

Equity-Based Insurance Guarantees Conference

Nov. 6-7, 2017

Baltimore, MD

Incorporating a Liquidity Premium into the  
Valuation of Insurance Liabilities

John Manistre

Sponsored by



# **Incorporating a Liquidity Premium into the Valuation of Insurance Liabilities**

**2017 EBIG Conference – Baltimore Md  
Session 3B: 1530 – 1700 hours**

# Agenda

- 1. Introduction – What’s the problem?**
  - » Some ideas from Solvency II
- 2. Methods that depend on the assets you own – Dariush Akhtari**
- 3. Methods that depend on assets you could own – John Manistre**
- 4. Methods that depend only on Liability characteristics – John M**
- 5. A debate on pros and cons**
  - » Should liability values depend on your asset values Yes/No?
  - » Open vs. Closed System Approaches to Risk Management

# 1

## Introduction: What is the Problem?

## Introduction – What is the Problem?

- Pricing actuaries have been incorporating a liquidity premium into their models for years
  - Good Example: Pricing SPIA contracts off long commercial mortgage rates, “liquidity match”
  - Bad example: In 1980’s priced Group Pension GICs off shorter commercial mortgage rates, “liquidity mismatch”
- Traditional US accounting models, Stat & GAAP, swept the issue under the rug – until it was too late
- “Market Consistent” reporting models won’t let you sweep the issue under the rug
- Solvency II tries to deal with the issue with two complex tools
  - a) regulatory liquidity premium & b) matching adjustment
- IFRS just tells you to figure it out

# 2

Methods that depend on the assets  
you own  
Dariush Akhtari FSA, FCIA

# Blank Slide For Dariush

# 3

Methods that depend on assets you  
could own  
John Manistre – FSA, FCIA, CERA



# An Optimization Problem – Static Control

1. Start with a suitably large set of  $N$  economic scenarios  $\mathcal{S}$ , assume these are real world (P measure) for now
2. Project *risk adjusted liability cash flows (LCF)* over each scenario and time point  $t$ . Result is an array  $LCF_{tA}$ ,  $A \in \mathcal{S}, t = 1, \dots, T$
3. Choose a set of linearly independent hedge instruments  $\mathcal{H}$  such as bonds, swaps, options etc. Project *risk adjusted cash flows* for each hedge instrument. Result is an array  $HCF_{tA}^\alpha$  for each  $\alpha \in \mathcal{H}$
4. Let  $Z^\alpha$  be the observed market price of hedge instrument  $\alpha$
5. Choose an asset to act as numeraire – returns on this asset will be used for discounting. Examples - bank account, stock index, bond fund etc.. Let  $v_{tA}$  be the discount factor from time  $t$  to the valuation date on scenario  $A$

---

6. Choose a CTE level  $a$  e.g.  $a = 20\%$

# An Optimization Problem - Outputs

Discount liability and hedge asset cash flows using numeraire

$$L_A = \sum_t v_{tA} LCF_{tA}, H^{\alpha}_A = \sum_t v_{tA} HCF^{\alpha}_{tA}$$

Consider a hedge portfolio where we buy  $b_{\alpha}$  units of each hedge instrument and form

$$W(LCF, \mathbf{Z}, \mathbf{b}) = \sum_{\alpha} b_{\alpha} Z^{\alpha} + CTE_{\alpha} \{L_A - \sum_{\alpha} b_{\alpha} H^{\alpha}_A\}$$

Intuition: first term is cost of buying hedge cash flows, second term is putting a value on unhedged liability cash flow

Now choose the hedge portfolio weights  $b_{\alpha}$  to minimize the total liability value

- » A convex optimization problem (has nice properties)
- » Let  $b^*_{\alpha}$  be the optimizing portfolio weights

Set optimal value  $V(LCF, \mathbf{Z}) = W(LCF, \mathbf{Z}, \mathbf{b}^*)$

# Static Control – Nice Properties

$$V(LCF, \mathbf{Z}) = \min_b \left[ \sum_{\alpha} b_{\alpha} Z^{\alpha} + CTE_a \{L_A - \sum_{\alpha} b_{\alpha} H^{\alpha}_A\} \right]$$

**Looks complicated? This is actually a linear program in disguise! (Uraysev's Theorem)**

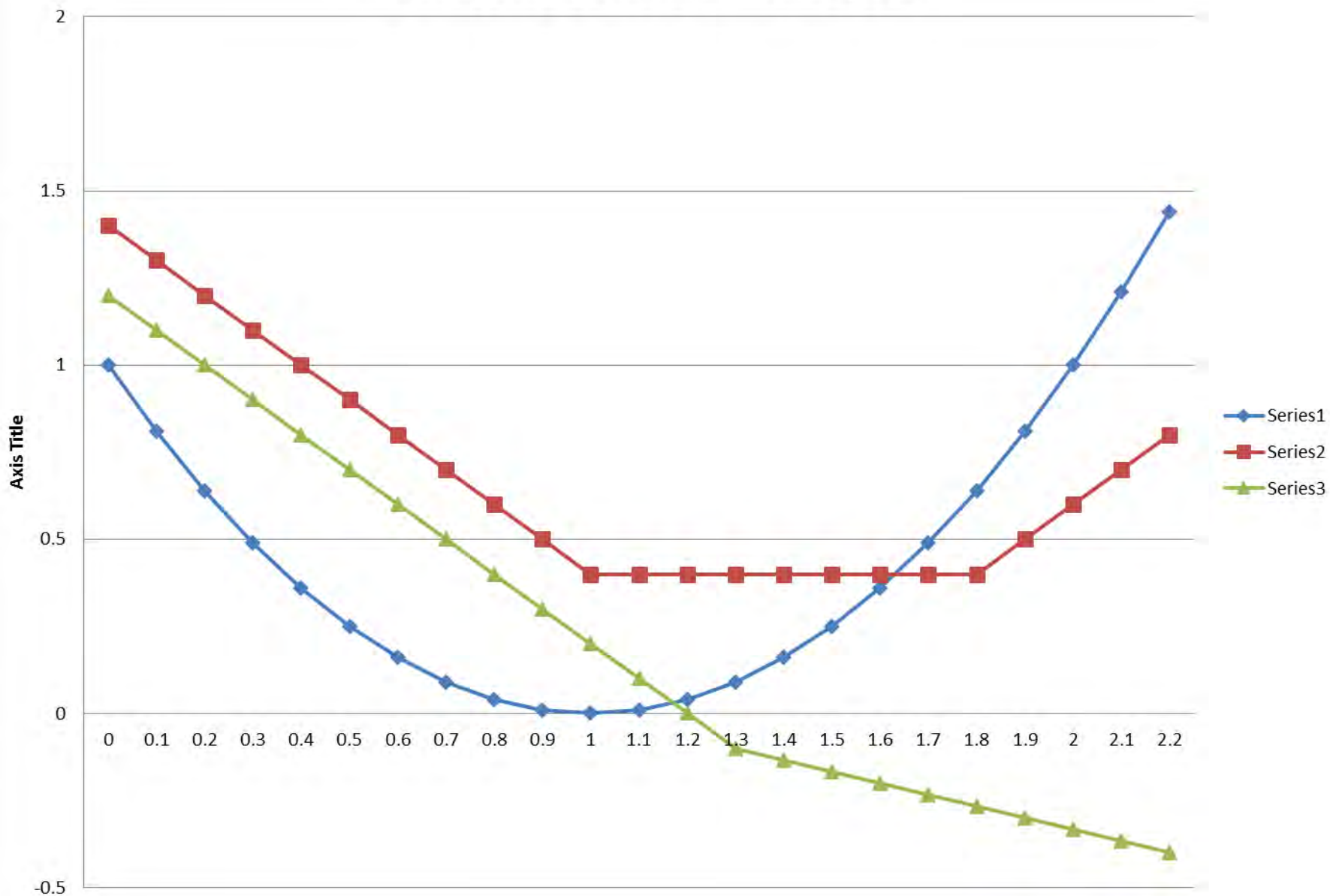
**Relatively easy to work with as a result. Optimization works (bounded) if the *CTE* level *a* is large enough**

**Optimal value  $V(LCF, \mathbf{Z})$  satisfies  $\frac{\partial V}{\partial Z^{\alpha}} = b_{\alpha}$  candidate for replicating portfolio**

**Valuation process is sub-additive**

**Value reflects any liquidity premium built into the hedge instruments and their projected cash flows**

# Convex Function Examples



# Static Control – Dual Version

$$V(LCF, \mathbf{Z}) = \min_b \left[ \sum_{\alpha} b_{\alpha} Z^{\alpha} + CTE_a \{L_A - \sum_{\alpha} b_{\alpha} H^{\alpha}_A\} \right]$$

All linear programs have a dual version

In this case dual variables are scenario weights  $\lambda^A$  that maximize the liability present value

**Dual Problem:**  $V(LCF, \mathbf{Z}) = \max_{\lambda} \sum_A L_A \lambda^A$

**Dual Constraints**

$$\begin{aligned} \sum_A \lambda^A &= 1, & \sum_A H^{\alpha}_A \lambda^A &= Z^{\alpha}, \\ 0 \leq \lambda^A &\leq \frac{1}{N(1-a)}. \end{aligned}$$

Optimization process extracts a calibrated subset of scenarios

# More on Dual Approach

» **If the dual is feasible then the primal is bounded and the two optimal values agree**

»  $\frac{\partial V}{\partial Z^\alpha} = b_\alpha$  **candidate for replicating portfolio**

»  $\frac{\partial V}{\partial b^\alpha} = Z^\alpha - \sum_A H^\alpha_A \lambda^A$  (Tasche's Theorem)

– **This result can be used to develop an interior method for solving the linear program**

»  $\frac{\partial V}{\partial L_A} = \lambda^A$  - **useful if you forgot a contract**

# Static Control Summary

- » **Convex optimization: can be solved if *CTE* level is high enough**
- » **Model produces a calibrated scenario subset  $\mathcal{S}^* \subset \mathcal{S}$**
- » **Liability value  $V(LCF, Z)$  is average PV over  $\mathcal{S}^*$**
- » **Optimal hedge portfolio weights are also “greeks”**

$$\frac{\partial V(LCF, Z)}{\partial Z^\alpha} = b^*_\alpha$$

- » **Calibrated scenario set reflects whatever liquidity premium we put into the universe of hedge instruments**
- » **Mechanics are manageable**
- » **Key issue is how we model *risk adjusted* asset cash flows**
- » **Asset cash flow should reflect best estimate defaults and appropriate cost of capital**

# 4

Methods that depend only on liability characteristics

John Manistre



# A Bottom Up Approach

- » **Basic Idea: Asset prices reflect liquidity premiums for a variety of reasons**
- » **Main issue: holding an illiquid asset means the value may change abruptly when you try to sell it**
- » **Owner should then hold capital for a potential shock to liquidity spreads**
- » **Liquidity spread itself should pay for cost of holding liquidity risk capital (circular)**
- » **If assets back an illiquid liability then there is less risk that the asset will need to be sold at a loss**
- » **Liquidity risk capital can be reduced and the spread used to subsidize liability pricing/valuation**
- » **For more detail see John M's 2015 ERM Symposium paper on this topic, still a work in progress**

5

## John and Dariush Debate

© 2016 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. AND ITS RATINGS AFFILIATES ("MIS") ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND CREDIT RATINGS AND RESEARCH PUBLICATIONS PUBLISHED BY MOODY'S ("MOODY'S PUBLICATIONS") MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL, FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS AND INAPPROPRIATE FOR RETAIL INVESTORS TO USE MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS WHEN MAKING AN INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's Publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Moody's Investors Service, Inc., a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by Moody's Investors Service, Inc. have, prior to assignment of any rating, agreed to pay to Moody's Investors Service, Inc. for appraisal and rating services rendered by it fees ranging from \$1,500 to approximately \$2,500,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at [www.moody's.com](http://www.moody's.com) under the heading "Investor Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

Additional terms for Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001.

MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail investors. It would be reckless and inappropriate for retail investors to use MOODY'S credit ratings or publications when making an investment decision. If in doubt you should contact your financial or other professional adviser.

Additional terms for Japan only: Moody's Japan K.K. ("MJKK") is a wholly-owned credit rating agency subsidiary of Moody's Group Japan G.K., which is wholly-owned by Moody's Overseas Holdings Inc., a wholly-owned subsidiary of MCO. Moody's SF Japan K.K. ("MSFJ") is a wholly-owned credit rating agency subsidiary of MJKK. MSFJ is not a Nationally Recognized Statistical Rating Organization ("NRSRO"). Therefore, credit ratings assigned by MSFJ are Non-NRSRO Credit Ratings. Non-NRSRO Credit Ratings are assigned by an entity that is not a NRSRO and, consequently, the rated obligation will not qualify for certain types of treatment under U.S. laws. MJKK and MSFJ are credit rating agencies registered with the Japan Financial Services Agency and their registration numbers are FSA Commissioner (Ratings) No. 2 and 3 respectively.

MJKK or MSFJ (as applicable) hereby disclose that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MJKK or MSFJ (as applicable) have, prior to assignment of any rating, agreed to pay to MJKK or MSFJ (as applicable) for appraisal and rating services rendered by it fees ranging from JPY200,000 to approximately JPY350,000,000.

MJKK and MSFJ also maintain policies and procedures to address Japanese regulatory requirements.