuarial costing techniques for life insurance, health insurance and annuity products. The primary focus of the work would be on products with longer-term guarantees. The research paper would also cover considerations in establishing assumptions and provide illustrative examples of how to approach assumption setting when experience is not directly available.

It would be noted that the mandate refers to “costing” techniques. This is in recognition that in most highly-developed insurance markets, rate-setting is quite often done based on market positioning and the actuary’s role is to analyze the potential cost of the product.

It would also be noted that the authors of this paper expanded the scope to cover risk analysis activities. The term “costing” was felt to be too narrow and implied a measurement of results at and about the mean. Risk analysis was felt to encourage the actuary to look at the possibility of events further out in the tail of the distribution and to consider the impact of other non-insurance and market risks that may impact the product’s profitability.

We would like to thank the members of the task force who were primarily responsible for the development of this report: Jason Wiebe, Dean Chambers, Paul Fryer, Naveed Irshad and Lloyd Milani. In addition, we would like to thank the following individuals who provided feedback on early drafts of the memorandum: Terry Demopoulos, Rino D’Onofrio, Richard Houde, Brian Louth, Gary Mooney, Bernard Naumann and Julia Wirch-Viinikka.

The opinions expressed herein do not represent the views of any current or past employer of these persons.

2. PRINCIPLES OF COSTING

There exist five key principles that would apply to any costing process. It is understood that insurance costing does not occur in isolation but, rather, is heavily influenced by a robust, competitive marketplace. This fact will naturally impact certain aspects of the overall costing process, however, the principles articulated below would always apply.

- **Unbiased** – Insurance costing would provide the user with an unbiased estimate of future costs, benefits, and risks.

- **Comprehensive** – Insurance costing would be performed with integrity and include an analysis of all relevant risks to the insurer. These include both financial and non-financial risks. To the extent that the potential impact or the volatility of the risk is greater, more extensive testing and analysis would be performed.

- **Documented** – The costing exercise would be documented. This documentation includes the development of the models and assumptions used as well as overall results and sensitivity testing. It would be recognized that the future outcomes of insurance products
are uncertain. Therefore, if possible, the documentation would include a range of possible outcomes with associated probabilities. Clearly written analysis of the results would be included.

**Communicated** – The results of the costing exercise would be clearly communicated in a manner understandable to the key decision-makers.

**Review/Approval Process** – The costing exercise would be subject to a review and approval process that is appropriate for the risks undertaken. This includes a peer review process to ensure data and model integrity, as well as a review to ensure that risks have been adequately analyzed. The individual(s) who approve and sign off on the costing exercise would be at a level of authority that is commensurate with the risks undertaken.

3. **DEFINITIONS OF RISKS**

Insurance companies face a multitude of risks on a daily basis. The company’s exposure to these risks is influenced by the design of the policies sold. In costing an insurance product, the actuary would be aware of the following risk categories and consider if they have the potential to impact the profitability of the product. Where the impact has the potential to be material, the actuary would document and measure them.

The following is a list of risks that would be considered in the costing of insurance policies:

<table>
<thead>
<tr>
<th>Risk</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Risk</td>
<td>The inability to build or maintain a sustainable, competitive advantage in a given market or markets.</td>
<td>Competitor actions may cause shifts in the distribution of sales resulting in different profit levels.</td>
</tr>
<tr>
<td>Regulatory Risk</td>
<td>Risk that legislative actions, tax change, court decisions or regulatory rulings will alter market or competitive abilities.(^1)</td>
<td>Changes in tax laws may result in changes to policyholder behaviour changing the profitability levels of the product; Favourable treatment of a product for valuation, capital or tax purpose may cease to exist.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>Description</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reputational Risk</td>
<td>The risk that negative publicity, whether true or not, causes a decline in the customer base, costly litigation and/or revenue reduction.</td>
<td>Complicated policy features not understood by policyholders may result in potential negative impact to a company’s image leading to extra-contractual benefits. Adjustment to policy features may not be utilized due to potential impact on reputation.</td>
</tr>
<tr>
<td>Credit Risk</td>
<td>Credit risk is the risk of default and change in the credit quality of issuers of securities, counter-parties and intermediaries to whom the company has an exposure.</td>
<td>Credit quality and level of diversification within the investment portfolios backing the product as well as the reinsured ceded.</td>
</tr>
<tr>
<td>Market Risk</td>
<td>Market risk arises from the level or volatility of market prices. Market risk involves the following: • exposure to movements in the level of financial variables; • exposure of options to movements in the underlying asset price; • exposure to other unanticipated movements in financial variables; and • exposure to movements in the actual or implied volatility of asset prices and options.</td>
<td>Adverse movement in assumed equity returns, currency rates or interest rates; “in-the-money” interest rate guarantees.</td>
</tr>
<tr>
<td>Risk Type</td>
<td>Description</td>
<td>Examples</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Liquidity Risk</td>
<td>Liquidity Risk is the exposure to a loss in the event that insufficient liquid assets will be available, from the assets supporting the policy obligations, to meet the cash flow requirements of the policyholder obligations when they are due, or assets may be available but only at excessive cost.</td>
<td>Product designs requiring the use of illiquid assets to meet pricing targets.</td>
</tr>
<tr>
<td>Underwriting Risk</td>
<td>Underwriting is the specific insurance risk arising from the underwriting of insurance contracts. The risks within the underwriting risk category are associated with both the perils covered by the specific line of insurance and with the specific processes associated with the conduct of the insurance business.</td>
<td>Mortality, morbidity, lapse, policyholder anti-selection.</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>Operational risk is defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events.</td>
<td>Inability to execute a hedging strategy on a timely basis; administration, illustration and pricing systems calculating values differently; errors in pricing system.</td>
</tr>
</tbody>
</table>

More in-depth information risk definition, assessment and quantification can be found from the following sources:

- Society of Actuaries Risk Management Section
- Society of Actuaries Risk Management Task Force

---

4. COSTING PROCESS

4.1 Introduction

It is important that a formal product development process be established. By utilizing a formal process, the actuary could ensure that the core principles established in section 2 are taken into consideration with each exercise. In addition, a good process will ensure efficiency of effort.

The process would include the following elements:

- Research;
- Review and vetting;
- Implementation; and
- Reporting and ongoing management.

The process outlined below includes the above elements.

4.2 Establish a process for product development and costing

The product development and costing process can be applied to both new products and those that are being re-priced. The process includes the following stages:

**Discovery:**

- Channeling of product concepts through a cross functional team.
- Initial review of ideas and decision to commit resources to further study.

**Scoping:**

- Preliminary feasibility study to assess technical, administrative, financial and regulatory requirements.
- Market research study and competitive analysis.

**Business Case and Development**

- Further refine product idea and develop business case with initial pricing, costs and sales projections.
- Translate the product definition into reality through product, process and other related support. Project team develops final pricing, systems, marketing and launch plan.

**Testing and Validation**

**Documentation and Approval**

**Launch:**

- Deliver to market a complete and serviceable product.

**Post-Launch:**

- Tracking, reporting and assessment of product and performance for future refinement.
The length or use of each of the above stages would depend on the size and scope of the project being contemplated.

4.3 Discovery

Initial design

The initial design of a product would include a list of possible features, options and guarantees. As well, the needs of the target market and sales channels would be considered.

Establish agreed upon profit targets and capital budget for the product

Management would establish profit targets and a capital budget for the product being developed. The profit targets and capital budget may be adjusted as additional information about the market place or risk characteristics of the product is established.

A situation in which this may occur is a company wanting to enter a new market. Management may establish a profit target of 15% but later finds that it can only participate if it accepts a profit target of 10%. This is, of course, up to the management of the company to determine the appropriate goals.

Alternatively, profit targets may be determined at a company level or line of business level. In these situations where cross-subsidies by product or class of business are taken, the distribution system and market share would be taken into consideration.

The capital budget may depend on a number of factors. These factors include:

- Expected sales;
- The willingness of management to back a certain product;
- Uncertainty with respect to the underlying assumptions; and
- Company size.

4.4 Scoping

Feasibility Study

After initial design and the high level identification of assumptions and costs, the feasibility of the product would be determined.

This would include estimates of:

- Sales;
- Set up costs;
- On going expenses;
- Capital requirements;
- Expected profit; and
- Reinsurance needs and availability.
Identify all possible costs and assumptions

As part of the initial design of a product, all costs and assumptions relating to the product features, options and guarantees would be identified in order that a proper assessment may be completed at a latter point. Some examples of options or guarantees include, conversion options available under term policies or guarantees provided on premium rates or interest rates.

At this stage of the product development, any costs and assumptions identified would not be eliminated or considered non-material without first going through a process of where each assumption or cost is analyzed.

Customer Value Analysis

Consideration would be given to doing a customer value analysis. Through the application of customer value analysis research, the actuary would be equipped to:

- Identify the attributes that matter to the actuary’s and their competitors’ customers;
- Show exactly how customers define these attributes;
- Quantify the company’s performance and its competitor's performance;
- Show which competitors have superior value propositions and what can be done;
- Reveal which market players are poised to gain or lose market share; and
- Provide a fact-based, data driven system for making decisions, beating the competition and tracking progress.

4.5 Business Case and Development

Assumptions and Market Scan

For each benefit or option available on the proposed plan key assumptions are would be developed. Expected values and plausible ranges would be documented.

In developing these assumptions, policyholder behaviour would be considered and how they might select against the company at the time the policy is issued and in subsequent years.

When analyzing the various assumptions, the actuary would determine the extent that the assumption will influence the financial performance of the product. For assumptions that have a greater influence, a greater level of research and refinement is usually appropriate. For immaterial assumptions, approximations may be acceptable.

Similar competitor products would be reviewed for product features and their marketability. As well, consideration would be given to how competitors will react to the new offering and modify sales assumptions or policyholder behaviour accordingly.

Possible Assumptions to be Considered

The assumptions to be used in pricing will obviously depend on the product features, benefits and options. Depending on these features some or all of the assumptions would
be developed. Note that this is not meant to be an all-inclusive list. Refer to the Assumptions section for more details.

- **Mortality**
  - Mortality improvement
  - Anti-selective lapses

- **Morbidity**
  - Incidence
  - Severity
  - Deterioration
  - Link to economic conditions

- **Longevity**

- **Lapses**

- **Premium persistency**

- **Term conversion rate**

- **Cost of conversion**

- **Cost of guaranteed insurability options**

- **Option utilization rates**

- **Interest rate projections**

- **Stock market projections**

- **Investment returns on assets backing**
  - Liabilities
  - Fund values
  - Surplus

- **Cost of guaranteed interest rate**

- **Expenses**
  - Compensation
  - Issue
  - Maintenance
  - Inflation

- **Reinsurance rates**

- **Sales distribution**

- **UL funding levels**
Sources of Information

In order to develop assumptions, the actuary would acquire data and information upon which he or she could develop such assumptions. In some cases where a product has been available for sale over a number of years, direct measurement of the sales data and experience from the market and the company can be done. Some other possible sources of information are as follows:

- **Experience Assumptions**
  - Canadian Institute of Actuaries
  - Society of Actuaries
  - American Academy of Actuaries
  - Casualty Actuarial Society
  - Other international actuarial societies
  - Census data (examples include Stats Canada, US Census Bureau, CPP, Old-Age, Survivors, and Disability Insurance)
  - Life Insurance and Marketing and Research Association
  - Medical journals
  - Disease research and support organizations (examples include Health Canada, Cancer Society, Canadian Deposit Insurance Corporation, US Surveillance, Epidemiology and End Results)

- **Economic Assumptions**
  - Banks
  - Government
  - Economic journals

- **Product Information**
  - Marketing material
  - Company websites
  - Industry magazines
  - Insurance price websites (like Compulife).

Risk Mitigation

It may be difficult to determine a cost for all of the risks embedded in the product or its sales process. In some cases the actuary may be able to determine a cost, but the
variability around the cost is very large and non-diversifiable. In these cases, consideration would be given to the following risk mitigation strategies:

**Divest to a Third Party**

*Pro:*
- May eliminate or minimize risk;
- Transforms volatile cash flows into stable cash flows;
- May reduce capital requirements; and
- May provide access to expertise.

*Con:*
- Transforms divested risk to counter party risk; and
- May limit the amount of profit generated.

*Examples:*
- Hedging programs for seg fund guarantees; and
- Reinsurance.

**Limit Exposure through Sales volume**

*Pro:*
- Reduces amount of risk to an acceptable level; and
- Allows the company to acquire experience and data in order to analyze risk.

*Con:*
- Implication with sales force; and
- May be difficult to manage sales volume in a timely manner.

*Examples:*
- Limits on the amount of business that can be sold for a particular plan.

**Change Policy Features**

*Pro:*
- Modify the risk profile, such that the tail is eliminated or reduced; and
- Eliminate or reduce policyholder anti-selective behaviour.

*Con:*
- Might be at a competitive disadvantage.

*Examples:*
- Age limits placed on term conversions relative to the end of the term coverage; and
• Limit the guaranteed interest rate to a certain time period or have it only apply to a maximum dollar amount.

4.6 Testing and Validation

Modeling Risk

Consideration would be given to the model used in determining the projected costs of the underlying product. Although it may be difficult or just too costly to test every premium rate or premium persistency pattern, the actuary would consider the materiality of what is not being modeled.

Some items that may seem immaterial, but might have a significant impact on results are:

• Substandard risks;
• Older age risks;
• Younger age risks;
• Joint lives;
• Funding level on UL plans; and
• Guaranteed insurability options.

A process would be put into place in which management may become comfortable that non-modeled cells are valued appropriately. This process may be a combination of in house testing, getting feedback from producers and competitors, and a review of the experience of the business sold.

Sensitivity analysis

The sensitivity analysis attempts to identify the impact associated with three types of risks:

• Misestimating of the mean;
• Statistical fluctuations around the mean; and
• Fundamental shifts in the environment.8

Sensitivity testing can be done using various methods:

• Testing specific events or scenarios (deterministic); and

---

8 Misestimation of the mean refers to the situation where the actuary estimates experience will occur at a certain level based on the evidence available but in reality future expected actual experience is something different. This may occur for several reasons such as the fact that experience studies are based on cohorts that may be different than your existing cohort or simply due to the fact that experience studies only give an estimate of the underlying experience.

A statistical fluctuation around the mean refers to the situation where the actual emergence of the experience is volatile and will vary around the mean from period to period. Fluctuations in the values of the stock market are one example, but for small blocks of business, the actual emergence could be of interest.

A fundamental shift in the environment refers to situations where the world has changed. For example, changes in medical technology or perhaps interpretations of contractual definitions might have a significant impact on future experience.
• Stochastic models.

The method of testing chosen depends on the specifics of the situation. For example, if the actuary is testing shifts in the mean due to misestimation or fundamental changes, deterministic scenarios are usually sufficient. For statistical fluctuations, the choice of stochastic or deterministic approaches is dependent on the materiality of the assumption.

Scenarios tested would be meaningful in context of product and risk, and not “canned”. Included with the sensitivities would be some sense of the likelihood of the scenario occurring.

More analysis would be done on assumptions that are more volatile or have less experience available. For example, a company may have a very large block of business where mortality results are stable and predictable year after year, whereas there may be limited or no experience on policyholder behaviour relating to interest guarantees.

Analysis would be carried out on the tail of the distribution, especially for non-diversifiable risks like interest rate risk. Please refer to the section on stochastic modeling for additional information.

Finally, consideration would be given to ways in which policyholders, beneficiaries, and agents can select against the company. An example of testing policyholder and agent behaviour is the impact of lapsing 100% of Term 10 business in the 11th year. There is great incentive for both the agent and the policyholder to re-write the case at this point in time and management would understand the possible financial impact.

4.7 Documentation and Approval

Documentation

The goal of the documentation is to allow another pricing actuary to reproduce the results and to have enough information to be able to challenge the assumptions being proposed on a professional level. As well, the documentation would provide sufficient information in order for management to be able to understand the risks and rewards and approve the product.

It is not the expectation that the actuary develop a single, massive document that includes all the following information. It is likely that several documents will exist that are appropriate for their purpose and audience.

Typical documentation would include:

• Background information - The documentation would include some background information on the reason for the product development and the goal of the product.

• Product description - There would be complete documentation with respect to the product description. This will include the following:
  - Features;
  - Coverage period;
  - Premium paying period;
- Special features, guarantees and options;
- Compensation and bonuses;
- Marketing material;
- System documentation; and
- Reinsurance treaty.

- Assumptions - All assumptions need to be documented in terms of what was used in the pricing of the product and how they were developed. Where quantitative analysis is either not practical or impossible, qualitative analysis would be included.

- Costing Result Analysis – There would also be a document providing an interpretation and analysis of the results. Costing results may include the impact on the following:
  - Financial projections;
  - Net income in current year;
  - Required capital at issue;
  - Internal Rate of Return;
  - Premium margin;
  - Embedded Value; and
  - Asset spread.

In addition to the above results based on the best estimate assumptions, the sensitivities also need to be documented and analyzed including pointing out the key risks associated with the product or assumptions.

If this is an update to an existing product, reference and comparisons would be made to the most recent version of the product documentation.

Approval

Any costing exercise would be incorporated into the existing approval process as required by the company’s management.

The peer review/approval process would differ depending on company size, experience of the pricing actuary and potential size or income impact of the product being developed.

This approval process would have the following elements:
  - Peer review; and
  - Management sign-off.

Another actuary would review the work in order to provide constructive criticism about anything that may impact the cost of the product and ensure appropriate actuarial techniques have been used. This would include:
Model integrity;
Reasonableness of assumptions, methods and analysis;
Assessment of risk; and
Quantification of risk.

Typically, management sign-off would be required. The level within the management hierarchy may depend on the amount of capital being used, the level of profitability, the amount of total risk, and/or variability of results. For example, a product that is expected to generate little premium but is well below the profit target might need approval from a senior person in the organization.

The key stakeholders vary from company to company, but they may include:

- Senior management at a business unit or division level;
- Board of Directors;
- Corporate Risk managers; and
- Functional departments.

4.8 Launch

In addition to the financial and risk elements being approved, there would be a process in place that insures that the policy contracts, pricing systems, illustration systems, administration systems and valuation systems are all in sync and able to deal with any special or unique features of the product before it has been issued. For example, the pricing may assume that there is no timing risk from the point a policyholder makes a fund purchase to the time the fund can actually be bought. These types of operational assumptions need to be verified and signed off.

4.9 Post-Launch

Systems and processes would be set up in order to measure the experience from the business being sold. Any material assumption that was made during the pricing of the product would be compared against the measured experience.

Earnings by source analysis can be valuable as it provides the actuary with information about what assumptions generated the additional gain or loss in dollar terms. This would account for all of the key assumptions, including modeling error.

The analysis of the experience post launch would allow management to re-position the product so that it continues to meet its key goals relating to sales and profit.

5. PRICING METRICS

A primary goal of any costing exercise is to provide advice to senior management on the range of profitability of the product under consideration. In order to do so, there would be agreement at the beginning of the process regarding:

- The pricing metric(s) and a description of what would constitute an acceptable result; and
- The manner in which the range of possible outcomes is presented.
Each of these topics is addressed in the following sections.

5.1 **Overview of Pricing Metrics**

The complexities of the insurance and wealth management business, the long-term nature of the business, and the impact of accounting and reserving standards on emergence of profit have spawned a number of pricing metrics. There is no one best metric and the results under several are influenced by the accounting standard. As a result, a number of these tools would be used to assess and illustrate profitability and it is good practice for the selected pricing metric(s) to be consistent with the financial goals of the company. The following is a review of the various pricing metrics and the strengths and shortcomings of each metric in communicating and assessing product profitability.

**Internal Rate of Return (IRR)**

*Definition*

IRR is defined as the discount rate at which either:

- The present value of the distributable earnings\(^9\) is equal to 0; or
- The present value of future contribution to free surplus equals the initial outlay.

*Uses*

This pricing metric is widely used – in particular with stock companies where the IRR ties into the equity return goals of the company.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compare various potential dissimilar investments.</td>
<td>Does not convey absolute dollar profits.</td>
</tr>
<tr>
<td>Helps ensure adequate return from the shareholder perspective.</td>
<td>Does not convey emergence of profit (i.e., a 15% IRR will not necessarily return 15% each year).</td>
</tr>
<tr>
<td>Easily understood by management as it is related to ROE.</td>
<td>Sensitive where there is low surplus usage.</td>
</tr>
<tr>
<td></td>
<td>Not linear – changes in profit can’t be related to changes in IRR.</td>
</tr>
</tbody>
</table>

**New Business Strain**

*Definition*

New Business Strain can be defined in terms of earnings or capital usage. From an earnings perspective, New Business Strain is the ratio of first year loss, including

---

\(^9\) Distributable earnings for a given year are the surplus or deficiency of the available assets compared to that required to provide for the statutory liability and required capital. Stated another way, distributable earnings are the statutory earnings for the year, less increases in required capital plus investment income on the required capital.
earnings on required capital, to the annualized premium. New Business Strain related to capital would add the increase in required capital to the first year loss.

New Business Strain can also be expressed as a dollar amount.

Uses

New Business Strain is used on all products, though typically as supplemental information to other pricing metrics. It is important in the business planning process to understand the potential impact of sales on earnings and capital consumption.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on income or capital from new sales is an important consideration.</td>
<td>Only limited value as not a comprehensive profit measure.</td>
</tr>
<tr>
<td>Shows sensitivity of need for surplus to reserving methodology.</td>
<td>Value depends on the reserving basis, unless a total balance sheet framework is used that links reserves and capital.</td>
</tr>
</tbody>
</table>

Value of New Business (VNB)

Definition

Value of New Business is related to the Embedded Value concept and represents the Embedded Value for a new sale at issue. VNB is defined as the present value of future distributable earnings, discounted at a hurdle rate related to shareholder expectations.

Uses

VNB is most commonly used to measure annual economic value added as a proxy for shareholder value creation. The value depends on the difference between the IRR and the discount rate, coupled with the amount of the capital investment.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can indicate value created by a new product.</td>
<td>Very sensitive to choice of discount rate.</td>
</tr>
<tr>
<td>Good macro pricing tool to compare alternatives.</td>
<td>VNB can not be used by itself, you also need to use some other metric like IRR.</td>
</tr>
<tr>
<td>Identifies poor value blocks that need to be addressed.</td>
<td></td>
</tr>
</tbody>
</table>

Profit Margin

Definition

Profit Margin is the ratio of present value of profits to the present value of premiums. Profits can be pre-tax or after-tax, with discount rate defined as pre-tax or after-tax best-estimate rate, and can include return on required capital.
Uses

Profit Margin is a widely used measure that provides an economic view of profit, independent of capital and reserve methodology. For products that do not consume significant capital, Profit Margin can be a good alternative to Internal Rate of Return.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to calculate dollar profits from model projections.</td>
<td>Varies considerably by type of product.</td>
</tr>
<tr>
<td>Provides for good comparison within same product type.</td>
<td>Cost of capital is not recognized.</td>
</tr>
</tbody>
</table>

Return on Assets (ROA)

Definition

ROA is defined as the ratio of present value of profits to the present value of assets. Profits can be pre-tax or after-tax, with discount rate defined as pre-tax or after-tax best estimate rate, and can include return on required capital.

Uses

ROA is typically used for annuity products as an alternative to Profit Margin.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to calculate dollar profits from model projections.</td>
<td>Varies considerably by type of product.</td>
</tr>
<tr>
<td>Consistent with some non-insurance (banking) measures.</td>
<td>Cost of capital is not recognized.</td>
</tr>
<tr>
<td>Logical for spread-based measures.</td>
<td>Meaningless for low-asset products.</td>
</tr>
</tbody>
</table>

Return on Common Equity (ROE)

Definition

ROE is defined as ratio of income, including any debt service costs, to common equity over a period of time (usually one year).

Uses

ROE is often used as supplementary information to help assess the potential impact of new sales on company ROE.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shareholders can see how effectively capital is utilized.</td>
<td>Does not convey dollar profits.</td>
</tr>
<tr>
<td>Easy for CFO to relate to.</td>
<td>ROE varies from year to year.</td>
</tr>
</tbody>
</table>
Risk-Adjusted Return on Capital (RAROC)

Definition
RAROC is defined as ratio of income, including income on capital, to economic capital.¹⁰

Uses
RAROC can be used as supplementary information on the economic return of the product. This metric can also be useful for annually renewable business such as Group Life & Health, Property & Casualty, and Travel Insurance.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures return relative to risk.</td>
<td>Economic capital may be difficult to calculate/attribute for a single product line.</td>
</tr>
</tbody>
</table>

Break-even Year

Definition
Break-even Year is the first year when the accumulated cash flows exceed the reserve or cash surrender value and subsequently remain greater. A year-by-year analysis is a derivative of this analysis and can provide valuable insight into how quickly the acquisition costs are recovered.

Uses
Break-even Year is typically used on products where there is a significant risk from early lapses such as on products with a high upfront acquisition cost or high early cash values. This measure typically provides supplemental information to other pricing metrics.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful to know how quickly the investment is recovered.</td>
<td>Only limited value as not a comprehensive pricing metric</td>
</tr>
<tr>
<td>Can be an indicator of sensitivity to persistency.</td>
<td></td>
</tr>
</tbody>
</table>

Premium Analysis

Definition
Premium Analysis is defined as the ratio of various elements such as present value of profit, benefits, expenses, commissions and taxes to the present value of premium. This can be done in aggregate or with representative cells.

¹⁰ Economic Capital is what a firm judges it requires for ongoing operations and, for an insurance company, what it must hold to gain the necessary confidence of the market place, its policyholders, its investors and its supervisors. [A Global Framework for Insurer Solvency Assessment. International Actuarial Association.]
Uses

Premium Analysis provides a broader view of the components of the price of the product. This can be helpful in understanding the product. One element of the analysis is the Profit Margin, which was discussed earlier.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides an overview of the relative components of the price.</td>
<td>Not a true comprehensive pricing metric.</td>
</tr>
</tbody>
</table>

5.2 Presenting the Results

While an overall single result can be helpful to management, additional information such as providing a range of results and results by various sub-classes can be important.

Range of results

A single point estimate of the profitability measure can be misleading, depending on the product design and assumptions. Using sensitivity analysis, it can be helpful to management to see a range of results, with some indication of the likelihood that the results will be in the range indicated.

Overall vs. Sub-Class Results

When pricing the product, the tools used can often provide profitability results at a very detailed level. The actuary would take care in interpreting these results. A variation in results at the detailed level (individual cell) may not be meaningful if the assumptions do not have credibility at that level. At the same time, sub-class results (an aggregation of cells) can indicate that some cross-subsidization risk is being taken. This can be important in assessing the risk and may influence marketing efforts.

6. NON-ECONOMIC ASSUMPTION SETTING

For baseline costing exercises, the actuary would start with best estimate, realistic assumptions. The use of overly aggressive or conservative assumptions will give management a distorted picture of product profitability and would be avoided. Deterministic sensitivity and stochastic analysis would always be presented in relation to this baseline. In unique situations where best estimates are not used, the associated rationale for not doing so would be clearly documented.

The starting point for developing any assumption is actual and relevant experience studies where available and credible. Internal studies can be supplemented, integrated or validated with externally available studies.\(^{11}\) It would be noted that very often what is considered a new product line in a certain country may have been offered for many years in other countries with significant associated experience. The actuary would ensure that any experience used is relevant and applicable to the product being costed. The actuary would also consult with topic experts, as necessary.

The development of any assumption would consider any possible interaction with other assumptions (for example, excess lapsation on mortality). Each assumption, however,

\(^{11}\) See list on page 13 of this document for a list of possible sources of information.
would be independently reasonable and the actuary would not rely on one conservative assumption offsetting another aggressive assumption as these relationships may change over time.

As a general rule, the actuary would spend more time on the assumptions that impact product profitability the most. As another general rule, the actuary would consider rational policyholder behaviour in setting his or her assumptions. Any assumption of irrational behaviour would be clearly documented, highlighted and quantified.

6.1 Claims

For most product costing exercises, the incidence rate assumption (for example, mortality or morbidity rates) will be key assumptions. For some products, the severity assumption will also be an important assumption.

In developing the incidence rate assumption, relevant actual data would be used as a starting point. This would be adjusted for any business-related differences, which can include the influence of the underwriting process (for example, a move to simplified underwriting) and differences in the demographic profile (for example, straight extrapolation of younger age mortality or morbidity results to older age business may not be appropriate). Underwriting, Medical Directors and other internal management who have an influence on the assumption would be consulted. This is especially important on fully underwritten business where preferred qualification rates and discounts are relevant.

Where actual experience lacks full credibility, relevant industry experience could be factored in. There are many sound actuarial methodologies for establishing credibility. Where expertise or experience is lacking, consulting an external expert (for example, a third party reinsurer) may be appropriate.

Past and future incidence rate trends would be considered. The costing assumption would be up to date and take into account any past trends and associated cyclicality, if applicable. Future trending would be based on sound actuarial methodology and would be reflected where their impact on profitability is significant (for example, payout annuities and critical illness insurance).

For certain product types, severity will also be a key assumption. The same principles can be applied in developing the severity assumption. In addition, for these products, careful attention would be paid to current interpretations of contractual definitions as well as policyholder expectations in this regards. The prevailing and potential future economic environment would also be considered.

6.2 Policyholder Options

Insurance contracts include various forms of policyholder optionality. Some common examples include:

- Lapses;
- Premium flexibility;
- Withdrawal Features;
- Policy loans; and
• Conversion options.

In developing assumptions relating to policyholder options, relevant actual experience would be used as a starting point. Careful attention would be paid to how the product is marketed, distributed and sold. Realistic assumptions that consider rational policyholder behaviour would be made (for example, very low lapses when a return of premium due date approaches or when segregated fund guarantees are in the money).

These assumptions would reflect the current and future external economic environment and interaction with the investment assumptions would be considered. The assumptions would also be reflective of product design features such as:

• Surrender charges;
• Product cliffs;
• Commission chargeback periods;
• Lapse-supported designs;
• Loan and withdrawal rights; and
• Rates.

Specific marketing and distribution strategies and concepts involving the products would also be given due consideration while setting assumptions.

For flexible premium products, careful attention would be placed on the level and persistency of premium funding and the costing would be based on a variety of premium patterns. Attention would also be placed on ensuring that assumed premium patterns do not lead to inadvertent lapses or unanticipated overfunding.

Interaction with the incidence rate assumption would also be considered. Higher lapse rates or a spike in expected lapses due to various product features may result in a remaining class of policyholders that will have a worse incidence rate profile than what would have been expected under normal lapse rates (for example, products designed for long-term coverage being used for short-term needs). There exist many accepted actuarial methodologies to cost for this type of anti-selection.¹²

The current and potential future existence of a secondary market for issued business would be considered, if applicable. This would be especially relevant to lapse supported products where the company derives economic benefits from lapsing policyholders where a potential third party could intercede to capture some of these benefits.

The development of any of these assumptions would be supplemented and/or validated with relevant industry experience.

### 6.3 Business Mix

In developing future business mix assumptions, actual past sales data would be used as a basis. The model office would be reflective of how the product is marketed and sold and

¹² Methods include the Dukes Macdonald Method (see “Term Mortality and Lapses” – Product Matters, August 2005 – Society of Actuaries) and the method defined under the former Valuation Technique Paper 2, Canadian Institute of Actuaries.
would reflect the competitiveness of the product relative to competitors and predecessor products (for example, if a product is targeted to be more competitive at certain issue ages, the model office would be adjusted to reflect this). The actuary may want to consult with internal or external distribution representatives to validate the assumption. All significant product features and options would be incorporated into the model office (for example, optional riders, substandard policies and jumbo cases, where applicable). The actuary would take account of the potential effect of business being “spreadsheeted” or the wide availability of price quotation systems that would influence the mix of business when the product is highly price-driven.

While the creation of a model office by definition requires grouping and mapping, the actuary would ensure that the associated grouping and mapping process is appropriate and representative. The end result would be a truly representative and comprehensive business mix assumption that would reflect the expected block of product sales. Any subsidization within the product would be highlighted for management. The business mix assumption would be validated on a regular basis based on actual sales data.

6.4 Expense Assumptions

The approaches used to develop expense assumptions can be vastly different from one company to the next. Expense assumptions would generally be based on unit cost studies. These studies would reflect all realistically expected relevant expenses consistent with actual expenses incurred and allocated to the product line. Ideally the expenses would match up with actual expense budgets or business plans. Expenses can be classified as both fixed and variable, and acquisition and maintenance. Clear decisions would be made and documented on the approach to allocate overhead expenses. Occasionally, certain expenses can be categorized as being non-recurring (for example, integration related expenses after an acquisition). In this circumstance, the actuary would use judgment in deciding whether to include the expense in pricing and how to reflect it.

Assumptions relating to compensation payable on the product would be consistent with actual compensation schedules. To the extent that there is any compensation cross-subsidization between or within distribution channels, this would be explicitly documented. In the case of potential chargebacks, the actuary would evaluate the probability that these chargebacks will be collected. The actuary may also want to consider the likelihood of payment of any trail or renewal commissions.

The impact of potential expense productivity improvements would be considered in the development of the expense assumption. This is especially relevant in fast growing business lines where economies of scale will improve. The actuary would review recent productivity improvement experience and also consider specific current and future company initiatives and investments to improve productivity.

The unit costs would be developed by unitizing expenses on drivers that most closely reflect the generation of the expenses (cause and effect relationship). Care would be taken in the selection of the drivers as improper drivers could result in unintended distortion. The actuary would understand how the drivers have been derived especially with respect to the underlying persistency assumption used. For example, a company may report sales as net of first year lapses. If the expense assumption is based on net sales, the actuary would ensure the pricing model applies the assumption on the same basis and not gross
sales. Ideally the company would have the ability to accurately track, verify and analyze the selected drivers.

The actuary may want to present results based on either a marginal or fully allocated basis. In certain unique circumstances (for example, a start-up business) fully allocated expenses may be too high to price with and unit costs based on target expense and sales levels may be more appropriate.

Expense assumptions would be reviewed for reasonableness by reviewing total expenses generated by new business models and comparing them to actual or budget expense levels. To the extent possible, expense assumptions would also be validated relative to any available internal and external benchmarks (for example, industry wide surveys).

Inflation assumptions used for maintenance expenses would be consistent with investment assumptions although some types of expenses may not correspond well to interest rates and may require a separate inflation assumption (for example, health care related expenses).

6.5 Investment Assumptions
See separate Market Risk Considerations section.

6.6 Reserves and Capital
Reserves used in pricing would be consistent with actual reserving practices and methodologies for all relevant reserve bases. Ideally a validation process would exist to compare reserves developed in pricing to those generated on the valuation system. A sign-off process would exist whereby the valuation actuary signs off on reserves developed in pricing.

Capital assumptions would be consistent with actual company capital allocation processes. The actuary would also consider the impact of the product on regulatory capital levels, including any local capital basis, where appropriate. Any foreseeable future regulatory changes would be considered and documented. Any perceived sufficiencies or deficiencies in regulatory capital that are likely to be resolved would be modeled as sensitivities.

6.7 Taxes
All relevant taxes would be considered in the costing. This includes income taxes, premium taxes, DAC taxes, investment income taxes, value added taxes and excise taxes. To the extent that the product pricing generates significant tax deductions, tax experts within the company would be consulted to determine the extent to which the deductions are usable and do not expire. The tax accounting methodologies used in pricing would be consistent with actual accounting practices. Any foreseeable future tax law changes would be considered and documented.

6.8 Reinsurance
All material reinsurance arrangements would be accurately factored into the costing. The actual mechanics of the transactions would be modeled consistently with the actual treaty terms and the administration of the treaties. The actuary would document the impact of each reinsurance transaction on product profitability. In instances where the reinsurance
terms have a significant impact on product profitability, the actuary would try to understand what may be driving the reinsurance terms in order to validate their own assumptions.

Reinsurance costs would consider any differences in costs due to material facultative versus automatic arrangements. Percentage ceded assumptions would be validated relative to actual experience and practices.

6.9 Other Assumptions

The same assumption development processes and approaches would be used for all other relevant assumptions. The industry will naturally develop new product designs and features and move into new markets. In such circumstances, extra care would be taken, especially where associated prior experience does not exist.

7. MARKET RISK CONSIDERATIONS

The return on investments backing the product can be a key assumption for many life and health insurance products as well as annuities. For some products (for example, single premium annuities), the return on investments is highly predictable as all premium is received at issue and it can be invested to match policy maturities. With other products (for example, Group Dental), the time between premium receipt and claim payment is so short it is not a key driver in the price.

For products like level premium whole life products, the return on investments may be highly uncertain. This is due to the fact that the block of policies will generate positive cash flows for investment for many years into the future. These cash flows need to be invested to cover future negative cash flows. As interest rates can move significantly over time, the actual return on investments can be significantly different than anticipated in the original pricing. The extent that these returns vary is dependent on the company’s Asset Liability Management (ALM) practices. Where the risk is material, the actuary would explicitly model the asset and liability cash flows under a wide variety of reinvestment rate scenarios.

More specifically, the pricing actuary would take into consideration the following elements when modeling products with significant market risk:

- Current economic assumptions such as the yield curve and credit spreads;
- Expected returns on real estate or equity markets;
- The range of future expected economic assumptions and market returns;
- The company’s investment strategy for the product, including any synergies with other products and any hedging strategies;
- Rate-setting strategies for any interest rates credited to policyholders;
- Explicit guarantees on credited interest rates; and
- Implicit rate guarantees for any guaranteed premium rates or fees.
7.1 Projected Economic Scenarios

In developing assumptions for the assets backing the policy, the actuary would begin by developing economic scenarios for the expected lifetime of the product. These scenarios would include:

- Yield curves;
- Inflation;
- Credit spreads;
- Credit defaults;
- Stock market dividends and appreciation;
- Stock market volatility; and
- Real estate rents, appreciation and volatility.

All scenarios would begin with the current economic environment. Following that, the scenarios would reflect the range of future results possible for the investment portfolio. This can be done using deterministic or stochastic scenario testing. The choice of method would depend on the complexity and optionality of the product as well as the impact of investment returns on the product.

In projecting the economic environment at later durations, there are three general considerations in estimating future economic environments. These considerations are:

- Historical data;
- Economic forecasts; and
- Capital markets data.

All are valuable sources of information but would be used with caution.

**Historical Data**

Historical averages provide insight into what future economic environments may look like, however, the actuary would recognize a couple of important issues. Historical data are limited in amount and potential applicability. For example, as historical data are only available for about 50-70 years, is it reasonable to assume we have a meaningful representation of the distribution of historical interest rates over long periods of time? Another consideration is that the world is constantly changing. As a result, one could question the relevance of historical data in this context.

**Economic Forecasts**

Economic forecasts based on econometric models are another source. These forecasts can be obtained from a company’s investment or economics divisions. These models attempt to predict future economic factors based on general economic data. These models may be of limited value to the actuary as they generally predict factors for the near term, while the actuary is often focused on longer terms.
**Capital Markets Data**

Capital markets data can be used to derive estimates of future economic factors. For example, the current yield curve can be used to derive a series of implied forward interest rates of any term. Similarly, implied future stock market volatilities can be derived using current derivative prices. The theory is that, under an efficient market, implied forwards reflect the consensus market opinion of what future interest rates will be. Again, caution would be used. Forward curves have proven to be a poor predictor of future interest rates. This may be because other forces may be at work as well. For example, investors may require a risk or liquidity premium to be incented to invest in the longer terms of the curve. Similarly, many investors decisions may be driven by forces other than perceived future values (for example, regulatory capital requirements and risk management policies may incent insurance companies and pension funds to invest at longer terms, driving down rates).

In addition, it is important that scenario development not focus only on the “base” or “best estimate” scenario. Economic factors can change significantly over time. Scenarios for stress testing purposes would reflect realistic movements over time.

### 7.2 Portfolio Returns

Once economic scenarios are developed, they would be translated into returns on the asset portfolio backing the liabilities.

These projections would take into consideration the investment strategy of the company including asset mix by credit class and term to maturity. Development of these assumptions would be done in conjunction with the company’s investment and asset liability management personnel. Note that this may be an iterative process to the extent that a policy’s cash flows may be dependent on the economic environment.

Once economic scenarios are derived and investment strategy assumptions are developed, asset portfolio projections can be developed. This involves projecting out asset and policy cash flows, future investments and disinvestments and transfers from and to the surplus account. It is usually prudent to do this for each asset segment. For example, most companies maintain separate accounts for surplus and policy liabilities. Other considerations include:

- Cross-subsidies may exist between products that need to be taken into consideration. For example, a company issuing both annuities and life insurance may be able to invest differently than if it were to offer only one or the other.

- Real world investment activities may not be as precise as implied above. While a company’s stated policy may be to invest to perfectly match cash flows, in reality, there will always be mismatches. As a result, modeling would reflect these imperfections and approximations of the approach can be acceptable if they do not bias results.

- Returns credited to products need to be consistent with company allocation processes.
7.3 **Impact of Company’s ALM Strategies**

A company’s ALM strategies can have a significant impact on the risk profile of the product. This would be taken into consideration in the costing exercise.

If a company’s practices are to keep the company’s interest rate risk at minimal levels through cash flow matching or other means, the investment returns are effectively locked in at the rates in the forward curve at the time the investment division rebalances the portfolio. As a result, the impact of any interest rate sensitivities on the product would be modest.

Alternatively, if a company does not maintain a tight ALM profile, the future profitability of the product is highly sensitive to interest rate movements.

7.4 **Fixed Income Crediting Rate Setting Strategies**

Rate-setting strategies for credited interest rates generally fall into two broad categories:

- New money crediting strategies; and
- Portfolio average crediting strategies.

**New Money Crediting Strategies**

New money crediting strategies set the credited rate in relation to current interest rates. GICs and annuity portfolios typically follow this strategy.

Crediting rates for new money products usually can be developed directly from the economic scenarios. These rates would reflect stated strategies as well as any inefficiency in the process such as lags in changing the rates.

**Portfolio Average Crediting Strategies**

Portfolio average crediting strategies set the credited rate in relation to the returns being earned by the portfolio of assets backing the product. This strategy is most commonly employed with par products.

Portfolio average products’ crediting rates are influenced by the cash flows of all other products in the portfolio, including the cash flows of future new business. Intergenerational cross-subsidies can exist as investments made in the past impact credited rates on future sales. In times of rising rates, existing policyholders typically are subsidized by new sales. However, new sales may decline as the company’s credited rates become uncompetitive due to the impact of the existing assets in the portfolio. In addition, the company could be faced with a disintermediation risk as existing policyholders are incented to lapse their policies in order to purchase new policies with higher credited rates. The opposite is true in times of declining rates.

In modeling portfolio average products, the actuary would consider the following:

- The impact of movements in the yield curve on portfolio investment returns are muted by the existence of inforce business in the portfolio.
- Movements in credited rates will similarly be muted, which may result in credited rates that are significantly out of line with new money rates available in the marketplace.
The differences between crediting rates may have significant impact on policyholder behaviour. The company may be forced to alter its crediting strategy.

The introduction of new sales into a portfolio may have a significant impact on existing inforce. For example, if current rates are below the portfolio rate, this will draw the portfolio rate downwards, potentially drawing guaranteed minimum interest rates into play. As a result, the introduction of a new asset segment may be warranted.

Investment returns credited to the product need to be consistent with the company’s investment income allocation policy.

Accounting policy may report assets and returns on a market value basis. The actuary would consider how this impacts policy design.

### 7.5 Equity Based Investments

Many insurance policies credit policyholders with returns based on equity returns. These may be based on the actual returns on an underlying portfolio of assets (for example, segregated funds and separate accounts) or linked to the return of an external index.

The actuary would take the following into consideration:

- The impact of active management on any actively managed portfolios;
- The nature of the underlying assets (including any cash positions for liquidity) and their impact on future returns;
- The volatility in equity returns and the impact it may have on the policy. For example, equity linked universal life policies experience a form of negative dollar cost averaging as more units are sold to pay charges when markets are down;
- For index linked products, the impact of the company’s actual practices on matching assets to liabilities; and
- Any permanent or temporary differences in the tax timing of equity investments.

### 7.6 Guarantees

Except in extreme cases, any time an insurance policy contains a guarantee, there is a cost. Some examples include:

- Interest rate floors on policyholder accounts;
- Guarantees on the redemption value of a portfolio of investments at maturity, death or annuitization;
- Guarantees on the level of future annuity payments;
- Indexing of benefits to an external source such as CPI; or
- Guarantees that premiums/fees will not change, or only change in a predetermined amount.

It would be noted that some guarantees are not readily apparent. A level premium product requires early duration positive policy cash flows to be invested to cover later flows. If
the premium rates are guaranteed, the discount rate embedded in the premium calculation is effectively guaranteed. In addition, due to the long-term nature of many products, guarantees perceived to be safely out of the money today may become meaningful over time.

Another factor with respect to guarantees is that there is no diversification of risk as commonly found with most insurance policies. Insurance is premised on the law of large numbers (i.e., if you have a large enough pool of policies, statistical fluctuations even out). However, with economic guarantees, this often works against you as your policies are highly correlated. Extensive sensitivity testing would be done to test the range of results. Depending on the level of optionality and likelihood of a guarantee being in the money, more sophisticated techniques such as stochastic modeling would be used.

7.7 Other Considerations

The actuary would also take the following into account when dealing with economic factors:

- The assumptions for inflation would take into consideration interest rate levels;
- Inflation may vary for different aspects of the product. For example, inflation on health care costs has historically been higher than CPI;
- Pricing and valuation economic assumptions would be consistent; and
- As economic assumptions can change rather rapidly, an understanding of the impact and periodic reviews of the impact are recommended.

8. POLICYHOLDER BEHAVIOUR AND PRODUCT FEATURES

A costing exercise would consider all the features that are available with the product being evaluated. This will include an analysis of any embedded guarantees that are available to the policyholder. The purpose and expected use of each of these features would be understood and accounted for.

In order to provide a sound costing assessment, the contract and policyholder’s reasonable expectations would be appropriately represented in the pricing model.

8.1 Contractual Guarantees

Many products contain minimum guarantees that provide the policyholder with certainty about future costs and crediting rates. While these guarantees may be “out of the money” at the time of product design and sale, even the weakest of guarantees has a cost that needs to be reflected in the costing. The actuary would look at the experience available to them to determine how the guarantee will impact policyholder behaviour and future profitability of the product. The costing would include an expected cost of the guarantee. This expected cost may be derived by using deterministic scenario testing and probability of occurrence. For more complex and/or material guarantees, stochastic modeling would be warranted.

For example, in the case of minimum interest rate guarantees, a stochastic analysis can provide the costing actuary with a better understanding of the risk profile. In addition, it
can provide a long-term cost estimate that would be factored into the fees associated with the guarantees.

Examples of contractual guarantees include:

- Segregated fund guarantees;
- Minimum interest rate guarantees;
- Maximum fee guarantees;
- UL No Lapse Guarantees; and
- Guaranteed premiums and loads.

8.2 Penalties and Bonuses

The existence of penalties and bonuses can have an impact on policyholder behaviour and affect the base assumptions. This would be taken into consideration when using past experience as a guide for assumptions such as lapse rates. For example, differences in surrender charge structure between products can impact policyholder behaviour. The actuary would review the experience and modify the assumption, if necessary, to reflect what they think future experience will look like.

A useful exercise to understand how policyholder actions may change is to look at the policyholder’s return on investment under the different alternatives. With product features such as return on premium riders and stepped cash values, the policyholder may achieve a substantial return on investment by paying another premium and keeping the policy in force for another period. If this is the case, the actuary would consider this in developing his or her assumptions.

Some examples of relevant policy features include:

- Surrender charges;
- Benefit expiry dates;
- Return of premium features; and
- Interest rate and other bonuses.

8.3 Plan Changes

The ability of a policyholder to exercise changes to his or her plan can be considered an embedded option and, therefore, would be costed. These options may be written directly into the contract or offered by the insurance company on an extra-contractual basis.

Some examples of the options available in the marketplace today include:

- The ability to convert to a different type of plan, (i.e., Term to Whole Life);
- The ability to “switch” to a different type of coverage, (i.e., CI to LTC);
- The ability under a UL policy to switch to a different risk charge pattern (i.e., LCOI vs. YRT) or risk profile (i.e., level DB vs. level NAR);
- The choice of different dividend options; and
• The choice of a wide variety of investment options.

Like previous “guarantees,” the costing of this flexibility can be determined via deterministic or stochastic means. Simple changes for which the cost is not expected to vary much by policyholder are probably handled fairly well with deterministic means. However, more complicated options with a wider variety of choices (for example, investment selection) may be best costed for by using stochastic means to determine which policy is impacted and/or the amount or nature of the change.

**Contract Definitions**

The definitions contained within the contract determine what benefits are payable. When designing the policy, the actuary would ensure that the wording utilized is consistent with what was intended to be covered and included in the costing. Any ambiguities or possible misinterpretations that can be foreseen would be reviewed and rectified to prevent the payment of benefits that were not anticipated. In addition, the actuary would consider the definitions in the context of the industry and allow for any possible anti-selection that may result.

For example, if your underwriting requirements are different than the rest of the industry, it would be assumed that the market will become aware of these differences and act accordingly, which could result in a risk pool significantly different in profile from what the actuary had anticipated.

An additional risk that the actuary would consider is the potential future changes in a contract’s interpretation. For example, with medical advances, the detection of certain medical ailments could be accelerated. This could affect the future incidence of critical illness claims. While the actuary cannot predict how future medical technology may emerge, the actuary would try and make the definitions in the contract as specific as possible to minimize the risk or alternatively cost for the added risk.

8.4 **Behaviour – Policyholder, Distribution, Underwriting**

Past experience and best estimates would be applied to those assumptions that involve policyholder behaviour in any costing exercise. In many circumstances, modeling behaviour would also consider the opportunity for the interested parties to select against the company (i.e., they are expected to behave in their own best interest). Policyholders and their advisors will act in a rational manner and will reasonably take advantage of the features that have been provided to them.

**Rationale of Purchase**

Concept-based sales are becoming increasingly more important in the market place. The pricing actuary would be aware of the marketing and distribution of the product being costed and make the appropriate modifications to any relevant assumptions. This includes the continuing evolution of “marketing concepts” and the impact this can have on the design and cost of a product or product feature.

For example, if a policyholder purchases an annuity contract to fund the premiums on a life insurance policy, it would be expected that both the annuity mortality and insurance lapse rates will be lower than what would normally be assumed with independent sales.
In addition, the actuary would consider the possible impact that the introduction of new concepts or the discontinuation of existing concepts could have on the actuary’s assumptions. For example, the introduction of a Life Settlement (viaticals) market place in Canada could result in a significant change in policy lapse rates. Similarly, future changes in tax laws could change the viability of certain sales concepts and result in significant changes in policyholder behaviour.

8.5 Premium, Deposit and Pay-out Flexibility

The increasing flexibility of new deposit and payment options has augmented the opportunity for policyholders to manage their cash-flows to and from the company. A costing exercise would include assumptions that reflect policyholder optionality. The plan design, marketing and experience can be used to provide best estimates of anticipated behaviour.

Such policyholder choices include:

- Premium persistency (e.g., lump-sum deposits, annual or monthly premiums, “premium vacations”);
- Managing account values through withdrawals or policy loans; and
- Choice of a benefit upon death or disability.

The actuary would take care in developing these assumptions. When simplifying assumptions are made to aggregate data, the actuary would ensure that the results are still representative of what would have been seen if seriatim data were run. For example, assuming that everyone will reduce their premiums by 5% in a year may have a significantly different result than assuming 5% of policyholders stop paying premium.

8.6 Advisor Behaviour

Advisors are generally well aware of selection opportunities and are educated about policy features. Opportunities to maximize compensation and exploit underwriting differences would be a significant consideration on product design and costing exercises. The impact that compensation can have on advisor behaviour would be considered in the determination of base assumptions and the mix of business used in the costing exercise.

Some ways that compensation can influence assumptions include:

- Policy funding levels;
- Policy conversion;
- Policy replacement; and
- Plan selection.

Underwriting criteria of the company relative to its key competitors will also influence the behaviour of the distribution force. Where one company is more liberal in its underwriting requirements, it would be expected there will be a level of anti-selection as the field becomes aware of the opportunity to more easily place business.
8.7 Corporate Behaviour

Past history and anticipated behaviour of the company would be taken into consideration. This can include:

- Dividend scale policies;
- Company practices regarding the adjustment of non-guaranteed elements of in-force policies;
- The company’s ability to react to changes in market, regulatory or economic environments; and
- The company’s ability to track, monitor and react to emerging experience.

9. STOCHASTIC MODELING

Stochastic modeling is a powerful tool that can be utilized to understand the risk profile of insurance products. While it is generally used for testing economic assumptions such as interest rates and equity returns, the actuary can use it to test any assumption. For example, most models treat policyholder behaviour assumptions as static assumptions that are applied uniformly on all policies. In reality, they are multi-state random variables. (For example, a person can only be alive or dead, not half dead). Stochastic modeling can be used to test the impact of random fluctuations in assumptions as well as the impact of different people dying or lapsing. Stochastic modeling could even be used to test the impact of different mixes of sales.

9.1 What is Stochastic Modeling

Stochastic modeling is not a radical departure from deterministic measures. It is an enhanced form of scenario testing whereby a wide range of random scenarios are developed using a model that is a representation of real life. Individual scenarios can be analyzed by the same approaches used for deterministic scenarios. In addition, stochastic testing gives the actuary an understanding of the likely distribution of these results.

9.2 When to use Stochastic Modeling

In deciding whether stochastic modeling would be utilized for an assumption, the actuary would consider the following:

- The inherent volatility of the assumption around the expected assumption;
- The distribution of possible values around the expected assumption;
- The level of diversification and correlation of results among individual policies; and
- The impact of that volatility on the results of the costing exercise.

Generally speaking, if likely changes in a particular assumption can lead to material changes in results and the changes in the assumption are random it is recommended that its impact be tested via stochastic modeling.
9.3 Advantages and Challenges

The chief advantage of stochastic modeling is that it allows the actuary to test a wide distribution of future outcomes. It allows the actuary:

- To see the distribution of results from the model;
- To pinpoint scenarios of interest and investigate; and
- To understand the impact of risk mitigation and diversification strategies.

As a result, it enables the actuary to learn more about how the product and real world interact, especially in the tails of the distribution.

Stochastic modeling does not come without some challenges. It is highly complicated and if used improperly, can mislead the actuary or give them a false sense of security. The actuary would recognize this fact and not blindly follow the output from their model. These challenges include:

- It can require significant investment in research. Many different models may exist for the behaviour of the variable being modeled which could result in the actuary expending significant effort in researching the appropriateness of several models for their purpose;
- It can require significant investment in planning and technology;
- Assumption-setting can be complicated; and
- It produces large volumes of data.

9.4 Model Selection

In stochastic modeling, there are a wide variety of models available. Each model has its pros and cons. The actuary, in selecting his or her model, would understand the benefits and limitations of the various models under consideration and choose the appropriate model for the purpose. Considerations include:

- Complexity – Are the data you need available? Do you have the expertise to parameterize properly and often enough?
- Is the model state dependent?\(^{13}\)
- For financial models, is the model “risk neutral” or “real world” (econometric)?\(^{14}\)
- Finally, do you understand and believe in the concepts of the model?\(^{15}\)

---

\(^{13}\) State dependent models predict future values based on the situation at the start of the period that the prediction is being made for. An interest rate model that bases future interest rates on current rates is state dependent. The decision as to whether to use a state dependent model is subject to the assumption being modeled and the preferences/beliefs of the modeller.

\(^{14}\) Risk neutral models base model inputs on observable parameters in the current capital markets. Real world models generally base model inputs on observed historical values.

\(^{15}\) For example, many interest rate models are based on the belief that over time, interest rates revert to a mean. Before using such a model, the actuary would understand the concept and feel comfortable that this is a reasonable premise.
9.5 Model Development and Testing

Run times can be significant in stochastic modeling. While this can be mitigated to some extent by faster computers and distributed processing, planning is important. The actuary would consider what the model will be used for in the future to avoid modifying and running the model multiple times.

Like any complicated model, extensive testing of reasonableness of results is necessary for stochastic modeling. Some possible tests include:

- Review of the distribution of stochastic model results to ensure they are within expectations.
- Review of the smoothness of the cash flows and profit emergence within some sample scenarios (including some in the tails of the distribution). Any discontinuity may indicate a problem with the model or the product design;
- Review of the stochastic path generator to see if it produces reasonable results. For example, are interest rates or stock prices negative?
- Review of the scenario paths produced for consistency with observable history. For example, interest rates have tended to move in long-term trends between levels. Is the model producing similar results?
- Using historical data, back-test the impact on policy cash flows and results to validate the appropriateness of the stochastic path generator. For example, if you are seeing large losses with a greater frequency in the historical data than the stochastic path generator, the actuary may need to recalibrate their stochastic path generator.

9.6 Assumption Selection

Building meaningful models may require a significant level of expertise in both statistical models and the behaviour of the assumption. The following are some considerations for assumption setting:

- Use of simplifying assumptions;
- Use of historical information; and
- Interaction of assumptions.

Simplifying Assumptions

Due to the complexity of the assumptions being modeled, the product design and policy behaviour, simplifying assumptions may be required. Any simplifying assumptions would be tested to ensure they do not introduce bias or unreasonable results. For example, while it may be simpler to build a model for bond fund returns using equity fund modeling tools, it is prudent to test that the resulting returns do not imply a nonsensical yield curve at future dates and bias the results of the model.
Use of Historical Information

Assumption selection is a balancing act between historical and current information and the outlook for the future. In using historical data to parameterize a model, the actuary would consider:

- The length of the historical period in relation to the projection period;
- The relevancy of the historical period; and
- The underlying components of the assumption being modeled.

Historical periods used in developing assumptions need to be sufficiently long to provide a meaningful range of possible results. This means that the data period would be substantially longer than the projection period.

Some products (for example, individual life insurance) may have very long terms to maturity. The experience periods used to develop assumptions are generally not long enough to provide more than a range of possible parameters. For example, is the distribution of high and low interest rates over the past century indicative of what we can expect going forward? As it is a single path, it may or may not give the actuary an indication of how extreme results can be. Similarly, for property and casualty catastrophe reinsurance, are the perceived 1 in 100 year events truly such just because they have occurred once a century over the past few?

Consideration would also be given to the fact that the historical data were potentially developed under a wide variety of environments completely different than what can be expected going forward, both short term and long term. For example:

- How relevant are historical interest rates or equity return data from the early 20th century when worldwide economies were not as integrated?
- Can domestic stock markets be expected to perform at historical levels when inflation and GDP growth rates are at lower levels than over the sample period?
- How long will the low inflation levels of the early 21st century persist?

Ideally, consideration would be given to the basic elements of the assumptions being modeled. For example, in modeling the returns of a global balanced segregated fund, theoretically, the actuary would take into consideration:

- Historical equity returns of the key stock markets of the world;
- Historical interest rates of the key countries in the world;
- Current economic conditions of the key countries in the world;
- Current and historical weightings of the key countries in the international equity indices;
- Current and historical weightings of the key countries in the international bond indices;
- Historical and current correlations between different stock markets and bond markets;
- Historical relationships between world currencies and the currency the fund is transacted in; and
- Degree and impact of active management on fund returns.

The degree to which these are considered depends on the materiality of the assumption on the results.

**Interaction of Assumptions**

It is important to recognize that many assumptions are interrelated. For example, bond returns, equity returns and inflation are interrelated. Similarly, in many cases, policyholder behavior is expected to vary with economic parameters. These interactions would be modeled if the impact is expected to be material.

In the end, the choice of assumption is an educated guess based on current and historical data. The actuary would recognize and understand the sensitivity of the results to the assumptions. This would be communicated to those involved in the decision process.

**9.7 Communication of Results**

Stochastic modeling produces volumes of data. Analysis and presentation of results can be complicated and time consuming. In communicating results, the actuary would consider:

- How the company is managed;
- Issues of concern to management; and
- The technical knowledge of the audience.

Generally, presentation of results would be done in a way that is consistent with the financial measures used in managing the company. Analysis would not just focus on the expected results. The distribution (positive and negative) of results would be communicated as well.

Communication of results would not just focus on long-term measures of profitability. Management is quite often focused on other items such as periodic income volatility and risk limits. Stochastic modeling can provide valuable insights into these issues.

Many members of the audience may not be statistically focused. As a result, analysis and presentation of results would not be focused solely on statistical measures. The results of specific scenarios need to be analyzed to understand the situations that are beneficial and adverse to the company. Presenting results of specific scenarios in real world terms can be powerful. For example, stating that a scenario would require the stock market to lose X% of its value over a Y year period and then putting it in a historical context can be more powerful than stating the CTE(Z) of losses.

**9.8 Other Considerations**

There are several other items that would be taken into consideration in stochastic modeling. These include:

- Random number generators;
- Number of scenarios to run;
• Variance reduction techniques;
• Frequency of scenarios; and
• Risk mitigation techniques.

**Random Number Generators**

Key to any stochastic modeling exercise is the random number generator. Commercial random number generators are not truly random but generate numbers based on a programmed algorithm. As a result, the results of the random number generator can be determined if you know the “seed” value and the algorithm used to project the numbers. A good random number generator will produce results that are statistically indistinguishable from truly random numbers.

In choosing a generator, the actuary would validate that it is sufficient for his or her needs. This includes testing that the periodicity\(^\text{16}\) of the generator is sufficiently large for the actuary’s purpose. The periodicity would be substantially higher than the required number of random numbers required for the projection.

It is generally desirable to be able to “seed” the random number generator as this will allow the results to be reproduced in the future.

**Number of Scenarios**

Another consideration in building the model includes the number of scenarios to be run. The number of scenarios to be run is dependent on the use of the projection and the materiality of results. Fewer scenarios are needed to calculate expected values than are needed for percentiles due to the required increased precision.

**Variance Reduction Techniques**

Variance reduction techniques are another consideration. They allow the user to generate results with fewer scenarios. It would be noted that these techniques are generally focused on improving the efficiency of projecting the mean, and not the tail. Tail risk measures may then be mis-estimated by their use.

**Projection Frequency**

The frequency to be modeled within projections is a function of the sensitivity of the model. Determination of the frequency to be used would consider the volatility of the assumption over the time frame and its interaction with other assumptions in the model. Care would be taken to ensure that any approximations made do not introduce biases.

**Risk Mitigation**

Stochastic modeling is a valuable tool to measure the effectiveness of risk mitigation techniques. This can include the use of capital markets to hedge economic risk or the use of reinsurance for insurance risks such as mortality. In doing so, the actuary would consider any mismatch between the base product and the risk mitigant.

The capital markets are a reasonably liquid market for derivative products with exposures that extend out for a few years based on the major indices and companies of the world.

---

\(^{16}\) Periodicity is the number of values produced before the sequence repeats itself.
However, these derivative products may not align very well with the hedging needs of insurance companies. There may be several reasons for this such as the introduction of uncertain policyholder behaviour or the underlying financial risk not being aligned with the index (for example, a segregated fund with a basket of actively managed stocks).

Hedging can take many forms. Insurance companies may enter into reinsurance contracts passing on risk to the reinsurer. Alternatively, the insurance company may purchase customized long-dated derivatives that align with the term of the risk. These contracts are typically expensive as the counterparties demand a premium due to the increased risk and the lack of liquidity. Also, these strategies have the trade off of reducing product risk but increasing counterparty credit risk.

Alternatively, the company may undertake a dynamic hedging program utilizing the short-dated contracts available in the capital markets. In such a program, the company purchases a basket of derivatives expected to offset the sensitivity of the company to market volatility. This portfolio of derivatives is periodically rebalanced to match changes in the risk profile. Depending upon the rebalancing frequency, large mismatches may occur when the market changes dramatically and these may be expensive to fix since volatility increases. For example, this method was widely used in 1987 and exacerbated the market crash since everyone was attempting to purchase/sell the same assets.

In modeling a hedging strategy, the model would try and recognize all weaknesses in a hedging strategy. The model would reflect at least the following:

- Pricing methodology - Capital markets pricing is generally based on a risk neutral pricing methodology;
- Basis risk – Differences can exist between the risk profile of the product and the basket of derivatives (for example, the hedging strategy may not purchase derivatives on all companies invested in the segregated fund);
- Price uncertainty – The costs of future derivative purchases will vary as interest rates and implied volatilities change;
- Periodic rebalancing – Over time, the risk profile of the product and the derivative portfolio will change requiring rebalancing; and
- Costs – Both transaction costs and the impact of bid-ask spreads would be considered.

In addition, the model would probably consider the fact that correlations between asset classes may change over time and that some liquidity risk exists as the company may not always be able to purchase/sell the derivatives needed, especially in volatile times.

10. CONCLUSION

Insurance product development has changed significantly over time. Insurance premiums and charges are frequently developed based on market positioning. Product designs are becoming more complex. Rates and charges are often guaranteed for the lifetime of the product. As a result, the actuary’s role is more important than ever.
As competition increases and the product life cycle shortens, the actuary is under increased pressure to respond quickly to changes in the market place. It is under these pressures that the product development actuary would remain aware of his or her dual role in the product development process. While actuaries are the engineers that develop the product structures, they are also the gatekeepers for risk. It is their role to analyze and communicate the risk/reward dynamics of all products being sold in order for senior management to make educated decisions on the products they sell.