

# Non-Life Insurance Liability Measure: Mark to Statistical Model, Financial Market, and Clients

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# Concept

The back-ground of clients' needs based valuation is that insurance products are made for solving the clients' risk management issues. To value through statistical data, there needs to be abundant data samples. Financial engineering gives us smart methods for insurance pricing and insurance risk management but it relies on market transaction. It often happens that there are few transactions or no transactions. Also financial engineering suppose arbitrage free, equilibrium, and, existence of risk adjusted measure. The clients' needs based method suggest solutions for those.

# Financial engineering's Three Aspects in Insurance Premium Calculation

## ◆ Pricing

- Many pricing methods come from financial engineering technique.

## ◆ Product development

- Earthquake-trigger-contingent loan accommodation
- Credit default swap

## ◆ Risk transfer

- Use financial market investors
- Contingent Surplus Note, ART (alternative risk transfer) instruments and Insurance Risk Transfer Securitization type financial market instruments

# Mark to Statistical Model

- ◆ The Law of Large Numbers
  - The risk premium ratio will be observed and will be gained stably by gathering large number of samples.
- ◆ Equilibrium / Premium vs. Expectation
  - The insurance premium ratio will be equal to the expectation of the loss probability of the risk.
- ◆ Sufficient-Enough
  - After a long time has passed, premiums earned by insurance companies and insurance payments by insurance companies will be match.
- ◆ “Extreme Value Theory”

# Mark to Financial Engineering

- ◆ Mark to Financial Engineering
  - Diversification is the tool for risk hedge.
  - Clients can be told by “certainty equivalent utility amount.”
  - Arbitrage free (No free lunch).
- ◆ No-arbitrage Free, No-equilibrium condition, and, No-risk adjusted measure conditions
  - Wang Transform

# Mark to Financial Engineering (2)

## ◆ Mark to Financial Market

- The role of the market is to gather participants, in order to make instruments pricing more unbiased.
- The role of the market is, risk burden sharing by participants to get new capacity.
- Risk distribution is the key for insurance companies.

## ◆ Examples

- Electricity (derivatives), Weather (derivatives), ART (alternative risk transfer) instruments, Securitization of catastrophe loss insurance, Contingent Surplus Note, and etc.

# Mark to Clients

- ◆ “Mark to Clients” expresses the most important point of view: clients needs.

# Contingent Loan by Earthquake Trigger

$$\diamond C = E^Q_t [\theta(t) \bullet h(t) \exp\left\{ \int_{t_0}^t -h(s) ds \right\}]$$

$$0.01 * 1.0\% * 0.5 = 0.50\%$$

(million yen)	damage by the earthquake			average loss
	light	middle	sever	
probability	50%	40%	10%	
loss with insurance	0	0	▲ 100	▲ 10
loss without insurance	0	▲ 100	▲ 100	▲ 50

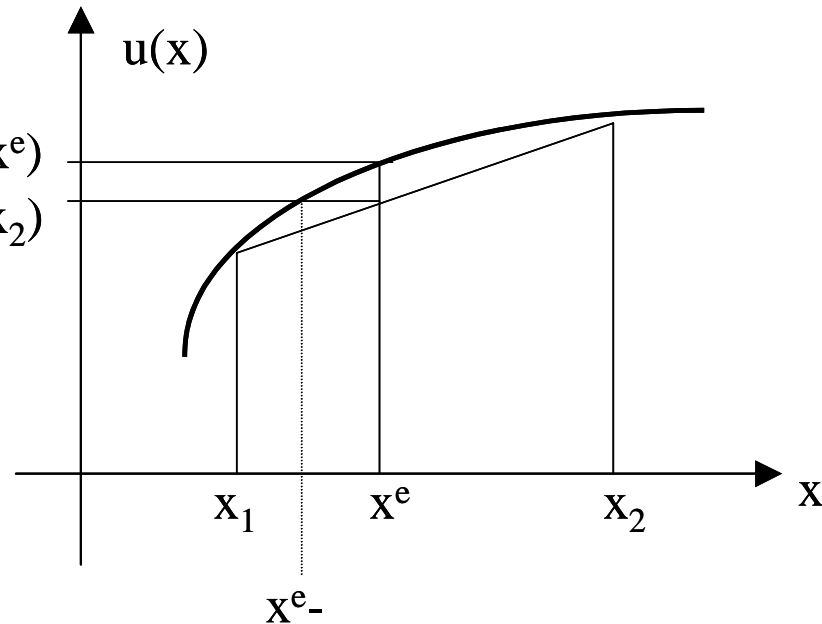
$$C = (50 - 10) \text{ million yen} * 0.01 = 400 \text{ thousand yen} \\ (0.40\%)$$



# K. J. Arrow – J. Pratt Measure

$$= -\frac{u''(E(X))}{2 \times u'(E(X))} \times \sigma^2$$

$$p_1 * u(x_1) + p_2 * u(x_2)$$



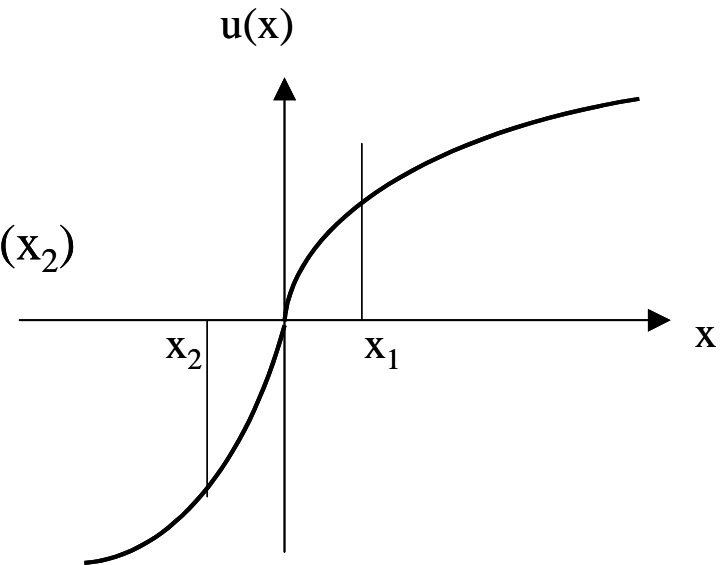
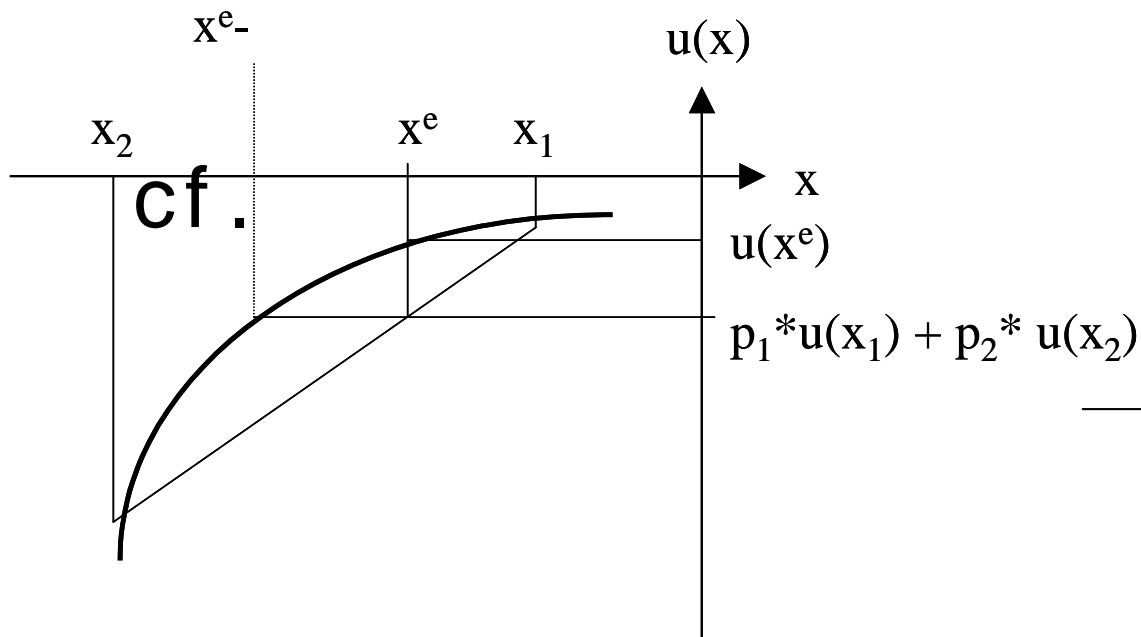
$$u(E(X)) = E[u(X)]$$

$$u(E(X)) + u'(E(X)) \times (X - E(X)) = E[u(E(X) + X - E(X))]$$

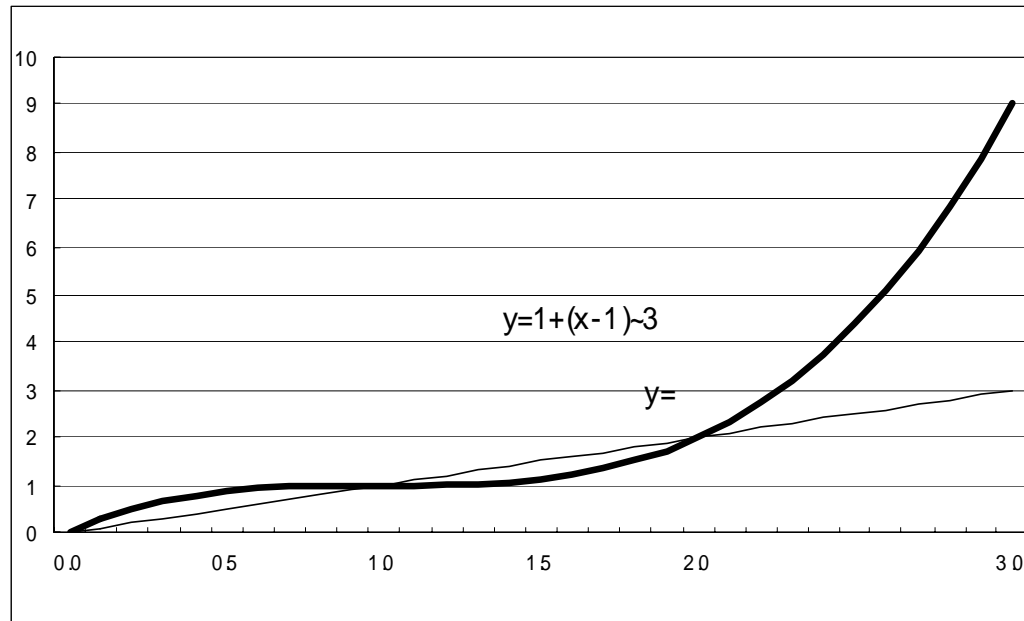
$$= E[u(E(X)) + (X - E(X)) \times u'(E(X)) + \frac{1}{2} u''(E(X)) \times (X - E(X))^2]$$

$$= u(E(X)) + \frac{1}{2} u''(E(X)) \times \sigma^2$$

# Why Buy Insurance



# Example



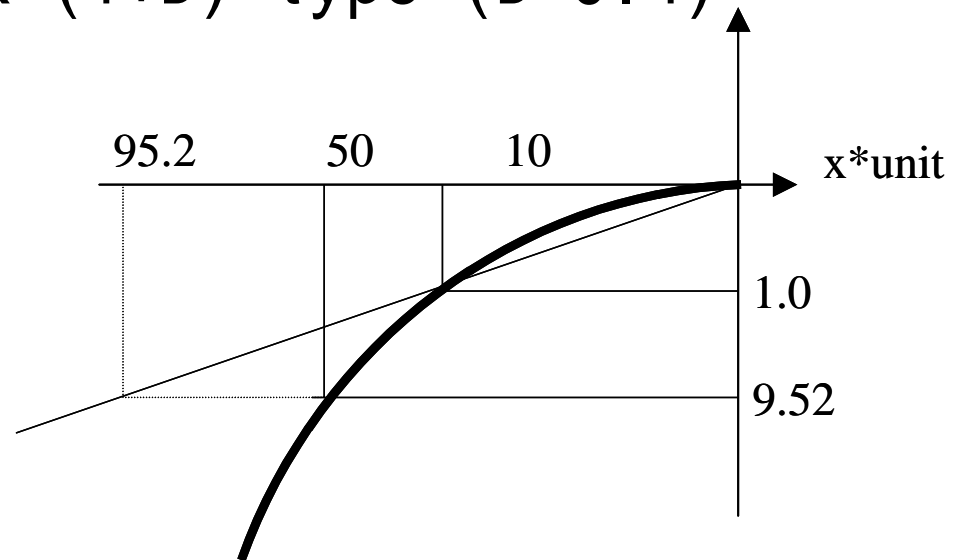
For insurance companies,

Negative for  
Business

Positive for  
Business

# Contingent Loan by Earthquake Trigger AGAIN!

- ◆ Utility Function  $x^{(1+D)}$  type ( $D=0.4$ )  $u(x)$



$$u(x) = x^{(1+D)}$$

- ◆ Premium:  $(95.2 - 10) * 0.01 / 100 = 0.852\%$
- ◆ The pure insurance premium is 0.50% and there is room to add costs and others by 0.352% (70% of pure premium) as is often seen in the non-life insurance pricing.

# Summary

- ◆ In case financial market interweave the clients' needs, the solution will be the same but usually there are differences.
- ◆ Behavioral science helps to understand that people willingly pay for insurance premium to insurance companies more than pure premium ratio.
- ◆ Structural Model using utility function shows several characteristics in insurance premium calculation.