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Fair value of property catastrophe reinsurance contracts

Theoretical considerations and a practical approach

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Outline

- Introduction
  - Why we are interested in the fair value of (re)insurance contracts
  - How we define fair value
- A *mark-to-model* valuation framework
- Application to the valuation of property catastrophe reinsurance contracts in insurance-linked security (ILS) funds
- Concluding remarks

Introduction

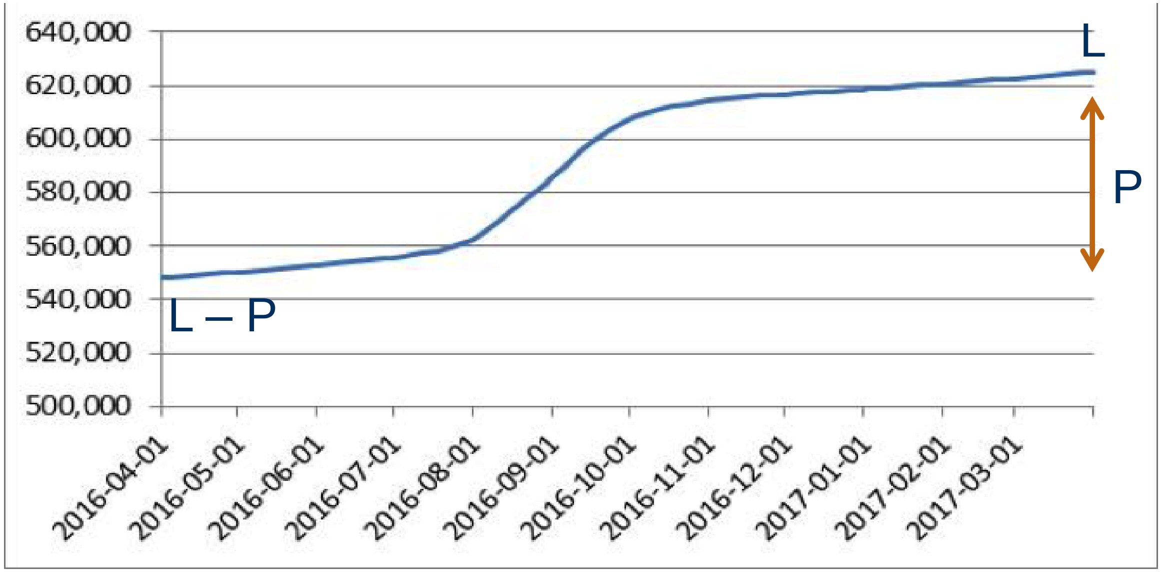
- Why we are interested in the fair value of (re)insurance contracts
  - Measure the performance of a (re)insurer or insurance-linked securities (ILS) fund, especially at intervals less than a year (e.g., weekly or monthly)
  - Share subscription/redemption for open-end ILS funds

Challenges

- Two challenges make this problem intellectually interesting and practically important
  - No secondary market trading for most (re)insurance contracts → no observable market price (exception: cat bonds)
  - The commonly adopted approach of earning premium on a straight-line basis does not produce a fair valuation estimate when the underlying risk exhibits systematic seasonal variations (e.g., all weather-related risks)

Defining fair value (1)

- Consider a simple reinsurance contract with a limit = L; premium = P
- Intuitively, we know that
  - Without any loss, its value V = L at expiration
  - Without any loss, its value increases by P during the contract period
  - At inception, its value = L – P
- The question: how does the fair value vary in between?



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Defining fair value (2)

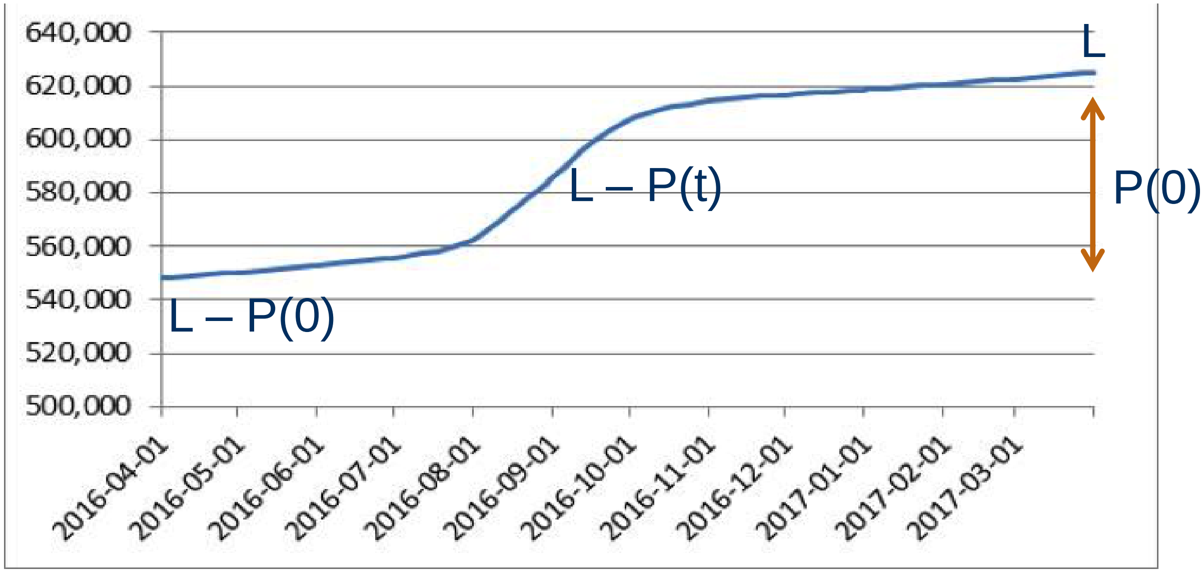
We define the fair value of the contract at a time t as:

$$V(t) = L - P(t)$$

where P(t) = the premium that the reinsurer must pay a third-party rational reinsurer to assume both

(a) All losses that have occurred prior to t

(b) The risk between t and expiration



Intuitive interpretation: Scenario 1

Why does this definition represent the **fair** value of the contract at a time t?

$$V(t) = L - P(t)$$

where P(t) = the premium that the reinsurer must pay a third-party rational reinsurer to assume both

(a) All losses that have occurred prior to t

(b) The risk starting on t until expiration

Case 1: the contract experienced a full-limit loss prior to t

- The third-party reinsurer will have to charge precisely L to assume (a) and (b) above → $V(t) = L - L = 0$
- Consistent with the fact that the contract is “worthless” after a full-limit loss

Intuitive interpretation: Scenario 2

Why does this definition represent the **fair** value of the contract at a time t?

$$V(t) = L - P(t)$$

where P(t) = the premium that the reinsurer must pay a third-party rational reinsurer to assume both

(a) All losses that have occurred prior to t

(b) The risk starting on t until expiration

Case 2: A full-year contract (1/1/2016 – 12/31/2016) covers US hurricane only. What is its value on 4/1/2016? Suppose the market has not hardened or softened relative to 1/1/2016

- $P(t) = P(0) \rightarrow V(t) = L - P(0) = V(0)$
- This is consistent with the fact that the contract has gained no value since no risk has been assumed as of 4/1/2016

Intuitive interpretation: Scenario 3

Why does this definition represent the **fair** value of the contract at a time t?

$$V(t) = L - P(t)$$

where P(t) = the premium that the reinsurer must pay a third-party rational reinsurer to assume both

(a) All losses that have occurred prior to t

(b) The risk starting on t until expiration

Case 3: A full-year contract (1/1/2016 – 12/31/2016) covers US hurricane only. What is its value on 4/1/2016? Suppose the same risk now costs twice as much to reinsure as it did on 1/1 due to a massive loss event elsewhere.

- $P(t) = 2 \times P(0) \rightarrow V(t) = L - 2 \times P(0) < V(0)$
- This is equivalent to ↓value of a bond in an ↑interest rate environment even without any change of its own credit quality

Implementation

- $V(t) = L - P(t)$, where $P(t) = P1(t) + P2(t) \times M(t)$

  P1(t) = to account for losses that had occurred prior to t; there is generally uncertainty in the estimate (i.e., loss development risk)

  P2(t) = the premium to cover the forward-looking risk between t and expiration (e.g., due to erosion of limit and aggregate deductible; seasonal pattern of the underlying risk)

  M(t) = a modification factor to take into account market hardening/softening

- Ideally, the inputs used to calculate P(t) should be
  – Based on objectively observed parameters
  – Free from subjective judgments that vary idiosyncratically for different transactions

Application to property catastrophe reinsurance ILS funds (1)

- Reasonably objective and observable parameters are available for the calculation of P(t) for property catastrophe reinsurance contracts in ILS funds

Application to property catastrophe reinsurance ILS funds (2)

- $V(t) = L - P(t)$, where $P(t) = P1(t) + P2(t) \times M(t)$

$P1(t)$ = reported losses that had occurred prior to t

Assumption: the amount of losses that had occurred prior to t is treated as a deterministic number. This is a reasonable choice for ILS funds because loss-impacted contracts are generally excluded from the calculations related to redemption/subscription (known as *side-pocketed*) until the uncertainty is removed

Application to property catastrophe reinsurance ILS funds (3)

- V(t) = L - P(t), where P(t) = P1(t) + P2(t) x M(t)

  P2(t) = EL(t) x P(0) / EL(0)

  EL(0) = model-calculated expected loss of the contract calculated at the inception of the contract

  P(0) = actual premium for the contract

  EL(t) = model-calculated expected loss of the contract at the time t

Assumption: without a systematic hardening/softening, the market demands a constant premium/EL ratio for a specific contract

Alternative assumptions: the market demands constant Sharpe Ratio or other risk/return measures

Application to property catastrophe reinsurance ILS funds (4)

- V(t) = L - P(t), where P(t) = P1(t) + P2(t) x M(t)

If the contract term is less than one year, M(t) = 1

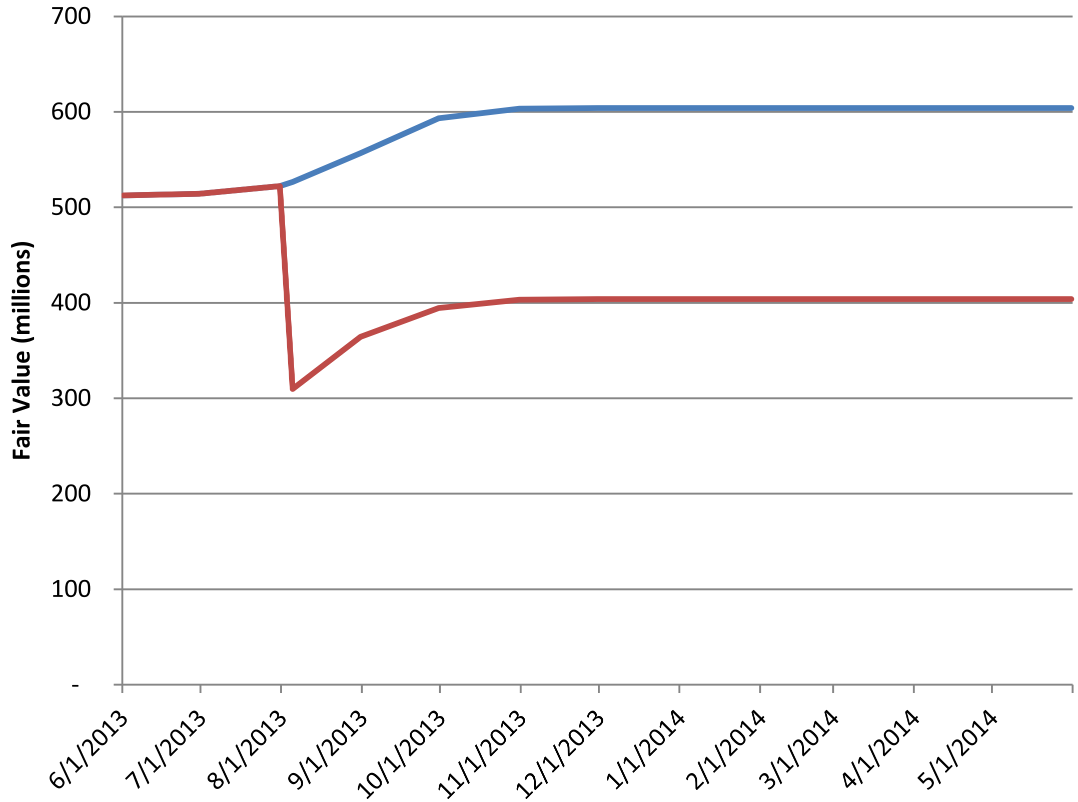
Otherwise M(t) is to be determined by the premium/EL ratio of similar contracts incepting at t

Assumptions:

- Systematic market conditions do not change significantly within a year;
- Comparable contracts can be found in the market to estimate M(t)

Example 1

- Excess-of-loss contract
  - US hurricane risk only
  - Limit = 604mm
  - Premium = 91mm
- Scenario 1: no loss
- Scenario 2: 200mm loss on Aug 1st; no other loss



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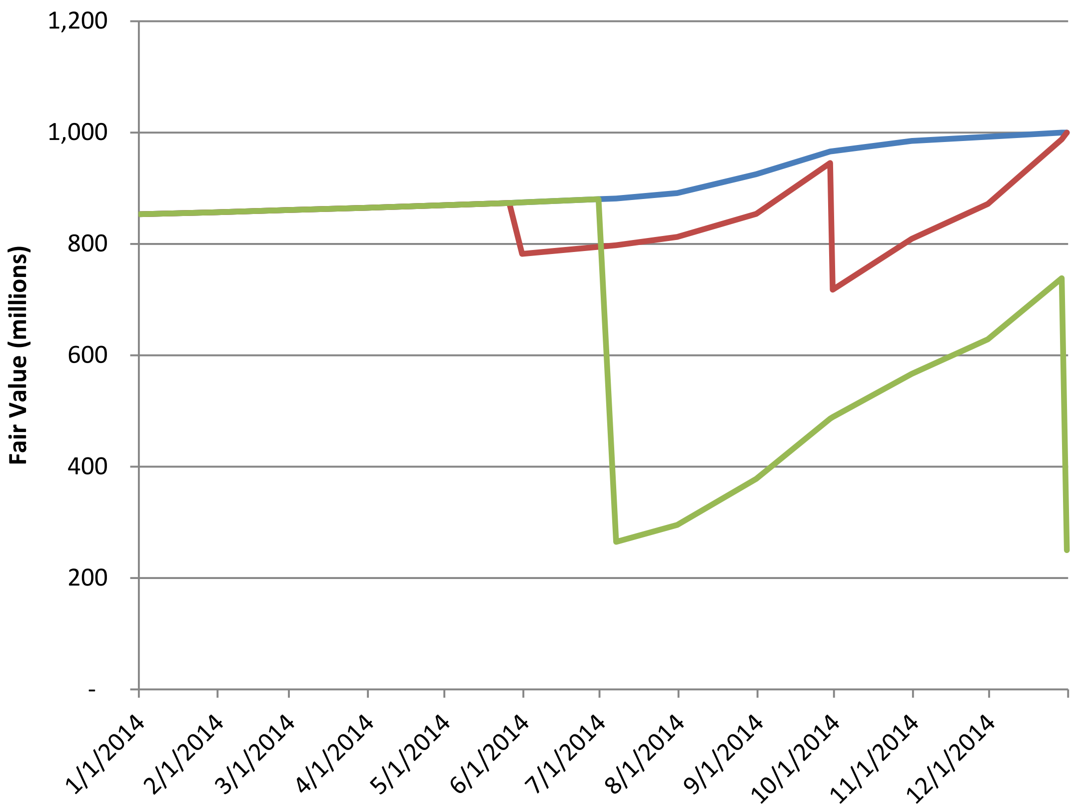
Example 2

- Aggregate stop-loss contract
  - World-wide cat
  - Limit = 1bn
  - Premium = 150mm

- Scenario 1: no loss

- Scenario 2: greater-than-expected deductible erosions reported on May 31st and Sept 30th; aggregate loss never exceeded AAD



- Scenario 3: loss in excess of AAD reported on July 7th and Dec 31st

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Concluding remarks

- For the purpose of ILS fund performance reporting and share subscription/redemption, we must establish the fair value of catastrophe reinsurance contracts in the absence of secondary market trades

- We have presented
  - A general “mark-to-model” framework applicable to most reinsurance contracts
  - A set of assumptions and rules to implement the framework for property catastrophe reinsurance contracts in ILS funds, enabling an ILS fund and/or fund administrator to establish a reasonably accurate and unbiased estimate of the fair value of a contract at any given time primarily based on observed and objectively calculated inputs

- Expanding the application to a broader subset of the (re)insurance business is an intellectually interesting and challenging problem. A solution will be extremely useful in practice