EBIG Session 3B: Incorporating Liquidity Premium into Valuation of Insurance Liabilities

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(1530 – 1700 hours)

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November 6, 2017

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

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Methods that depend on the assets you own

Dariush Akhtari – FSA, FCIA

Moody's Analytics

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2.1 | Table Setting

What is the Goal

- Finance: Need to evaluate company value
  - Know MVA, need to know MVL to get MV of Surplus (MVS)
  - MCEV = MVA – MVL
- Governance: Need to know how much assets needed to back liabilities
  - In parts of the world liabilities are calculated at market value (not book)
- M&A
  - Falls under Finance above

2.2 Current Approach

Current Approach

- Discount liability cash flows at risk free rate plus a spread
- How is the spread defined?
  - Generally independent of assets backing the liabilities (except in CALM)
  - Prescribed (e.g., ICS)
  - Company decides different rates for different products w. disclosure

Spread created independent of assets backing liabilities creates noise in the value of surplus

Concerns with Current Discount Rates

- Use of risk free rate is based on valuation of deep and liquid assets
- Does not take into account insurance business model – long and illiquid
- Evaluating liability value independent of assets backing them:
  - Results in volatile MCEV/surplus
  - Results in inappropriate investing – inappropriate ALM
  - May not be appropriate for UL and FA products when liability cash flows are tied to assets backing them
  - Any spread over risk free would be arbitrary and would not reflect the nature of the liability

2.3 New Proposal

Is There Only One Way to Skin A Cat?

- In practice, calculating MVS is the goal in both finance and governance
- Most solutions start by solving for MVL to get to MVS
- Why not solve for MVS directly
  - MVL becomes a byproduct (MVL = MVA – MVS)

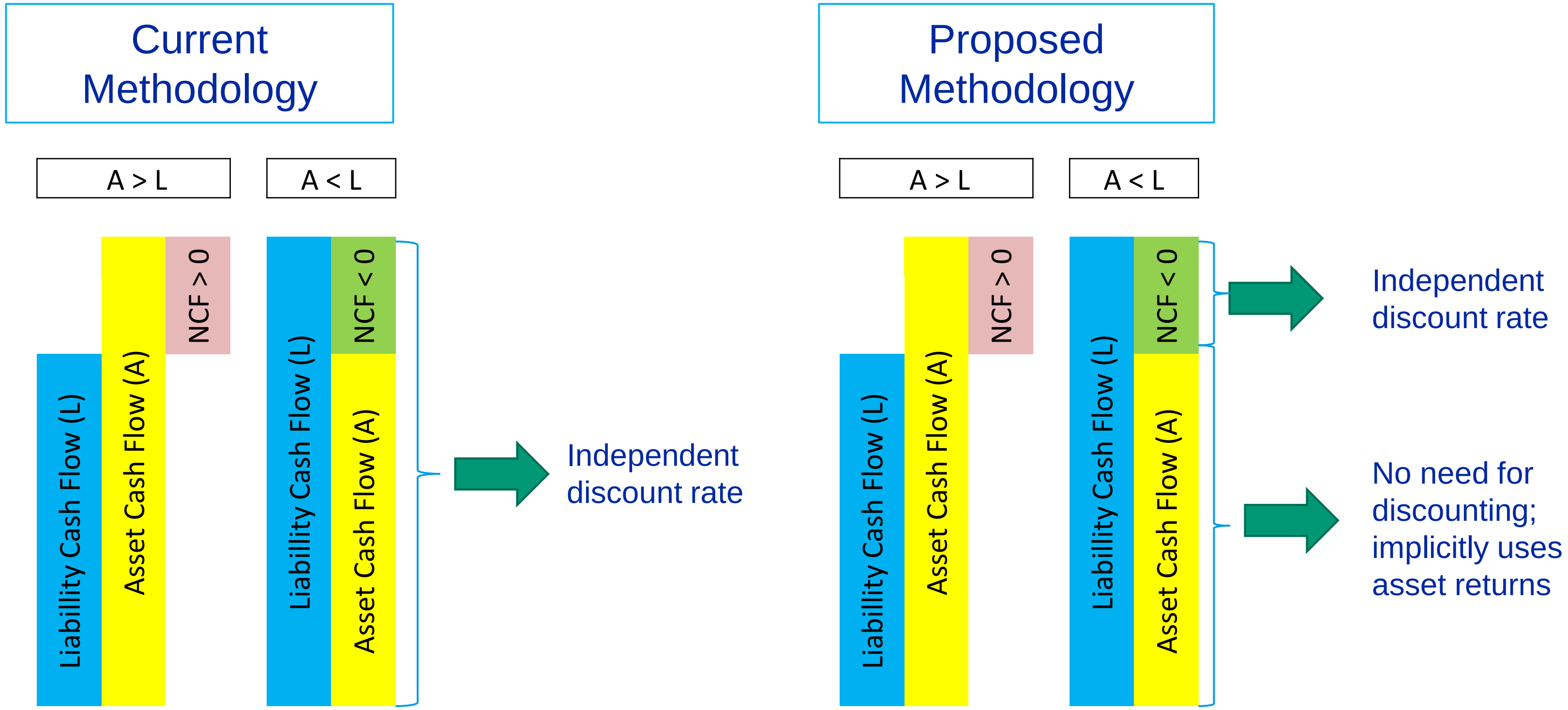
- This also makes sense when managing business
  - ALM risk is the risk of mismatching assets' and liabilities' cash flows
  - Knowledge of surplus cash flow over time is key
  - Why not understand the value of these cash flows?

How Do We do it

- Discount net cash flows instead of liability cash flows
  - Net Cash Flow = Asset Cash Flow less Liability Cash Flow
  - Net cash flow is what gives rise to ALM risk
  - MVL = MVA – Discounted Net Cash Flow
    - Need to account for FCRC, CRNHR, and TVOG (MCEV terminology)
- Asset cash flows are default adjusted (i.e., net of credit risk)
- Positive net cash flows are discounted using credit rating of the company
  - Company can borrow today and pay in future with the positive cash flow
- Negative cash flows are discounted using assets returns expected to be invested in today to pay for the future cash flow
- When this is applied stochastically, cost of options and guarantees gets captured implicitly
  - Still need to calculate CRNHR and FCRC (MCEV terminology meaning cost of capital and double taxation)
  - Asset default assumption becomes another assumption that should be included in CRNHR

Graphical Representation

True ALM is about understanding and managing the volatility in the cash flow mismatch in all future periods (NCFs in the below graphs)



Rationale for the New Proposal

- If asset cash flows perfectly match those of liabilities in all durations and scenarios, MVL should equal MVA and liabilities' ALM metrics should match those of assets
  - This is not the case if liability discount rate is independent of assets backing them
- To the extent asset cash flows back liabilities', that portion of liabilities' risk is mitigated by the assets, resulting in a zero surplus impact
  - Risk is resulted from asset and liability cash flow mismatch since that amount is to be invested (if +ive) or divested/borrowed (if –ive)
- The discounted rate for –ive net cash flow should be what is expected to be used in investing, thus those produced by the investment document/philosophy (net of expected default charges)
- The discounted rate for +ive net cash flow should be based on company rating as company could borrow at that rate and pay its liability with +ive net cash flow
  - For simplicity, one could just use the same rate as used in –ive net cash flow for both

Benefits of the New Proposal

- Less volatile MCEV/surplus
  - Results in more acceptance of the concept
  - Assets and liabilities are valued using the same scenarios
- More appropriate investing
- Used to optimize portfolio to better match to the liabilities
  - Achieved by finding portfolios that minimize the variation of discounted NCF under various scenarios
  - Reduces C3 risk
- ALM metrics are more aligned with reality
- Reduces some modelling error from ESGs

Acceptability of the New Proposal

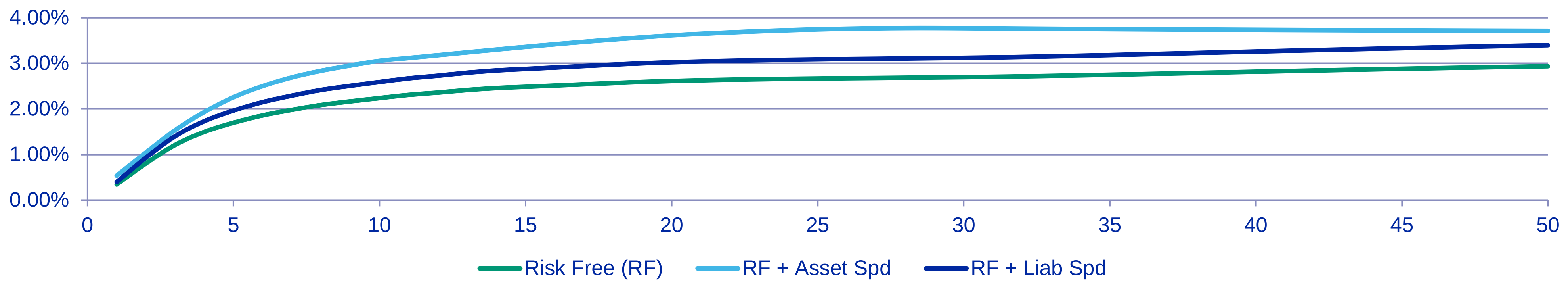
- Use of assets backing liabilities
- This is similar to CALM
  - Yet does not depend on future reinvestment strategy (only today's)
- AIA, AIG, Allianz, AVIVA, and Manulife proposed use of own assets with guard rails in the ICS valuation
- Solvency II allows for matching adjustment for liabilities with fixed cash flows
- MCEV allows to add spread to RF rate

2.4 An Example

Issues in Current Framework

The independency of discount rate between assets and liabilities in the current methodology could cause misalignment with actionable and usable ALM framework

- In the next slide we look at a perfectly matched portfolio of assets and liabilities i.e., the asset and liability cash flows are the same at all projected periods
  - While this is for illustrative purposes, this actually does happen in real world when a sold GIC is backed by the same asset from the purchaser
- The **asset's value is observed from the market** and **a discount curve is imputed** to apply to its cash flows to reproduce its market value (Risk free + Asset Spread)
  - Assume assets implied rate is ~RF + 84bps
- The **liability cash flows are discounted** at a rate independent of the imputed asset rate (Risk free + Liab Spread)
  - Assume liabilities are discounted with ~RF + 36bps
- Liability spread is thus roughly 48bps lower than the asset spread (see discount curves graph below)



Issues in Current Framework

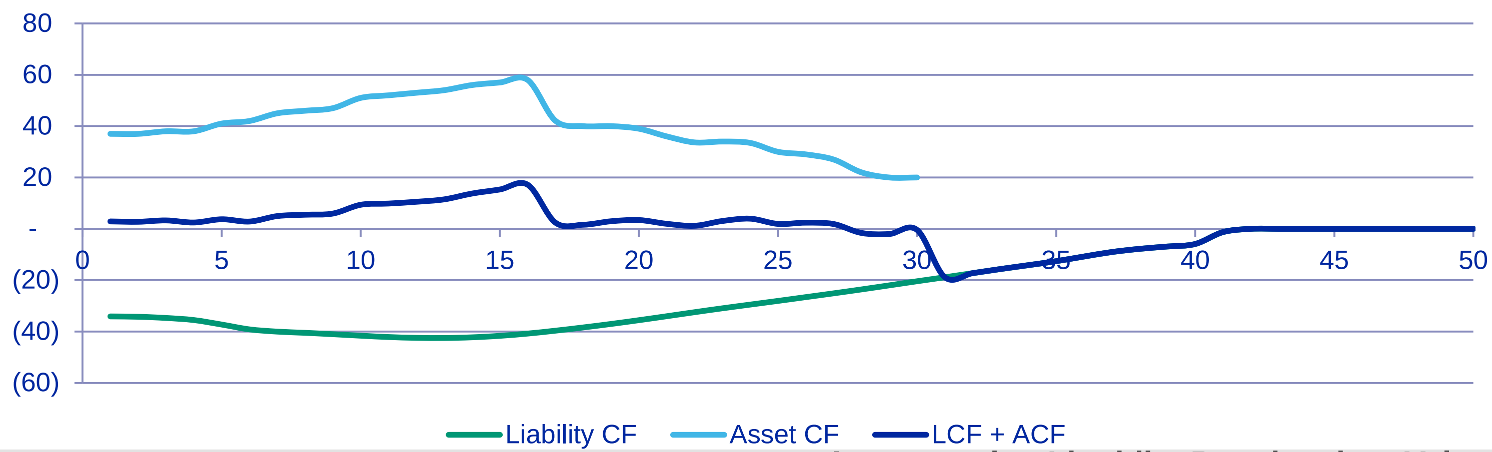
- Liability cash flows are realistic
- In this example asset cash flows match those of liabilities at all periods
- Assume assets implied rate is ~RF + 84bps, but liabilities are discounted at ~RF + 36bps
- **From market risk management perspective, all of liabilities' ALM metrics (duration, DV01, etc.) should have matched those of assets**
- **This example clearly suggests a need for aligning the discount rate of liabilities with assets'**

	Current Method			
($M)	Base Curve	Rates up 25bps	Rates up 300 bps	Rates down 25 bps
MVA (to defease LCF)	714.9	692.9	507.6	737.9
Dur Asset	12.6	12.4	10.3	12.8
Conv Asset	2.43	2.36	1.73	2.50
DV01	(0.9)	(0.9)	(0.5)	(0.9)
MVL	765.2	740.7	535.3	791.0
Dur Liab	13.2	12.9	10.8	13.4
Conv Liab	2.62	2.54	1.86	2.70
DV01	1.0	1.0	0.6	1.1
Surp	(50.4)	(47.8)	(27.8)	(53.1)
Surp DV01	0.11	0.10	0.05	0.11

Proposed Method Example

Using asset value and ALM metrics for the portion of the liability cash flows that is backed by asset cash flows, reduces the volatility of ALM metrics and allows for the alignment of ALM and MCEV

- In the next slide we look at a more realistic situation where asset cash flows (A_t) are generally higher than liabilities' (L_t) in early years but missing or lower in later years
- The asset's value is observed from the market and a discount curve is imputed to apply to its cash flows to reproduce its market value (Risk free + Asset Spread)
  - Assume assets implied rate is ~RF + 84bps
- The liability cash flows are discounted at a rate independent of the imputed asset rate ~RF + 36bps. Applied to L_t under current MCEV and to (A_t - L_t) under the proposed method
- Liability spread is thus roughly 48bps lower than the asset spread (see discount curves graph)



Proposed Method Example

- Under current methodology surplus is $13.4M and its value changes by $0.11M for 1bp interest rate increase
- Under the proposed surplus is $62.1M and its value changes by only $0.02M for 1bp interest rate increase
- Further, should rates change, there seems to be less volatility in the surplus (both in value and in DV01) under the proposed methodology

	Current Method (Discount L)						Proposed Method (Discount L – A)			
($M)	Base Curve	Rates up 25bps	Rates up 300 bps	Rates down 25 bps		($M)	Base Curve	Rates up 25bps	Rates up 300 bps	Rates down 25 bps
MVA	778.6	756.6	565.3	801.5		MV(A – L)	62.1	62.5	58.7	61.)
Dur Asset	11.5	11.4	9.9	11.7		Dur (A – L)	(2.7)	(1.6)	4.8	(4.0)
Conv Asset	1.95	1.90	1.49	1.99		Conv (A – L)	(4.71)	(4.16)	(0.97)	(5.33)
DV01	(0.9)	(0.9)	(0.6)	(0.9)		DV01 (A – L)	0.02	0.01	(0.03)	0.02
MVL	765.2	740.7	535.3	791.0		MVL	716.5	694.1	506.6	739.9
Dur Liab	13.2	12.9	10.8	13.4		Dur Liab	12.8	12.6	10.4	13.0
Conv Liab	2.62	2.54	1.86	2.70		Conv Liab	2.52	2.45	1.77	2.60
DV01	1.0	1.0	0.6	1.1		DV01	0.9	0.9	0.5	1.0
Surp	13.4	15.9	30.0	10.5		Surp	62.1	62.5	58.7	61.6
Surp DV01	0.11	0.10	0.02	0.12		Surp DV01	0.02	0.01	(0.03)	0.02

3

Methods that depend on the assets you could own

John Manistre – FSA, FCIA, CERA

An Optimization Problem – Static Control

» Start with a suitably large set of N economic scenarios $\mathcal{S}$, assume these are real world (P measure) for now

» Project *risk adjusted* liability cash flows (LCF) over each scenario and time point t. Result is an array LCF_{tA}, $A \epsilon \mathcal{S}, t = 1, \dots, T$

» 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 $HCF^{\alpha}{}_{tA}$ for each $\alpha \epsilon \mathcal{H}$

» Let Z^{α} be the observed market price of hedge instrument α

» 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

» 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_α units of each hedge instrument and form

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

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_α to minimize the total liability value

» A convex optimization problem (has nice properties)

» Let $b^*{}_\alpha$ be the optimizing portfolio weights

Set optimal value $V(LCF, Z) = W(LCF, Z, b^*)$

Static Control – Nice Properties

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

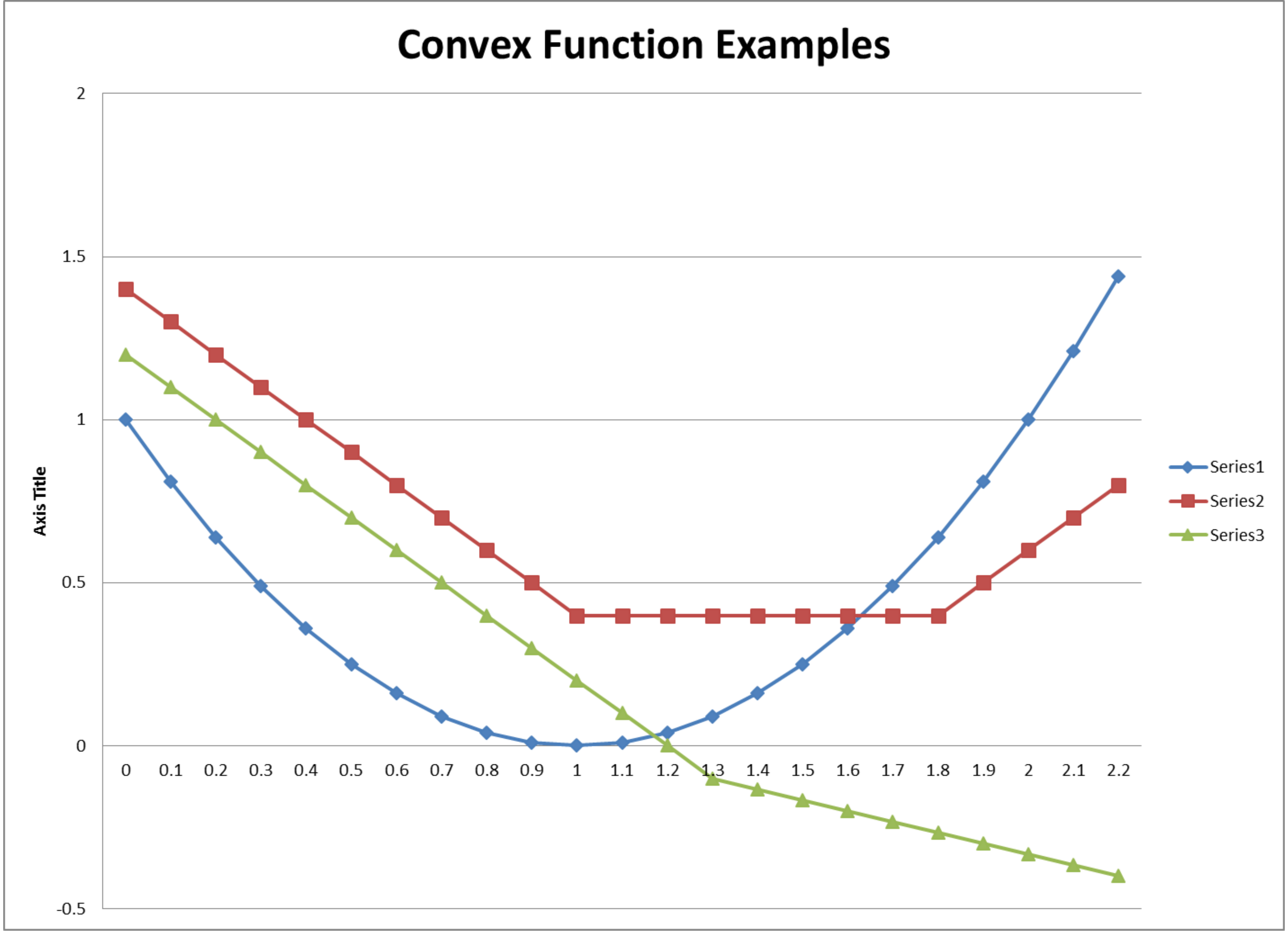
Looks complicated? This is actually a linear program in disguise! (Uraysev's Theorem)

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

Optimal value $V(LCF, Z)$ 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
Axis Title
2
1.5
1
0.5
0
-0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
Series1
Series2
Series3

Static Control – Dual Version

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

All linear programs have a dual version

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

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

Dual Constraints

$$\sum_A \lambda^A = 1, \qquad \sum_A H^\alpha{}_A \lambda^A = Z^\alpha,$$
$$0 \le \lambda^A \le \frac{1}{N(1-a)}.$$

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

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John and Dariush debate