Presentation for
Department of Statistics and Actuarial Science
The University of Hong Kong

From
Analytical Actuarial
To
the Era of Dynamic Risk Management
involving
Fintech

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The Era of Analytical Actuarial Processes

$$A_x = A^1_{\overline{x:\infty}|} = \sum_{k=0}^{\infty} v^{k+1}\,{}_kp_x \cdot q_{x+k} = \sum_{k=0}^{\infty} \frac{v^{x+k+1}\,(l_{x+k} - l_{x+k+1})}{v^x\,l_x}$$

$$= \sum_{y=x}^{\infty} v^{y+1}\,\frac{d_y}{D_x} = \frac{M_x}{D_x}\,, \qquad M_x \equiv \sum_{y=x}^{\infty} v^{y+1}\,d_y$$

$$\ddot{a}_x = \ddot{a}_{\overline{x:\infty}|} = \sum_{k=0}^{\infty} v^{k+x}\,\frac{l_{k+x}}{D_x} = \frac{N_x}{D_x}\,, \qquad N_x = \sum_{y=x}^{\infty} v^y\,l_y$$

Suppose that at a single rate of interest the present values of the assets and liabilities are equal, i.e.

$$\int_0^\infty v^t A_t\,dt = \int_0^\infty v^t L_t\,dt. \qquad (1)$$

Let us examine the effect of a small change in the rate of interest by differentiating each side with respect to the force of interest δ.

$$d/d\delta \int_0^\infty v^t A_t\,dt = -\int_0^\infty t v^t A_t\,dt \qquad (2)$$

and similarly for L.

Define the mean term of the assets as

$$\tau_A = \int_0^\infty t v^t A_t\,dt \Big/ \int_0^\infty v^t A_t\,dt \qquad (3)$$

and similarly for the liabilities. Then another way of stating Redington's theorem is that the fund is immunized if

$$\tau_A = \tau_L, \qquad (4)$$

Due to **slower and less advanced computer processing capacity** available **in the past**,
analytical approach was favoured;
analytical equations and deterministic calculations were often used
in actuarial processes

The Era of Analytical Actuarial Processes

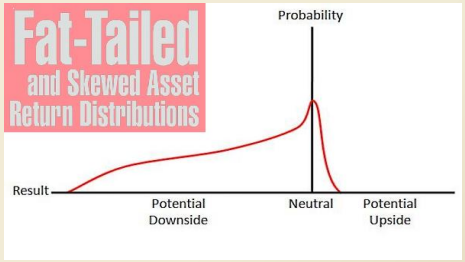
- To assess an expected value of the future, **analytical approach** can efficiently **provide the answer without too many calculations** or iteration processes involved
- Often for this kind of analytical calculations to be applicable, it would require **certain given conditions to be satisfied or assumed**, like in the Black- Scholes formula
- In determining financial liabilities, assessing financial risks or pricing insurance products, **actuarial processes** usually involve **many variable parameters** over a pretty **long term time horizon** with calculations started from **first principles**
- It is noteworthy that with the usual volume of data and calculations involved, if an actuarial program is not clever or analytical enough, it may easily take **half a day to produce the output for one single run** in the old days
- To ensure feasibility of calculations, **fixed sets of assumptions** and/or input variable values are commonly used in traditional actuarial processes to provide **deterministic outcomes**

The Era of Analytical Actuarial Processes

- Traditional actuarial processes often involve computations with **input variables**/ assumptions made up of **(Expected Value + Implicit Margin)** for deterministic outputs
- **Conservative margins** are implicitly built into the variables or assumptions **used in** the **actuarial calculations** to assess profits and/or provide buffer to absorb random fluctuations of claims
- **Less volatile economic and market conditions** as well as **simple product designs in the past** allowed the use of implicit margins as the means for asset-liability risk management
- Different from banking, **insurance liabilities** are generally **illiquid** reducing liquidity risk and any immediate market volatility impact on insurance business
- Also, **insurance risk** can theoretically be **diversified** with business volume
- Insurance supervision previously was largely **rules-based driven**, involving **simple factors to assess solvency**, with business volume as key risk monitoring measure

The Era of Analytical Actuarial Processes

- **Actuaries** were often the ones to **deal with** the **implicit margins**, thus giving the public a feeling of being conservative
- However, **competition** has **driven down margins**
- **Implicit margin** as allowed in an analytical actuarial process may easily **become insufficient** to tackle any adverse scenario, especially with any asymmetric relationships existed in the actuarial calculations



- When any volatility effect is accounted for, the margin as allowed in the process may possibly be **turned into negative**, without notice
- For **complex financial products**, **change** in outcomes is often **not** directly **proportional** to or consistent with any change in implicit margin to the variables
- Although insurance risk can be diversified, **financial risk** is **concentrated** and proportional to (if not increasing with) business volume

Insurance Core Principles

- With
  - advance in modern finance theory and practice leading to **innovative product designs**;
  - **increasing market competition** squeezing the available buffer; and
  - change in demographic and macro-economic conditions leading to **a low interest rate environment** with **increasing financial volatility**,

  simple analytical approach using implicit margin is **no longer sufficient** for financial risk management

- Simple implicit margin approach may easily produce a **system risk** to the industry when commercial players under-estimate the risks involved in a given product design

- Computing power available now is totally different from the past and can enable **complex simulations** and **modeling** to be practically **possible**

- As a result, the IAIS has gone back to basics and prescribed the **insurance core principles** for local regulators to develop relevant practices to supervise insurers

- Instead of rules-based, **principles-based** is now commonly advocated

Insurance Core Principles

- The Insurance Core Principles ('ICPs') have been specified by the IAIS providing a globally accepted framework for the supervision of the insurance sector on:-
  - **Corporate Governance**
  - **Conduct of Business**
  - **Risk Management and Internal Controls**
  - **Valuation and Liability Assessment**
  - **Investment and Asset Management**
  - **Enterprise Risk Management for Solvency Purpose**
  - **Capital Adequacy**
  - **Disclosure and Reporting, etc**

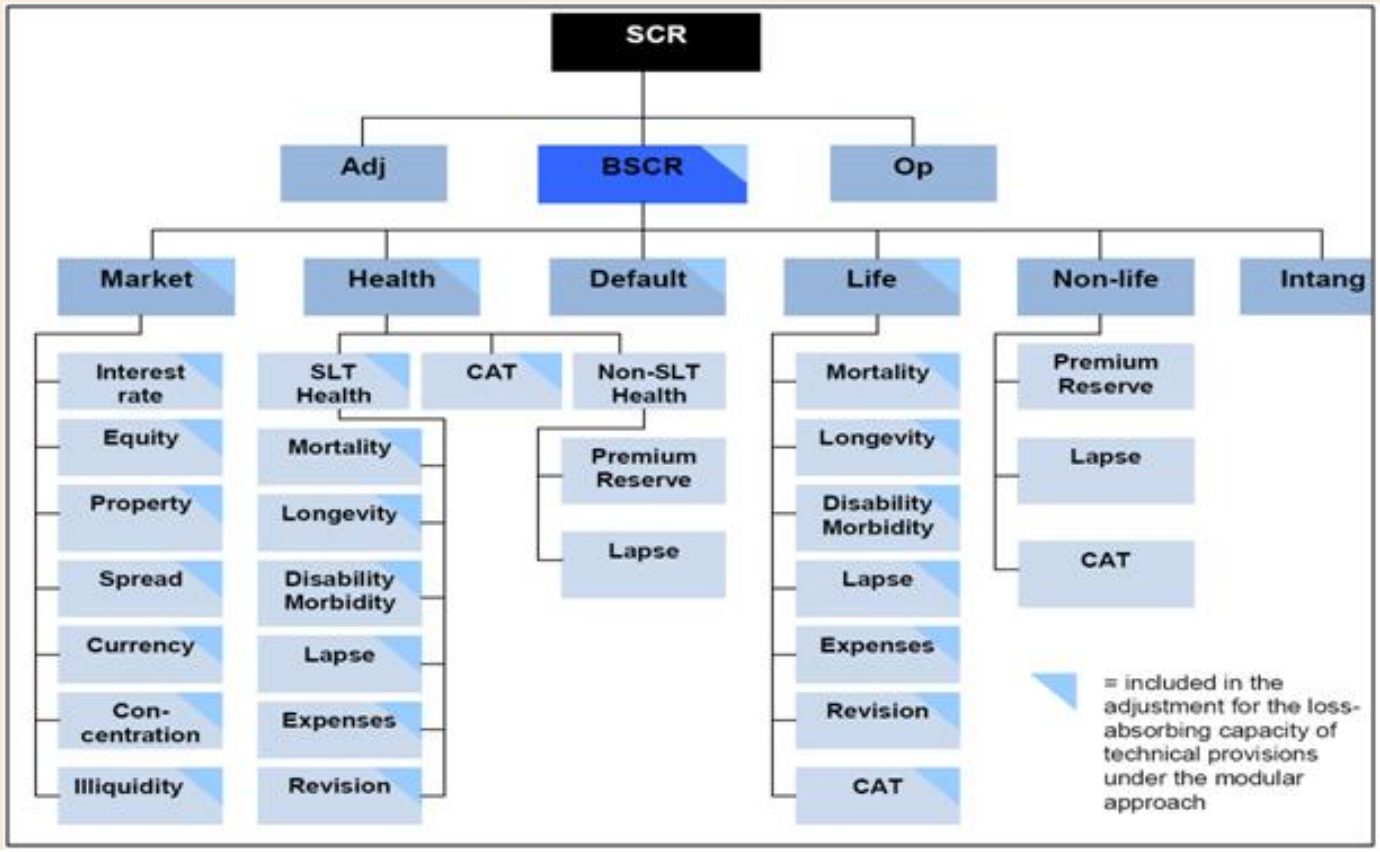
- The **ICPs** (comprised of **statements, standards & guidance notes**) set out the hierarchy of supervisory materials applying to all insurance supervisions

- When implementing the **standards** in a jurisdiction, one can take into account the domestic context, industry structure and developmental stage of the financial system and overall macroeconomic conditions

- No mandated method of implementation, which **can vary across jurisdictions**

Enterprise Risk Management for Solvency Purpose

- For capital adequacy and solvency management purpose, risk involved by an insurer is now generally split into **market risks**, **counterparty risks**, **insurance risks, operational risks**, **liquidity risk**, **strategic risk and reputational risk**



Enterprise Risk Management for Solvency Purpose

- Valuation approach used:-
  - **Explicit** approach and margin with identifiable purpose
  - **Stochastic** providing probabilistic distribution of outcomes
  - Stochastic on Stochastic (**Nested Stochastic**)
  - Modeling with consistent update of **market parameters**
- Common risk assessment methodologies:-
  - Market, Asset-Liability, Insurance Risks : **Stress tests**
  - Counterparty Risks : **Factor approach**, **CVA**
  - Liquidity Risk : **Dynamic cash flow testing**

$$\mathrm{CVA} = E^{Q}[L^{*}] = (1-R)\int_{0}^{T} E^{Q}\left[\frac{B_0}{B_t}E(t)|\tau = t\right] d\mathrm{PD}(0,t)$$

- Qualitative assessment on operational risks, strategic risk and reputational risk
- **Operational risks** no longer just clerical process risk matters, but involve:- **conduct of business**, **management of financial models**, etc
- With fintech developments, **operational risk management** will require further sophistication, and may become a **specialist knowledge** in financial services

Increase in Risk Management Expectations

- For life insurance, its volatility is theoretically dependent of its **illiquidity and contingency nature** as driven in the product design
- If a long term insurance product is designed as **liquid** & less insurance risk contingency based, it will simply **become an open** long term **financial put option**
- As an open tradable financial option, the liabilities of long tem insurance would become **sensitive to** the modelled future **volatility structure of** interest rate and/or the **underlying** market instrument
- $\text{Volatility}_{\text{Liquid Unit}} = \text{Volatility}_{\text{Illiquid Unit}} + \text{Volatility}_{\text{Liquid Premium}}$
- $\text{Volatility}_{\text{Traditional Par WL}} \approx \text{Volatility}_{\text{Illiquid Unit}}$
- $\text{Volatility}_{\text{Variable Annuity}} \approx \text{Volatility}_{\text{Liquid Unit}} + \text{Volatility}_{\text{Smile}}$

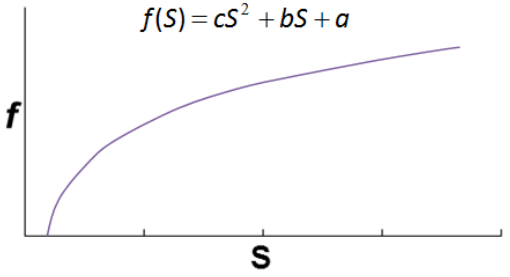
  $\approx \text{Volatility}_{\text{Illiquid Unit}} + \text{Volatility}_{\text{Liquid Premium}} + \text{Volatility}_{\text{Smile}}$
- With insurance product designs now become akin to tradable financial products, the new enterprise risk management practice in substance is to **market-value insurance volatility (σ)** for the purpose of Hedging or Trading

Increase in Risk Management Expectations

- Theoretically, the actual **cost of** underwriting a liquid financial option (after **Delta/Dynamic hedging**) is the **Gamma loss**. Gamma may vary materially over time. **Hedging of Gamma** will involve Vega (volatility). The whole hedging cost for a liquid option effectively **links to** the **Vega** (volatility) charge of the underlying S.

Short Put leads to the non-linear exposure position f which can be expressed in the parabolic form of the underlying (**S**): -

$$f(S) = cS^2 + bS + a$$



Dynamic Hedging means to create a hedged portfolio π so that $\pi = f - \delta * S$

At time 0, for the delta hedged portfolio,

$\pi_0 = f(S_0) - \delta * S_0$ **and** $\delta = \left.\frac{\partial f}{\partial S}\right|_{S=S_0}$

At time 1,

a) If S_0 **moves up to** $S_0 + \Delta S$, $\pi_1 = f(S_0 + \Delta S) - \delta * (S_0 + \Delta S)$

given Negative Gamma, $\left.\frac{\partial f}{\partial S}\right|_{S=S_0+\Delta S} < \left.\frac{\partial f}{\partial S}\right|_{S_0<S<S_0+\Delta S} < \delta$

$$\Delta\pi_1 - \pi_0 = f(S_0 + \Delta S) - \delta * (S_0 + \Delta S) - f(S_0) + \delta * S_0$$
$$= \left[f(S_0 + \Delta S) - f(S_0)\right] - \delta * \Delta S$$
$$= \left[\left.\frac{\partial f}{\partial S}\right|_{S_0<S<S_0+\Delta S} - \delta\right] * \Delta S \quad = \textbf{NegativeValue} * \Delta S = \textbf{Loss;}$$

b) If S_1 **moves down to** $S_0 - \Delta S$, $\pi_1 = f(S_0 - \Delta S) - \delta * (S_0 - \Delta S)$

given Negative Gamma, $\left.\frac{\partial f}{\partial S}\right|_{S=S_0-\Delta S} > \left.\frac{\partial f}{\partial S}\right|_{S_0>S>S_0-\Delta S} > \delta$

$$\Delta\pi_1 - \pi_0 = \left[f(S_0 - \Delta S) - f(S_0)\right] + \delta * \Delta S$$
$$= \left[\left.\frac{\partial f}{\partial S}\right|_{S_0>S>S_0-\Delta S} - \delta\right] * (-\Delta S) = \textbf{PositiveValue} * (-\Delta S) = \textbf{Loss}$$

Increase in Risk Management Expectations

- **Traditional actuarial** has **assumed constant volatility** in assessing financial risks, which has led to substantial under-pricing and under-reserving for financial option alike insurance, which caused some insurers changing hands due to insolvency in the 2008/9 financial crisis
- **IFRS4**, accounting standard for insurance, has been under debate since 2000, with phase 1 on asset valuation implemented in 2005, but phase 2 for **liability recognition and income presentation** still under debate (for almost 20 years) with the latest target date for implementation as 2021
- New **IFRS9** will be effective in 2018 to require the set-up of **upfront credit default provisions** for financial instruments, impacting both banks and insurers
- What the implications of the above would be in terms of **strategic risk**?
- When **assessing risk** these days, we need to go **back to principles** to assess things, and no longer on any straight application of rules
- To apply principles properly, one would need **good fundamental knowledge** and a **wider scope** of consideration on issues, as well as **thinking ahead**

Increase in Risk Management Expectations

- New IFRS9 practice is in response to the 2008/9 financial crisis
- The **three lines of defence** on risk management governance
  - Front-line and business operations – risk & control in the business
  - Oversight functions – policy and procedure + oversight + risk management
  - Independent assurance – provide independent challenge & assurance
  - Regulatory supervision
- Insurance relies on the principle of utmost good faith
- **'Trust' has become an issue** for financial services
- Blockchain technology, as a recent popular fintech innovation area, is to remove the 'trusted' centralised operator for financial service transactions
- Have you heard **fintech disrupt financial services**?
- Banks are now under serious threats of disruption by fintech, but insurance may feel a greater impact later. **What do these mean on risk management**? How to gain back the 'Trust'!

Fintech (Internet Finance)

- Report on the Future of Financial Services by the World Economic Forum in 2015 has identified **6 areas** that will be **impacted by fintech** over the coming decades:
  - **Payments**
  - **Deposits and lending**
  - **Capital raising**
  - **Investment management**
  - **Financial markets**
  - **Insurance**
- Fintech innovations **leverage advanced algorithms** and **computing power** to automate activities that were once highly manual
- They attack areas where customer friction meets with the profit pools and threaten to eliminate incumbents' traditional role as intermediaries, putting pressure on traditional **end-to-end financial services models to unbundle**
- Insurance has been a stable business, but often with frustrated customers!
- Innovations will have the greatest impact when able to employ a **platform**-based, **data-intensive** and **capital light business model**

Fintech (Internet Finance)

<table>
<tr><th>Payments</th><th>Funding</th><th>Investment</th><th>Risk Management</th><th>Others</th></tr>
<tr><td colspan="5">Fintech Innovations</td></tr>
<tr><td colspan="4">Internet/Mobile Banking</td><td>Digital Currency</td></tr>
<tr><td rowspan="3">Mobile Payments (Open-loop sol’n to link to POS e.g. PayPal, vs Mobile merchant sol’n to integrate POS into devices e.g. Uber)</td><td colspan="2">P2P Lending & Deposit Platforms</td><td>Internet Credit Rating Assessment</td><td rowspan="3">Cryptographic Protocols/ Security -- Blockchain</td></tr>
<tr><td colspan="2">Crowdfunding Platforms</td><td rowspan="2">Online/Direct Insurance and Healthcare Services</td></tr>
<tr><td colspan="2">Online Capital Market Instruments Exchange Platforms (vs Over-the-counter)</td></tr>
<tr><td rowspan="2">P2P Transfers/ Payments (Online vs Offline; Software vs hardware)</td><td rowspan="3">Internet Financing (Mini-loans, Consumer loans)</td><td>Wealth Management Platforms</td><td rowspan="2">Sharing Economy/ P2P Insurance</td><td>Aggregators/ Financial Services Search Engines</td></tr>
<tr><td>Robo-Advisers</td><td>Big Data Analytics</td></tr>
<tr><td>Displacement of Cards (Default Card)</td><td>Algorithmic Trading</td><td>Sensors, Telematics, Wearable, IOTs</td><td>Financial Services Cloud</td></tr>
<tr><td></td><td>Social Trading</td><td></td><td></td></tr>
</table>

Fintech (Internet Finance)

- Like in the areas of **insurance**, the recent fintech developments include:-
  - **E-aggregators** to compare prices on motor, household and travel insurance e.g. Confused and Moneysupermarket in the UK, Policy Bazaar in India (for all kinds of insurance)
  - Sharing economy/**P2P insurance** to provide mutual or captive insurance to social networks of individuals e.g. Friendsurance in Germany, InsPeer in France
  - **Specialised** insurance needs **group purchase** e.g. Bought By Many in the UK
  - **Telematics** insurance models through connected devices and platforms like sensors for motor insurance, wearable for life and health insurance
  - **Internet-of-things** e.g. Zenefits in the US offering free cloud-based HR software and free publicity to insurers to connect up customers with insurers for a fee
  - **Startup insurers** e.g. Oscar in the US operating as an interface layer between individuals and their healthcare providers, like Uber; ZhongAn in China providing e-payment insurance & online claim settlements on all insurance; TaiKang Online in China using social care and red packets to build customer database and cross-sell in customer social networks

Fintech (Internet Finance)

- The **emergence of fintech** is to help those unbanked and less affluent customers to get financial services easier
- But it has now got an effect of **changing our daily lives**, impacting each financial service sector differently
- Innovative fintech players will likely fill in the areas where existing institutional providers are financially costly to perform or financially not viable to perform
- This will increase the blur of financial service sectors, **attacking costly customer acquisition** and **operating areas**, and putting pressure to integrate services
- Banks have no distinct digital advantages versus other e-platform providers
- The world economy is moving from the previous supply side economy to likely a **demand side economy**, increasing the negotiation power of individual customers
- Most of financial services products are 'bought', but insurance is often regarded as being 'sold'. Up to now, insurance is least impacted by fintech. **Would customer behaviour on insurance be changed by fintech**?

Fintech (Internet Finance)

- Apart from increasing customer focus, enhancing operational efficiency and transparency, **fintech** innovations may likely **drive changes in product designs** and **acquisition approaches**, towards **product fragmentation**, engagement of big data analytics, dis-intermediation, integration of services as well as **finer pricing**

- These would further squeeze the margins for profits or errors/risks, and providers have to **employ sophisticated risk management techniques** in the finer margin business space

- Long term insurance which involves protection (insurance risk) and asset management (financial risks) will see the investment management space be expanded with fintech to avail **investment opportunities on P2P platforms** and **online exchanges** (i.e. more 2nd or 3rd line markets), demanding **advances in risk management knowledge**

- The emergence of fintech will also demand a **wider** scope of **knowledge to address operational risk**

Fintech (Internet Finance)

- One of the 'pain' points on insurance is high acquisition cost. With massive volume of data available in this internet era, data analytics will undoubtedly be the tool to enhance acquisition cost efficiency. **Actuaries** use to deal with data and modelling, thus have the obvious **advantage in** manning **data analytics**
- **Risk management** remains a key impetus for **business to sustain** in the P2P (or alternate financial services) operating space, not to mention the traditional financial services space**. In the fintech era,** there will be **increasing opportunities and exposures** for the actuarial/ risk management profession
- In the developed insurance markets, actuaries often expand their exposures beyond their traditional actuarial roles into IT and systems, thus there is a term called '**system actuary**', similar to the term like '**investment actuary**' into asset management
- Application of fintech on insurance requires a lot of re-thinking on systems and processes, together with the potential 'fragmentation' of insurance products, creating a lot of work opportunities for actuaries and others on redesigns of products, systems and processes to address **operational risk**

Summary Remarks

- In summary,
  - **Principles-based** supervision requiring assessment of business in substance would demand more skilled risk management resources
  - Insurance core principles require insurance organisations to avail **comprehensive** internal **risk management frameworks** and **operating structures**
  - Skilled knowledge and sophistication on **financial modeling**, **financial risk**, **insurance risk** and **operational risk management** would be demanded
  - **Innovative** insurance products may need hedging
  - New accounting standards further emphasize **risk management for results**
  - **Fintech disruption** would also generate risk management role opportunities
- Actuary is just a typical **specialist** in my generation, thus it is so **valued**
- With the **world practice changing**, **new specialized skills** will be **in demand** and generate new specialists. As I understand, your Department now offers you with new specialized skills on risk management for your career success

~ Thank You ~