

## Variable Capital Loads GIRO Convention

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Hilton Sorrento Palace

Martin Cairns and Richard Skelding

### Introduction

- The property insurance for CatExposed Inc. is up for renewal
- Your firm is interested in participating on both the working layer and the high excess layer
- You've been asked to supply the technical rate

### CatExposed Inc – your analysis

	Working layer	High excess layer
Expected loss	47	14
Standard deviation	46	106
Probability of a claim	71%	3%
95th Percentile	139	0
99th Percentile	192	677
99.5th Percentile	200	1,000
Technical rate	?	?



## Agenda

- Introduction
- The purposes of variable capital loads
- Methods for variable capital loads
- The impact of variable capital loads
- The pitfalls of variable capital loads
- Other Issues
- And ***Not In The Paper***, Our conclusions

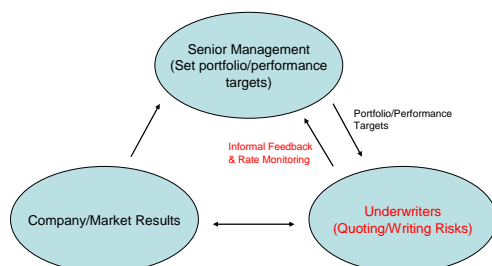
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## Purpose, Methods and Communications

- Purpose of
  - Technical Pricing
  - Capital Loadings
- Capital Loading Methodologies
- Communication Issues and Pitfalls

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## Why Technically Price?

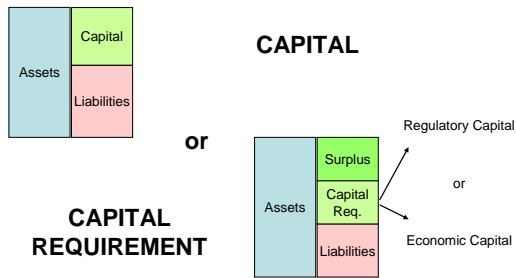


Fundamentally, technical pricing formalises price adequacy feedback to underwriters and senior management

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## What do we Mean by Capital?



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## Why Load for Capital?

- Cost of capital - provide feedback
- Total costs – ensure reflected in technical price
- Policy riskiness - formalise price allowance
- Portfolio diversification - encourage through loadings
- Risk appetite – better embed throughout the firm
- Portfolio capital efficiency – improve
- Risk mitigation strategies - encourage

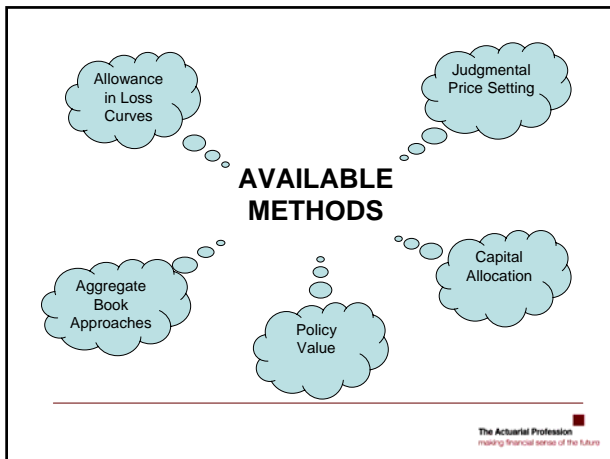
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## Linking Capital and Pricing

- Objective is for sellers and buyers to vary load in a risk consistent manner optimal to firm
- Could take account of
  - Volatility of costs
  - Potential call on capital
  - Riskiness of business (under appropriate measure)
  - Correlation of costs with rest of the portfolio
  - Correlation of costs with investors other investments (CAPM)

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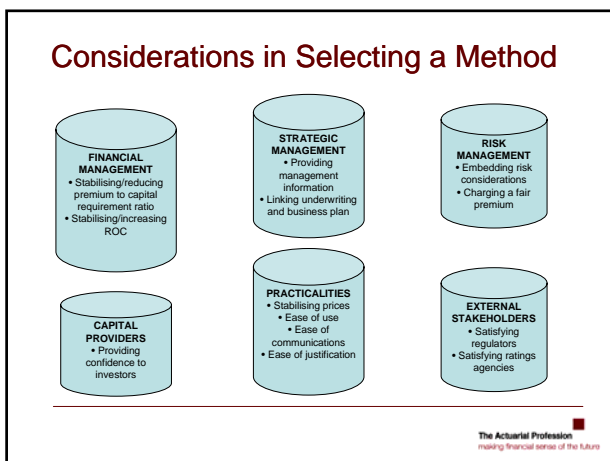
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### Judgmental Price Setting

- Price according to management led plan
  - ✓ Automatic linkage between business planning and underwriting
  - ✓ Simple to use and communicate
- Judgmental pricing at case level
  - ✗ Results are fully dependant on skill, experience and preferences of individual underwriters
- Any judgmental method
  - ✗ Provide low levels of confidence to external parties (reinsurers, regulators, ratings agencies)

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## Allowance in Loss Curves

- Implicit allowance in loss curves
- Loadings in certain parts of the loss curves
- Different loss curves use for different segments
- ✓ Easy to use and communicate
- ✓ Provides a framework for stable pricing over time
- ✗ Unlikely to fully reflect risk considerations
- ✗ Limited justification from a company financial management perspective

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## Aggregate Book Approaches

- Capital markets
- Incremental marginal capital value add
- ✓ Provides a high degree of confidence to ratings agencies, capital providers
- ✓ Straightforward to communicate methodology to stakeholders
- ✓ Improves overall capital management efficiency of firm (particularly marginal capital method)
- ✗ Pricing will vary depending on circumstances, reducing the ease of implementation

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## Policy Value

- Mean of transformed loss
  - Proportional hazard
  - Wang
- CAPM
- ✓ Provides a high degree of confidence to ratings agencies, capital providers
- ✗ Difficult to communicate to a non-technical audience

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## Communication and Pitfalls – Issues to Consider

- **Sponsorship** – Risk committee needs to oversee and is important in managing politics
- **Buy-in** - Can be a long and slow process and will vary significantly from stakeholder to stakeholder
- **Subjectivity** – The assumptions used process will be open to challenge by various stakeholders (particularly underwriters), but this can be positive process in demonstrating 'integration' to third parties
- **Incentives** – Linking capital measures to performance bonuses aids debate and internal engagement but also increases politics
- **Allocating Capital** – Requires decisions to be made as to what capital measure is used, how capital is defined and agreeing who has responsibility for managing its various components
- **International issues** – Different cultures, understanding and local legislation need to be managed
- **Professionalism** – Maintenance of professional standards whilst dealing with political pressures is a key skill

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## Understanding the impact

- This is clearly not a decision to be taken lightly
- Decision could be based on:
  - Technical qualities
  - Stability of results
  - Business's perspective of the method
  - Practicalities
- Investigated for ten methods

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## Methods tested

- Proportional spread
  - Mean
  - Tail-Value-at-Risk
- Mean of transformed loss
  - Wang
  - Proportional hazard
- Equalise relative risk
- Myers-Read
- Incremental marginal capital
- Game theory
- Apply co-measure
- Insurance capital as a shared asset

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## CatExposed Inc – your analysis

	Working layer	High excess layer
Expected loss	47	14
Standard deviation	46	106
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Technical rate	?	?

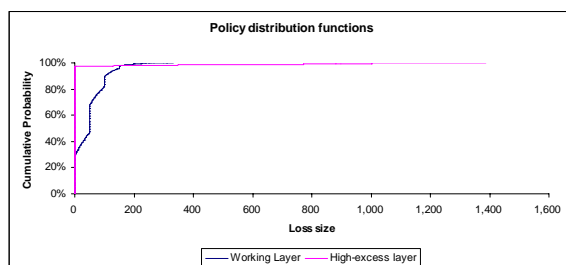
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## Example: CatExposed Inc.

- CatExposed Inc.'s risk modelled by
  - Frequency: Poisson(3)
  - Severity: LogNormal(100, 250)
- Layer Structure
  - Working: 50 xs 50 EEL
  - High Excess: 1,000 xs 1,000 EEL
- Price to achieve 50% loss ratio overall
  - Total premium target: 123.6
  - Target RoC 7% (low due to **very** small book)

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## CatExposed Inc. – Distribution functions



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### CatExposed Inc. – Mean proportional spread

	WL	HEL	Total
Mean Loss	47	14	62
Target LR	80%	50%	50%
Mean Proportional Premium	95	29	123

Premium = Mean Loss / LR

Same LR used for all policies

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### CatExposed Inc. – TVaR proportional spread

	WL	HEL	Total
Mean Loss	47	14	62
TVaR	168	294	430
RoC	7%	7%	7%
Technical Premium	55	32	87
Target Premium			123
Final Premium	78	45	123

Premium = Mean + (TVaR – Premium) \* RoC

Rescaled to get aggregate premium – needs knowledge of total

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### CatExposed Inc. – Transformed Loss

	CDF	HEL	Adjusted CDF	Adjusted PDF	Product
	A	B	C=f(A)	D=g(B/C)	E=B*D
	0.01%	0	0.00%	0.01%	0
	0.02%	0	0.01%	0.01%	0
	0.03%	0	0.02%	0.01%	0
	0.04%	0	0.02%	0.01%	0
	0.05%	0	0.03%	0.01%	0
	99.80%	1,000	98.58%	0.05%	0
	99.81%	1,000	98.63%	0.05%	1
	99.82%	1,000	98.69%	0.05%	1
	99.83%	1,000	98.74%	0.05%	1
	99.84%	1,000	98.79%	0.05%	1
	99.85%	1,000	98.84%	0.05%	1
	99.95%	1,000	99.48%	0.08%	1
	99.96%	1,000	99.56%	0.09%	1
	99.97%	1,165	99.65%	0.10%	1
	99.98%	1,565	99.75%	0.12%	2
	99.99%	2,000	99.88%	0.16%	4
			PH Technical Premium - Sum		57

CDF adjusted so more weight given to more extreme outcomes

Adjustment needs calibration

A weighted average of simulations

Guaranteed to have LR<100%

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## CatExposed Inc. – Relative Risk

Start by guessing premium

CDF	WL Claims	HEL Claims	WL Loss	HEL Loss
0.01%	0	0	0	0
0.02%	0	0	0	0
0.03%	0	0	0	0
0.04%	0	0	0	0
0.05%	0	0	0	0
28.93%	0	0	0	0
28.94%	0	0	0	0
28.95%	1	0	0	0
28.96%	1	0	0	0
28.97%	1	0	0	0
99.95%	290	1,000	228	938
99.96%	293	1,000	232	938
99.97%	299	1,165	237	1,103
99.98%	300	1,565	238	1,503
99.99%	303	2,000	241	1,938
Equalise Relative Risk Premium	62	62		
Average Loss			13	13
Average Loss per unit			0.21	0.21

Loss = Max(0, Claims – Premium)

Vary premium to get target

Vary target to get aggregate premium

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## CatExposed Inc. – Myers Read

Correlation is between policy and whole account (including that policy)

Beta is a function of CV and correlation

Asset ratio determined by beta and aggregate book dynamics

Policy	Average	CV	Corr	Beta	Asset Ratio	Capital	RoC	Premium
WL	47	98%	51%	25%	954%	-451	7%	19
HEL	14	734%	93%	346%	999%	1,450	7%	104
Total	62	197%	100%	100%	1602%	988	7%	123

Capital is average \* asset ratio

Premium calculated by RoC formula

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## CatExposed Inc. – Marginal Capital

Not the theoretical definition of incremental capital – but this is what we used

Included	Tail Results
WL Only	200
HEL Only	1,000
Both	1,050

Incremental Tail - WL	
First In	200
Last In	50
Average	125

Incremental Tail - HEL	
First In	1,000
Last In	850
Average	925

Also tried a "Game Theory" approach – specify order, but rotate through all possible starting points

Again not theoretically pure

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## CatExposed Inc. – Co-measure

CDF	Total Liabilities	HEL	Co-measure weight	Weighted HEL
0.01%	0	0	0.00	0
0.02%	0	0	0.00	0
0.03%	0	0	0.00	0
0.04%	0	0	0.00	0
0.05%	0	0	0.00	0
98.95%	743	643	0.00	0
98.96%	744	693	0.00	0
98.97%	761	675	0.01	6
98.98%	761	611	0.01	6
98.99%	790	740	0.01	7
99.00%	791	626	0.01	6
99.95%	1,173	1,000	0.01	10
99.96%	1,228	1,000	0.01	10
99.97%	1,389	1,165	0.01	11
99.98%	1,665	1,565	0.01	15
99.99%	2,240	2,000	0.01	20
TVaR Percentile	98.98%			953
		Tail Result		953
		Average		52
		RoC		7%
		Premium		73

Included if total claims CDF > 98.98%

Weights sum to 100%

Weighted average outcome feeds tail result

Premium set by RoC

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## CatExposed Inc. – Shared Asset

Set the target rental and consumption premium

Total Claims CDF	WL Claims	HEL Claims	Total Claims	Drawdown amounts	Consumption charges
0.01%	0	0	0	0	0
0.02%	0	0	0	0	0
0.03%	0	0	0	0	0
0.04%	0	0	0	0	0
0.05%	0	0	0	0	0
98.95%	62	62	62	0	0
98.96%	62	62	62	0	0
98.97%	62	62	62	0	0
98.98%	62	62	62	0	0
98.99%	62	62	62	0	0
99.00%	62	62	62	0	0
99.95%	62	62	62	0	0
99.96%	62	62	62	0	0
99.97%	62	62	62	0	0
99.98%	62	62	62	0	0
99.99%	62	62	62	0	0
100.00%	62	62	62	0	0
For Loss > 2 EL	168.20%	0.88%	62	62	1
Actual Consumption Profit Load	31	179	1,179	1,117	1,780
		228	1,000	1,165	1,861
		224	1,165	1,389	2,129
		100	1,565	1,460	2,589
		240	2,000	2,179	3,544
				Total	31

Utility weighting for cost of capital consumption

Drawdown is claims – mean (minimum of 0)

Rental charge a weighting on average

Consumption costs allocated to policies

Apply utility weights

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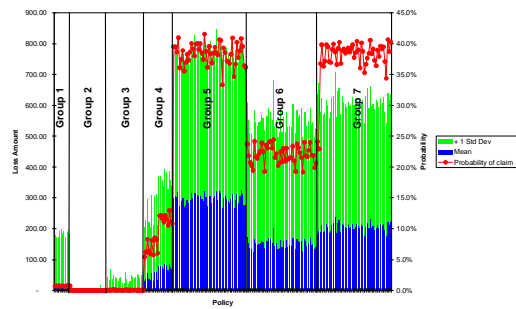
## CatExposed Inc. – Comparison

	WL	HEL
Mean Proportional	95	29
TVaR Proportional	78	45
PH Transform	67	57
Wang Transform	73	50
Equalise Relative Risk	62	62
Myers-Read	19	104
Marginal Capital	52	71
(TVaR) Co-measure	73	50
Shared Asset	82	41

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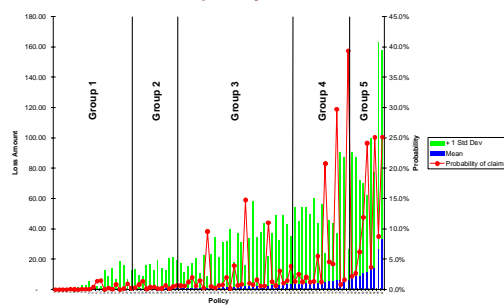


## The data – Credit Risk dataset



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## The data – Property D&F dataset



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## The data - summary

Data Summary - Credit Risk			
Group	No. of Policies	Average Mean Loss	Average St Dev of Loss
1	11	11.3	173.1
2	25	0	1.0
3	25	0.9	41.1
4	20	60.3	246.8
5	50	298.6	475.5
6	48	152.4	398.3
7	51	205.9	404.7
Total	230	148.3	310.5

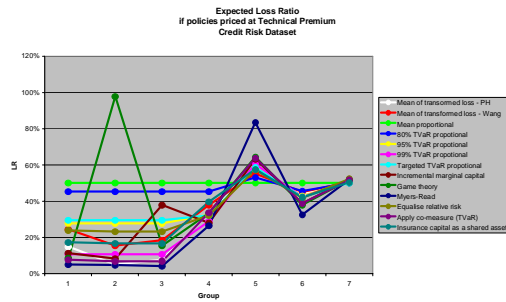
  

Data Summary - D&F Property			
Group	No. of Policies	Average Mean Loss	Average St Dev of Loss
1	21	0.1	5.6
2	12	0.5	14.8
3	30	1.8	27.8
4	15	5.0	46.7
5	9	15.0	82.8
Total	87	3.1	29.6

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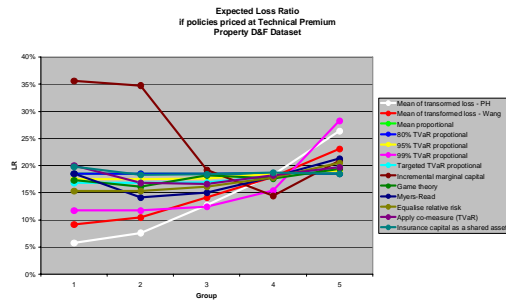


## Technical premium loss ratios – Credit risk



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## Targeted loss ratios – Property D&F



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## Stability of RoC – Credit risk

Change in Expected Return on Capital following non-renewal of a Group Credit Risk Dataset								
Group	1	2	3	4	5	6	7	Average movements
Method								
Mean of transformed loss - PH	+0.4%	-0.0%	-0.1%	-0.1%	-2.3%	+3.0%	-0.1%	<b>+0.8%</b>
Mean of transformed loss - Wang	+0.6%	-0.0%	<b>-0.9%</b>	+0.2%	-3.3%	+3.4%	-0.3%	<b>+1.1%</b>
Mean proportional	<b>+8.9%</b>	<b>-0.0%</b>	<b>+0.1%</b>	<b>+8.9%</b>	<b>-5.7%</b>	<b>+5.4%</b>	-0.4%	<b>+1.5%</b>
80% TVaR proportional	+0.8%	-0.0%	+0.1%	+0.6%	-4.2%	+3.7%	-0.4%	<b>+1.4%</b>
95% TVaR proportional	+0.7%	-0.0%	+0.0%	-0.2%	-2.2%	+2.5%	-0.3%	<b>+0.8%</b>
99% TVaR proportional	+0.1%	-0.0%	-0.1%	-0.5%	-1.1%	+2.2%	<b>-0.1%</b>	<b>+0.6%</b>
Targeted TVaR proportional	+0.7%	-0.0%	+0.0%	-0.2%	-1.8%	+2.2%	<b>-0.4%</b>	<b>+0.8%</b>
Incremental marginal capital	+0.2%	-0.0%	+0.0%	-0.6%	<b>-0.9%</b>	+0.5%	+0.3%	<b>+0.2%</b>
Game theory	<b>-0.1%</b>	-0.0%	-0.0%	-0.1%	+0.3%	<b>-0.1%</b>	+0.3%	<b>+0.1%</b>
Myers-Read	<b>-0.8%</b>	<b>-0.0%</b>	<b>-0.3%</b>	<b>-0.6%</b>	<b>+5.6%</b>	<b>-3.3%</b>	+0.4%	<b>+1.6%</b>
Equilise relative risk	+0.6%	-0.0%	+0.0%	-0.2%	-2.4%	+2.5%	<b>-0.3%</b>	<b>+0.9%</b>
Apply co-measure (TVaR)	-0.2%	-0.0%	-0.1%	<b>-0.1%</b>	+0.1%	+0.5%	+0.5%	<b>+0.2%</b>
Insurance capital as a shared asset	+0.5%	-0.0%	-0.0%	+0.3%	-2.2%	+2.2%	-0.3%	<b>+0.8%</b>

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## Stability of RoC – Property D&F

Change in Expected Return on Capital following non-renewal of a Group Property D&F Dataset						
Group	1	2	3	4	5	Average movement
Method						
Mean of transformed loss - PH	-0.0%	-0.4%	-3.2%	-0.9%	+5.4%	+2.1%
Mean of transformed loss - Wang	-0.2%	-0.9%	-2.1%	-1.1%	+2.6%	+1.2%
Mean proportional	+0.0%	+0.6%	+0.1%	-0.7%	-2.5%	+0.8%
90% TVaR proportional	+0.0%	+0.6%	+0.1%	-0.7%	-2.5%	+0.8%
95% TVaR proportional	+0.0%	+0.5%	-0.3%	-0.8%	-1.8%	+0.7%
99% TVaR proportional	-0.1%	+0.2%	-3.4%	-2.8%	+3.7%	+2.6%
Targeted TVaR proportional	-0.0%	+0.5%	-0.6%	-1.0%	-1.0%	+0.6%
Incremental marginal capital	+0.2%	+0.9%	+0.4%	-3.7%	+0.3%	+1.1%
Game theory	+0.0%	+0.5%	-0.9%	-1.3%	-1.4%	+0.6%
Myers-Riad	+0.0%	+0.3%	-1.6%	-1.1%	+0.8%	+0.8%
Equalize relative risk	-0.0%	+0.4%	-1.0%	-1.2%	-6.1%	-5.9%
Apply co-measure (TVaR)	+0.1%	+0.5%	-0.7%	-1.0%	-1.0%	+0.6%
Insurance capital as a shared asset	+0.1%	+0.5%	-0.1%	-0.6%	-5.5%	+0.8%

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## Price elastic market – Credit risk pairwise comparison

Return on Capital											
	Mean of transformed loss - PH	Mean of transformed loss - Wang	Mean proportional	90% TVaR proportional	95% TVaR proportional	99% TVaR proportional	Targeted TVaR proportional	Incremental marginal capital	Game theory	Myers-Riad	Apply co-measure (TVaR)
Mean of transformed loss - PH											
Mean of transformed loss - Wang											
Mean proportional											
90% TVaR proportional											
95% TVaR proportional											
99% TVaR proportional											
Targeted TVaR proportional											
Incremental marginal capital											
Game theory											
Myers-Riad											
Apply co-measure (TVaR)											
Insurance capital as a shared asset											
Profits											
	Mean of transformed loss - PH	Mean of transformed loss - Wang	Mean proportional	90% TVaR proportional	95% TVaR proportional	99% TVaR proportional	Targeted TVaR proportional	Incremental marginal capital	Game theory	Myers-Riad	Apply co-measure (TVaR)
Mean of transformed loss - PH											
Mean of transformed loss - Wang											
Mean proportional											
90% TVaR proportional											
95% TVaR proportional											
99% TVaR proportional											
Targeted TVaR proportional											
Incremental marginal capital											
Game theory											
Myers-Riad											
Apply co-measure (TVaR)											
Insurance capital as a shared asset											

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## Price elastic market – Property D&F pairwise comparison

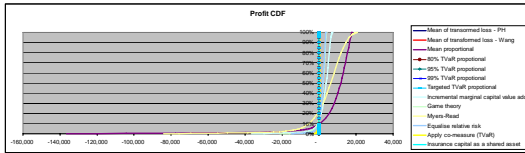
Return on Capital											
	Mean of transformed loss - PH	Mean of transformed loss - Wang	Mean proportional	90% TVaR proportional	95% TVaR proportional	99% TVaR proportional	Targeted TVaR proportional	Incremental marginal capital	Game theory	Myers-Riad	Apply co-measure (TVaR)
Mean of transformed loss - PH											
Mean of transformed loss - Wang											
Mean proportional											
90% TVaR proportional											
95% TVaR proportional											
99% TVaR proportional											
Targeted TVaR proportional											
Incremental marginal capital											
Game theory											
Myers-Riad											
Apply co-measure (TVaR)											
Insurance capital as a shared asset											
Profits											
	Mean of transformed loss - PH	Mean of transformed loss - Wang	Mean proportional	90% TVaR proportional	95% TVaR proportional	99% TVaR proportional	Targeted TVaR proportional	Incremental marginal capital	Game theory	Myers-Riad	Apply co-measure (TVaR)
Mean of transformed loss - PH											
Mean of transformed loss - Wang											
Mean proportional											
90% TVaR proportional											
95% TVaR proportional											
99% TVaR proportional											
Targeted TVaR proportional											
Incremental marginal capital											
Game theory											
Myers-Riad											
Apply co-measure (TVaR)											
Insurance capital as a shared asset											

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## Price elastic market – Credit risk all methods comparison

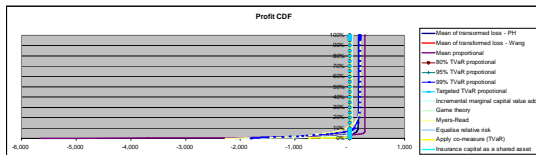
	Mean proportional	Incremental marginal capital value	Game theory	Myers-Read	Equalise relative risk	Apply co-measure (TVaR)
Premium Income	17,489	6,933	3,935	21,639	3,512	369
Expected Loss Ratio	50%	57%	58%	75%	53%	52%
Expected Profits	8,718	2,965	1,651	4,605	1,680	178
Capital Requirement	84,833	21,455	10,495	59,095	10,106	1,787
Capital Ratio	485%	309%	267%	273%	288%	485%
Expected Return on Capital	10%	14%	16%	8%	16%	10%



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## Price elastic market – Property D&F all methods comparison

	Mean of transformed loss - PH	Mean proportional	99% TVaR proportional	Incremental marginal capital value	Game theory	Myers-Read	Apply co-measure (TVaR)
Premium Income	155	275	161	39	16	186	15
Expected Loss Ratio	22%	19%	42%	57%	26%	49%	30%
Expected Profits	121	224	95	16	8	88	11
Capital Requirement	1,883	2,320	1,705	1,123	248	1,501	465
Capital Ratio	1086%	844%	1021%	3029%	2375%	851%	3023%
Expected Return on Capital	7%	10%	6%	1%	3%	6%	2%



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## Other issues

- The market cycle
- Marginal capital
- Updating and communicating methods and parameters
- Risk profiles
- Reinsurance
- Risk appetite
- Tax
- Length of tail
- Mergers and acquisitions; group and market considerations

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## Conclusions

- Can variable capital loads be beneficial?
  - Yes
- Can they be implemented
  - Depends on data, but generally yes
- Is it easy to do?
  - It's not difficult
- Is this a solved problem
  - Not by a long way
- Conclusion: Can be a useful addition to a well-structured pricing process, but needs care

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## Some future thoughts

- What have we learnt?
  - Horses for courses
  - Don't forget the simple things
- What surprised us?
  - Magnitude of differences
  - Mean proportional performance
- What else could be done?
  - More work – confirm our findings (or otherwise)
  - Assess value in more homogenous classes
  - What effect does the backwards looking parameterisation have?

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