



Institute
and Faculty
of Actuaries

Underwriting Risk Charge Calibration – Standard Formulas

Allan Kaufman
on behalf of the
Casualty Actuarial Society (CAS)
Risk Based Capital (RBC)
Dependencies and Calibration
Working Party (DCWP)



Background

Purpose of Presentation

- This session is based on research regarding the calibration of Underwriting (UW) Risk Charges for the US NAIC Risk-Based Capital (RBC) Formula
- For this GIRO audience, we select a number findings from our US data that might also be interesting from a Solvency II (S2) Standard Formula perspective
- We discuss RBC/S2 Standard Formula differences **ONLY** to the extent necessary to explain calibration issues

Introduction

- “We,” in this presentation = Dependencies and Calibration Working Party (DCWP) of the CAS
 - Researching methods for calibrating P&C RBC parameters,
 - Particularly underwriting and reinsurance risks.
 - Many work streams, many contributors (see final slides)
- Caveats
 - The analysis is solely the responsibility of DCWP members and not that of their employers, the CAS or the American Academy of Actuaries
 - Presentation assumes the audience has a working knowledge of Standard Formulas
- Interim results have been published in the CAS E-Forum
- More complete results will be published in a CAS Monograph

Data

14 Annual Statements (1997-2010)

- 24 accident years
- 23 years of reserve runoff, up to age 10 years
- By company, 2,700 companies, in total across all Lines of Business (LOBs) & years

- Premium risk

- Premium and L&LAE ratios by LOB company and year, e.g.
 - 14,000 data points for PPA
 - 3,500 for med malp occurrence

Schedule P Part 1			
Net Loss and Loss Expense Percentage			
	Co A	Co B	Co C
1988	0.222	0.656	0.387
1989	0.771	0.602	1.023
1990	0.506	1.052	0.746
1991	0.393	0.899	0.259
1992	0.526	1.161	0.784
1993	0.797	0.993	0.356
1994	1.021	0.814	0.231

- Reserve risk

- Reserve Runoff Ratios by LOB, company, initial reserve date
 - 13,000 data points for PPA
 - 4,000 for med malp occurrence

Statement	Initial Date	Initial Inc'd	Latest Inc'd	Runoff Ratio
2010	2010	10,282	10,249	0%
2010	2009	10,338	9,556	-8%
2010	2008	10,363	9,622	-7%
2010	2007	10,569	10,285	-3%
2010	2006	10,975	11,391	4%
2010	2005	10,609	10,473	-1%
2010	2004	10,435	9,965	-5%
2010	2003	10,903	10,488	-4%
2010	2002	10,695	10,058	-6%
2010	2001	10,350	10,710	3%
2010	PRIOR	10,034	10,119	1%
2009	2000	10,152	9,262	-9%
2009	PRIOR	10,436	9,821	-6%
2008	1999	10,392	9,717	-6%

Data – DCWP vs. S2 UW Calibration Data

Sample Characteristics

Data item	DCWP Calibration	S2 Calibration (1)
Completeness	100% of companies (2)	68% of companies writing 85% of premium with 95% of reserves
Number of companies	2,500	1,500 (3)
# of LOB/Company/Year Data Points	Over 120,000	Under 30,000 (4)
LOB homogeneity	Long-standing LOB definitions	LOB definitions created specifically for S2 Calibration
Data Quality	Public data subject to audit review	Confidential survey subject to reasonableness checks
“Survivorship” Considered	Yes	No

Data – Notes for Chart on Prior Page

- **Notes:**
- Note 1 - Characteristics of S2 UW risk calibration data from:
 - EIOPA, including “Report on fifth Quantitative Impact Study (QIS5) for S2” and
 - “Joint Calibration of the Premium and reserve risk Factors in the Standard Formula of S2, Report of the Joint Working Group on Non-Life and Health NSLT Calibration”, 12 December 2011
- Note 2 – All companies that file a NAIC Annual Statement. There are a small number of companies that do not make those filings.
- Note 3 – 1,500 companies provided data. Not all of the data was usable.
- Note 4 – Estimate from average years per LOB and maximum number of premium or reserve LOB/company data points.
- **Other Comparisons:**
- 23 years of Loss Ratio data for RBC Calibration; Average 10 years and at most 20 years for S2.
- DCWP Volume \$7.3 trillion in premium, including \$418 billion in 2010. \$8.7 trillion in initial reserves including \$548 billion at year-end 2009. S2 values not available to us.
- AY years/initial reserves dates 1987-2010 for DCWP (23 years) and 1990-2009 for S2 (20 years).

RBC Formula: UW Risk Charge Calculation – Very Brief Overview

- Factors applied to net premium and net reserves by LOB
 - Premium Risk Factors (PRFs)/ Reserve Risk Factors (RRFs)
 - Investment Income Adjustment
- LOB Diversification Credit for multi-line companies
- Other UW Elements in RBC Formula:
 - own-company experience, loss sensitive contract credit, ‘growth risk’ charge, own-company expenses (for premium risk), a portion of reinsurance ‘credit risk’ applied to UW risk.

RBC Formula: Calibration Target

- RBC is a Minimum Standard
 - Company must increase capital, reduce risk or cease operations if it falls short of RBC
 - Satisfying RBC does not provide a ‘passport’ for cross-state business
- Risk Factors Calibrated to 87.5th Percentile
 - Lower calibration target than S2, which operates as ‘passport.’
 - RBC calibration is based on observed percentiles, while S2 calibration is based on “multiple of standard deviations.”
 - Premium – For RBC, historical profitability is an offset to risk charge;
S2 includes company current year projected profitability in capital levels.
 - Reserves - RBC calibration reflects historic bias in reserve adequacy;
S2 risk charges do not.

Selected Findings-1

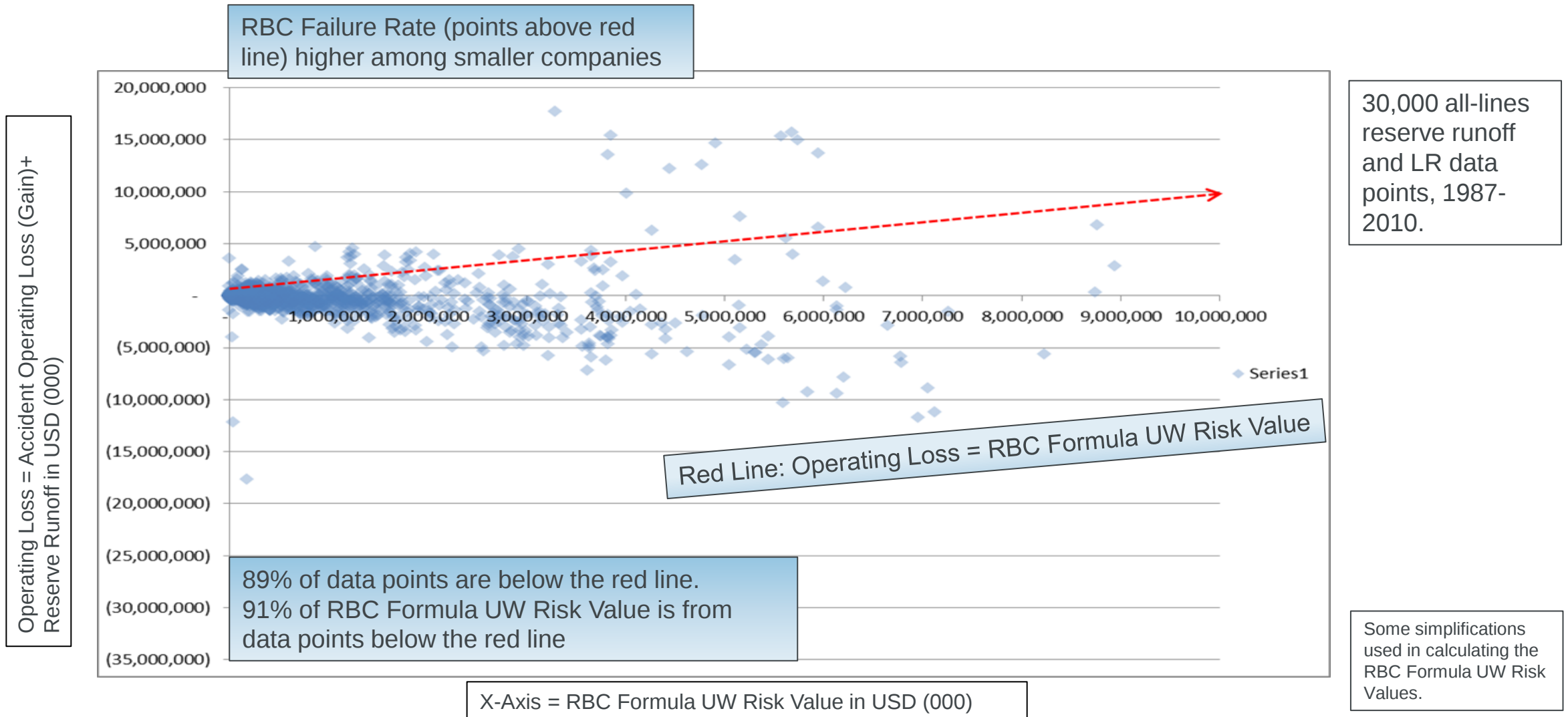
1. Actual vs. Expected	A test of achieved safety level Overall and by risk characteristic
2. Diversification Calibration	A data-driven calibration of indicated diversification credits
3. Diversification Credits - RBC vs. S2	Less difference than expected between correlation matrix and RBC's approach
4. Risk versus Interest Rate Environment	Data suggests risk varies with interest rate, [Although, even 30 years of data is not enough to confirm a relationship.]

Selected Findings-2

5. Risk Increases with Increasing Reinsurance Usage	Risk per unit of net exposure INCREASES as Reinsurance Usage increases
6. Time Horizon	Observed one-year reserve runoff may not properly calibrate the One-Year Time Horizon on reserve risk
7. LOB risk factor considerations	Size Matters - Not surprising... but it's not just "law of large numbers" Type of Company matters – Especially significant for specialty LOBs "Minor Lines" – A new risk characteristic

1. Actual Risk vs. Expected Risk

1. Actual Risk versus Expected Risk from RBC Formula



1. Actual vs. Expected

“RBC Failure” Rate by Company Size Band

- RBC Formula does not reflect company size, even though risk varies with size
- Therefore, not surprisingly, the observed risk of “RBC Failure” is much higher for smaller companies than for larger companies:

Size Band	Upper Size (\$millions)	"RBC Failure" Rate	
		By dollars	By Counts
0-20%	4	14.2%	16.4%
20-40%	15	12.4%	12.6%
40-60%	50	10.0%	10.0%
60-80%	203	8.6%	8.6%
80-100%	75,000	8.7%	8.5%
All		8.7%	11.2%

Size = AY NEP + initial reserve

RBC UW Failure Rate = 100%
minus UW Safety Level

16.4% RBC Failure for smallest quintile
of companies.
8.5% for largest quintile of companies.
11.2% average for all companies.

1. Actual vs. Expected – Actual Failure Rate well below RBC Failure because:

Actual Capital is well above RBC level, even more so for smaller companies:

Asset Size (millions)		Ratio of Actual Capital to RBC:
From	To	
0	10	8.6
10	25	7.9
25	100	5.5
100	250	4.4
250	500	4.5
500	1000	3.9
1000	10000	3.6
10000	over	2.8
All		5.2

Small company capital ratio:

- Larger than average, 5.2,
- 3 times the large company capital ratio, 2.8

Average Capital is 5.2
times RBC

2. Diversification –

RBC CoMaxLine⁰% vs Correlation Matrix

2. Diversification Credit - RBC and S2 Formulas

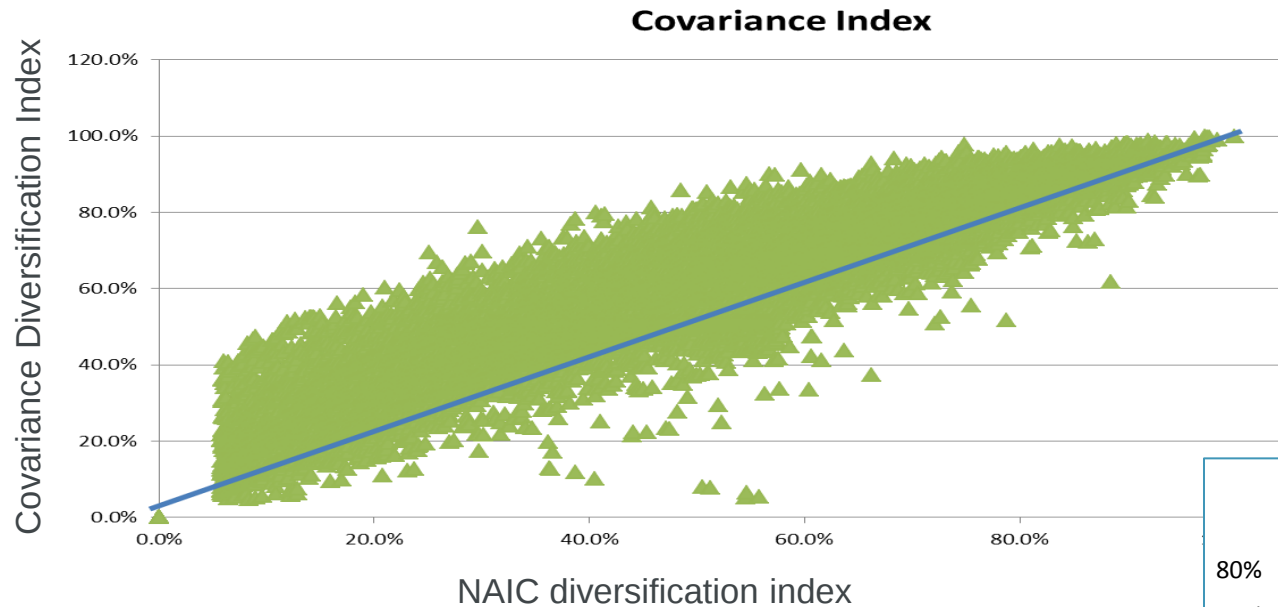
RBC Formula:

- $\text{CoMaxLine\%} = \{\text{Volume from largest LOB}\} / \{\text{Total Volume}\}.$
- $\text{Diversification Credit} = 0.30 * (1 - \text{CoMaxLine\%}).$
 - 1-CoMaxLine% is the “Diversification Index”
- Examples:

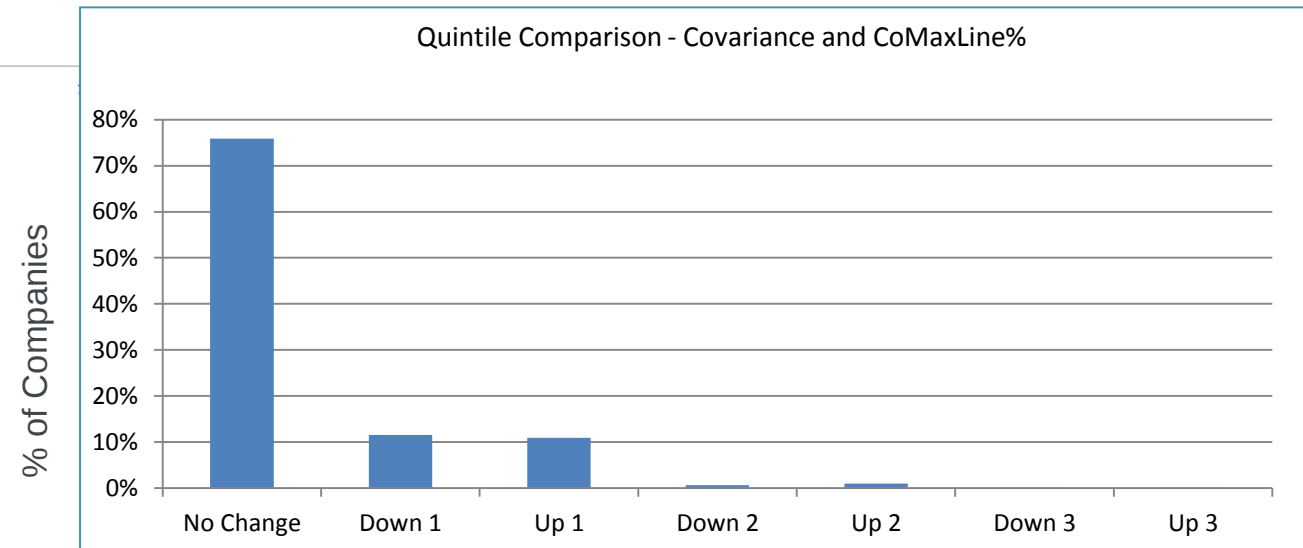
LOB Distribution	Diversification Credit	
	CoMaxLine%	Correlation
100% one LOB	0%	0%
70% one LOB/30% in, say 2 further LOBs	9%	21% to 35%
Equally divided among 12 LOBs	28%	59%

2. Covariance vs. NAIC

Both Diversification Metrics Rank Companies Similarly



Even through RBC and S2 diversification credits are different, each ranks companies similarly.



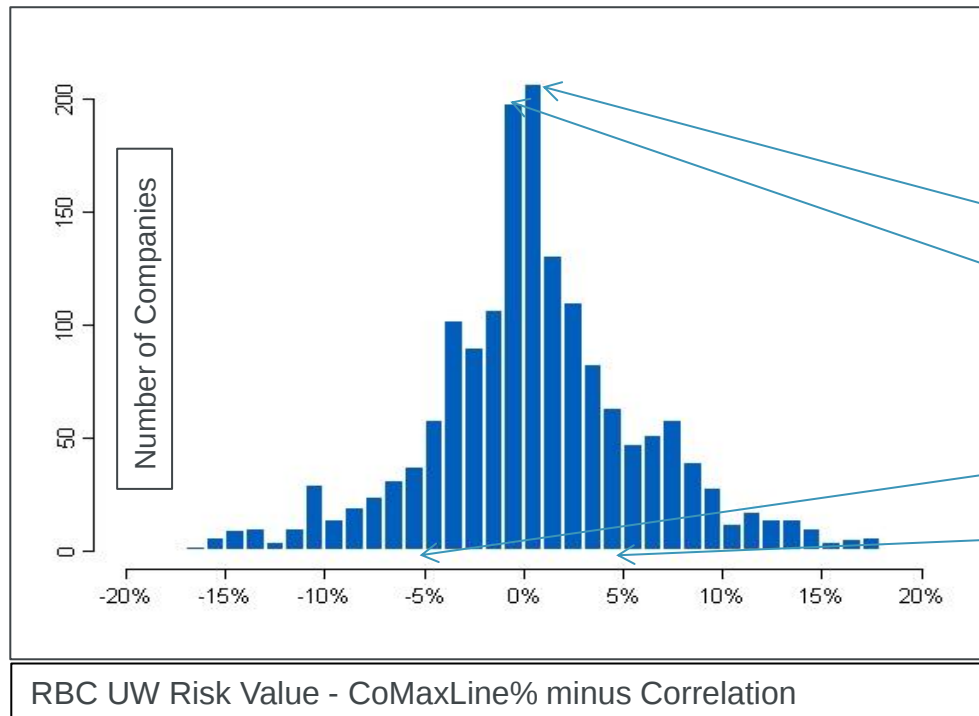
2. Covariance vs. NAIC

UW RBC Risk Values are Similar

2010 RBC UW Risk Value Differences by Company

Distribution of Number of Companies

Correlation matrix approach versus CoMaxLine% Approach (37.6% MDC)
(Multi-line Companies)



Histogram does not include 32% of companies with zero RBC UW Risk Values.

24% of multi-line companies (including 22% of total multi-line RBC Value) within $\pm 1\%$.

69% of multi-line companies (including 78% of multi-line RBC Value) within $\pm 5\%$.

Differences are $> \pm 10\%$ for only 10% of companies (with 9% of RBC UW Risk Value).

3. Diversification – Indicated Diversification Credit

3. Diversification Analysis

Indicated Average Diversification Credit

Indicated Average Diversification
(Excluding smallest companies/Excluding Monoline Companies)

Item	Premium	Reserves
1. Observed Risk - 87.5th AYUL/RRR	17.8%	27.2%
2. Modeled Risk – Apply RBC Formula before diversification	25.0%	34.2%
3. Indicated Diversification Credit 1.0-(1)/(2)%	28.8%	20.6%
4. Current Average Diversification Credit	13.3%	9.9%
5. Indicated Change in Average Diversification Credit	116%	108%
6. Indicated Maximum Diversification Credit	65%	62%

Note: Lines 1-5 of this calculation apply to ANY diversification formula.

3. Diversification Analysis

Calibration Framework

The calibration in the prior slide might seem to be an unexpected approach to measuring diversification.

That is because there are important differences between calibrations of individual company capital models and Standard Formulas. We find it useful to think about those differences as being analogous to the differences between individual risk rating and manual ratemaking.

Individual Company Capital Modeling - Risk Theory

- Company specific risk parameters
- Risk charges relate to risks underwritten by the insurer, with adjustments for risk mitigation.

Standard Formulas –Manual Ratemaking and Risk Classification Approach

- Data from many insureds are combined.
- The risk charges are those associated with companies having similar risk characteristics.
- The risk charges in a Standard Formula may not operate in the same way as risk characteristics in individual company models.
 - Increased reinsurance usage → higher risk charges, as % of net premium/reserves, on average
 - LOB diversification → affected by benefits of specialization for companies with limited diversification
- The diversification analysis on the prior slide follows a manual ratemaking perspective and provides a measure of the diversification credit that will match the experience, after considering LOB and other risk factors in the RBC Formula.

3. Diversification Analysis

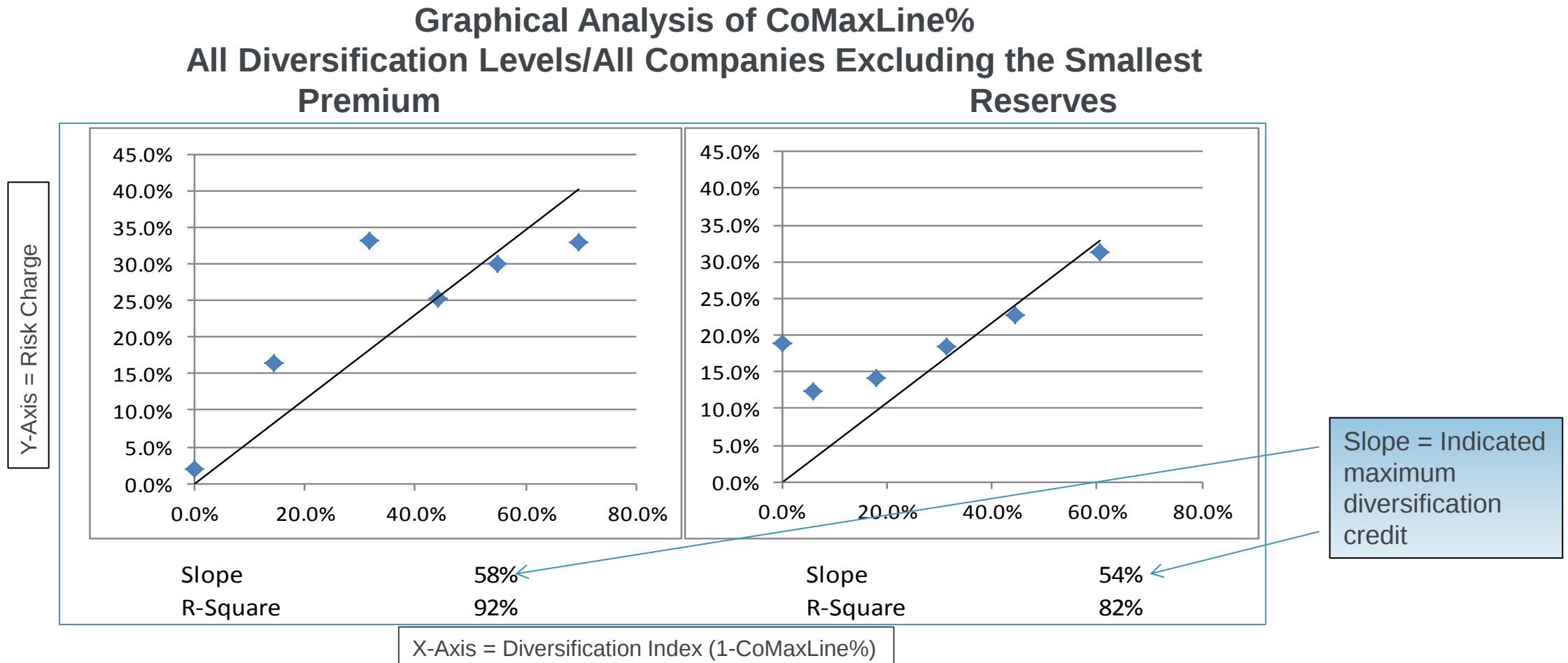
Is Indicated Credit Linear with CoMaxLine%?

- Divide companies by diversification band
 - 6 diversification bands, (0 = mono-line; 1 = most concentrated multi-line 20%, ... 5= most diversified 20%)
 - Slide 21 examined all 6 bands combined.
- Calculate 87.5th %ile all-LOB PRC% / RRC% for each cell
 - Indicated diversification credit is ratio of indicated risk charge vs. RBC formula risk charge before diversification credit.
 - If no diversification effect, indicated risk charge %s are constant regardless of diversification.
 - Decreasing indicated risk charge %s with increasing diversification denotes diversification benefit.

3. Diversification Analysis – Indicated Credit is Linear with respect to CoMaxLine%

	Premium			Reserves		
	1	2	3	4	5	6
Div. Band	Avg Div. Index (1-CoMaxLine%)	Indicated Credit	Fitted Credit	Avg Div. Index (1-CoMaxLine%)	Indicated Credit	Fitted Credit
0	0.0%	1.9%	0.0%	0.0%	18.8%	0.0%
1	14.5%	16.5%	8.3%	5.8%	12.4%	3.2%
2	31.8%	33.1%	18.4%	18.1%	14.2%	9.9%
3	44.2%	25.3%	25.5%	31.5%	18.4%	17.2%
4	55.0%	30.1%	31.7%	44.5%	22.7%	24.2%
5	69.4%	33.0%	40.1%	60.5%	31.2%	32.9%
	Slope		58%	Slope		54%
	R-Squared		92%	R-Squared		82%

3. Diversification Analysis – Indicated Credit is Linear with respect to CoMaxLine%



3. Diversification Analysis – Assessment of CoMaxLine%

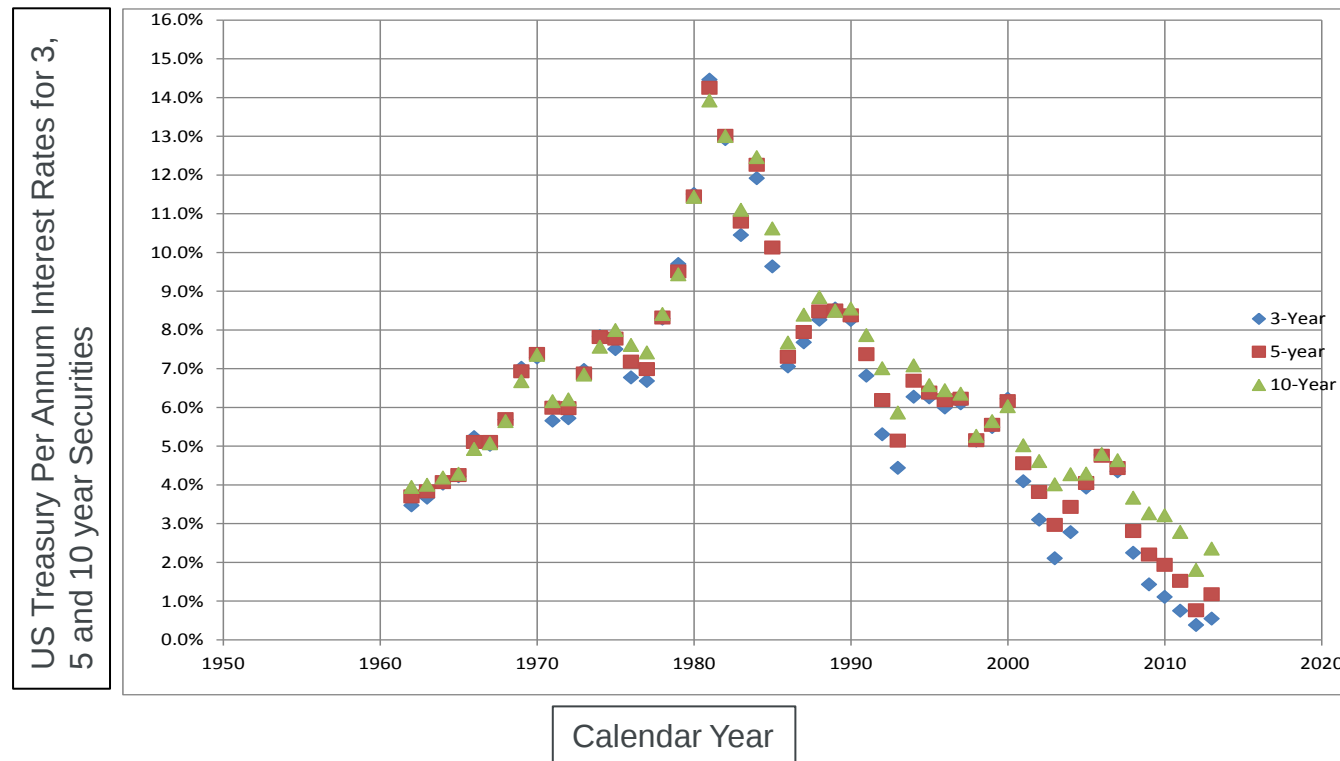
Overall Findings

- The linear relationship between diversification credit and 1.0-CoMaxLine% in CoMaxLine% Approach is a reasonable approximation, especially for the more diversified companies.
- For the smaller or less diversified multi-line companies, the linear relationship does not apply, at least in part, because of variation in LOB risk charges with increasing company-diversification.
- A Maximum Diversification Credit of at least 50% is better supported by the data than the current 30% maximum.

4. Risk Charges Vary With Interest Rate Environment

4. Interest Rate History

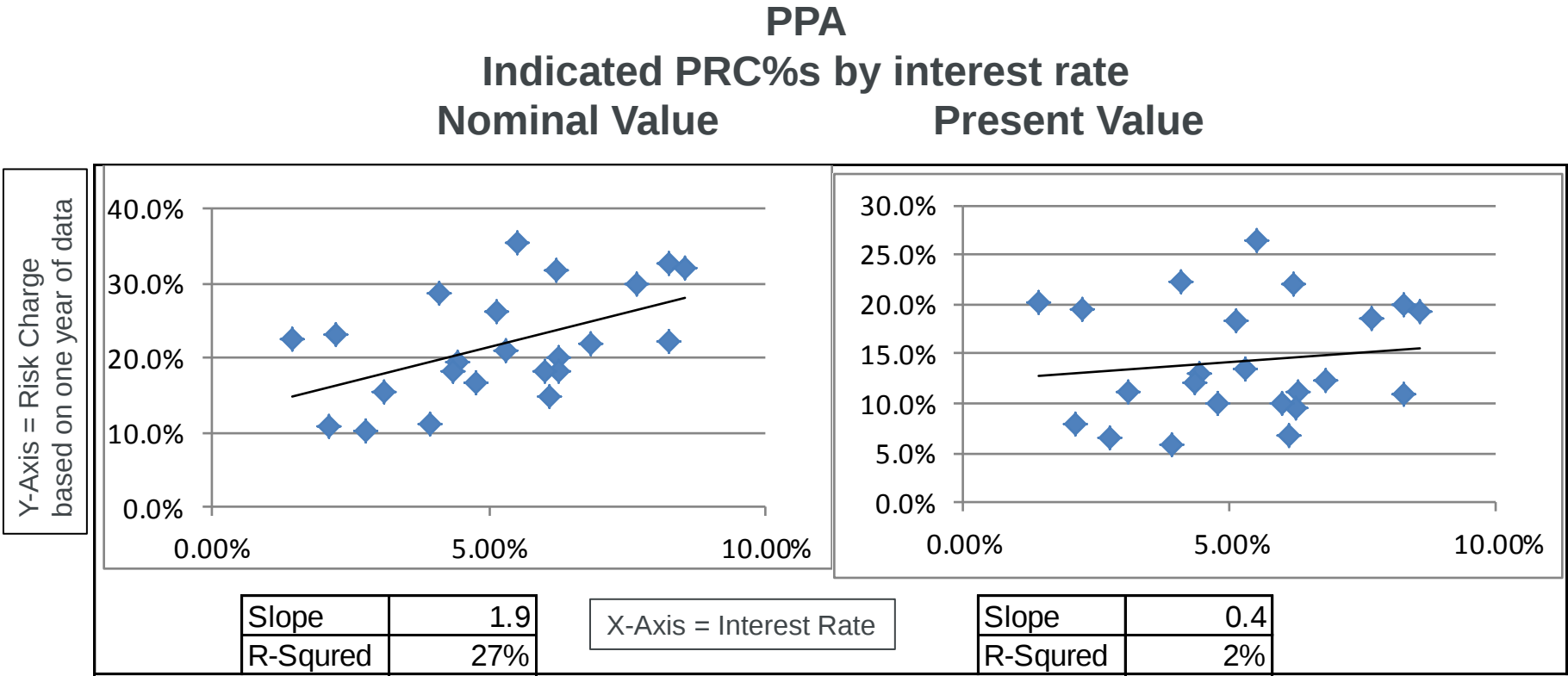
Annual Interest Rates by Year- 1962-2013
US Treasury Bonds / Durations of 3 years, 5 years and 10 years



4. Investment Income Approach

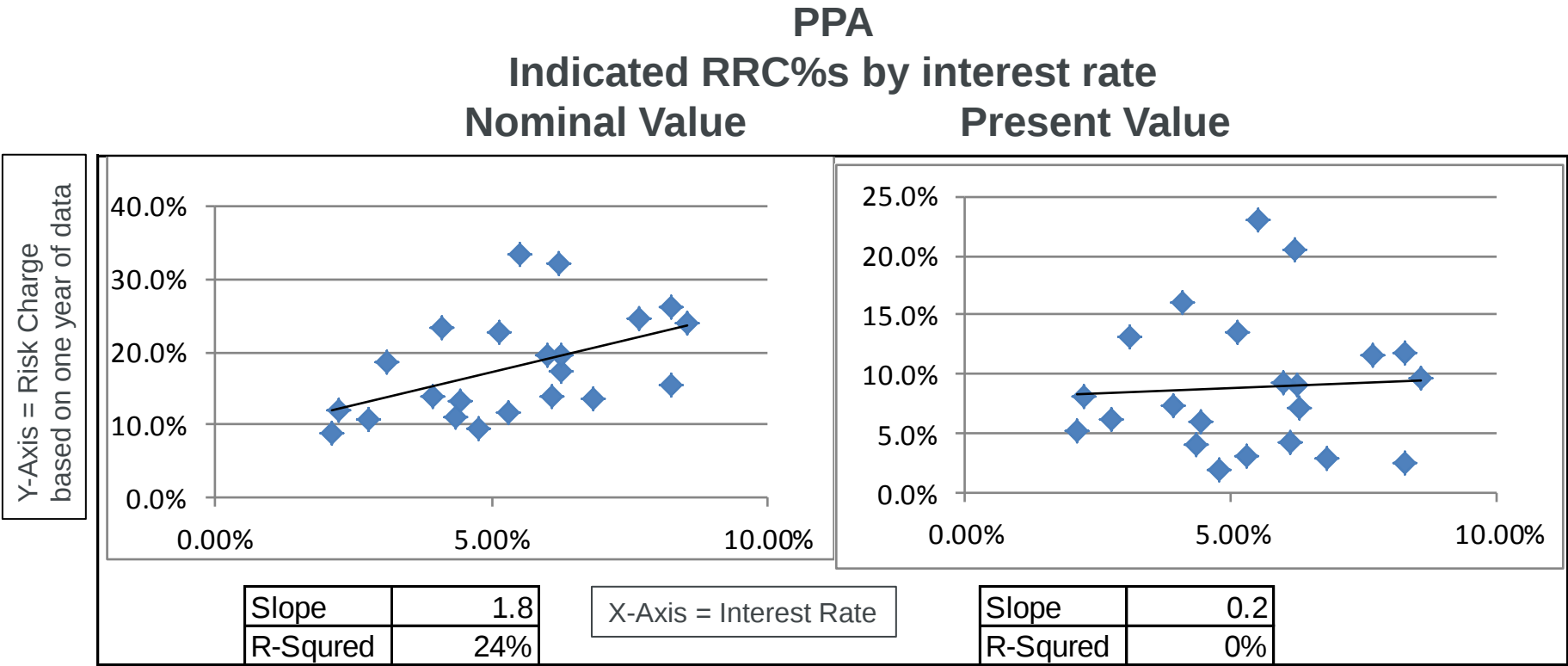
- Nominal Value Approach (NVA)
 - Calibrate nominal risk factors and separately determine effect of investment income
 - Assumes risk and interest rates are independent
- Present Value Approach (PVA)
 - Calibrate risk factors using data discounted based on historical interest rates.
- Current RBC and S2 calibrations are based on NVA.
- Past US actuarial recommendations suggested PVA.

4. Nominal Value Model vs. Present Value Model Premium



Premium Risk Charges from PVA approach are more stable in varying interest rate environments, for this LOB, at least.

4. Nominal Value Model vs. Present Value Model Reserves



Reserve Risk Charges from PVA approach are more stable in varying interest rate environments, for this LOB, at least.

4. Premium Risk – NVA vs. PVA = Summary by LOB

Lines of Business	Nominal (NVA)			Discounted (PVA)			2010 NEP %
	(1)	(2)	(3)	(4)	(5)	(6)	
	Slope	R-Sqr	Slope/ Std Err	Slope	R-Sqr	Slope/ Std Err	
A- Homeowners/Farmowners	0.0	0%	0.0	(0.7)	3%	(0.8)	15%
B- Private Passenger Auto	1.9	27%	2.8	0.4	2%	0.7	23%
C- Commercial Auto	3.1	25%	2.7	1.0	4%	0.9	4%
D - Workers Compensation	3.0	17%	2.1	(0.2)	0%	(0.2)	8%
E - Commercial Multi-Peril	1.3	5%	1.1	(0.2)	0%	(0.2)	7%
F1 - Med Prof Liab-Occ	1.9	1%	0.6	(3.7)	9%	(1.5)	1%
F2 - Med Prof Liab-CM	2.0	2%	0.7	(1.1)	1%	(0.5)	2%
G - Special Liability	4.6	32%	3.1	2.5	15%	1.9	1%
H - Other Liability	1.3	3%	0.7	(1.8)	8%	(1.3)	9%
I - Special Property	0.4	1%	0.4	(0.4)	1%	(0.5)	8%
J - Auto Physical Damage	0.4	1%	0.6	0.0	0%	0.0	16%
K - Fidelity/Surety	(2.0)	8%	(1.4)	(2.8)	18%	(2.2)	1%
L - Other	(0.6)	3%	(0.8)	(1.5)	15%	(1.9)	2%
M - International	8.1	7%	1.3	5.0	3%	0.9	0%
N&P - Reinsurance-Prop/Fin	6.0	7%	1.3	3.1	2%	0.7	2%
O - Reinsurance-Liability	6.0	12%	1.7	1.0	1%	0.4	1%
R - Products Liability	1.9	1%	0.5	(2.1)	2%	(0.7)	1%
S - Financial/Mort Guarantee	NA	NA	NA	NA	NA	NA	NA
T - Warranty	NA	NA	NA	NA	NA	NA	NA
Wtd Avg	1.4	10%	1.3	(0.2)	3%	(0.2)	100%

NVA –
Slope
significantly >0,
for some LOBs.
Almost always
>0

PVA –
Slope NOT
significantly >0,
for essentially
any LOBs.
Average near 0.

4. Reserve Risk – NVA vs. PVA = Summary by LOB

Lines of Business	Nominal (NVA)			Discounted (PVA)			2010 Rsv %
	(1)	(2)	(3)	(4)	(5)	(6)	
	Slope	R-Sqr	Slope/ Std Err	Slope	R-Sqr	Slope/ Std Err	
A- Homeowners/Farmowners	(0.0)	0%	(0.0)	(1.4)	13%	(1.7)	4%
B- Private Passenger Auto	1.8	24%	2.5	0.2	0%	0.2	17%
C- Commercial Auto	1.7	11%	1.6	(0.5)	1%	(0.5)	4%
D - Workers Compensation	4.2	21%	2.3	(0.3)	0%	(0.2)	21%
E - Commercial Multi-Peril	6.2	33%	3.1	2.7	11%	1.5	7%
F1 - Med Prof Liab-Occ	(2.6)	6%	(1.2)	(5.2)	26%	(2.7)	2%
F2 - Med Prof Liab-CM	(0.3)	0%	(0.2)	(2.3)	14%	(1.8)	3%
G - Special Liability	7.2	30%	2.9	4.0	14%	1.8	1%
H - Other Liability	5.1	20%	2.2	0.7	1%	0.3	24%
I - Special Property	0.7	2%	0.7	(0.1)	0%	(0.1)	2%
J - Auto Physical Damage	1.6	4%	0.9	1.0	2%	0.6	1%
K - Fidelity/Surety	2.8	2%	0.6	1.0	0%	0.2	1%
L - Other	3.4	9%	1.4	2.5	6%	1.1	1%
M - International	9.4	26%	2.2	6.3	17%	1.7	0%
N&P - Reinsurance-Prop/Fin	10.7	44%	4.0	7.2	31%	3.0	1%
O - Reinsurance-Liability	6.6	10%	1.5	0.7	0%	0.2	7%
R - Products Liability	8.4	16%	1.9	2.8	3%	0.8	3%
S - Financial/Mort Guarantee	NA	NA	NA	NA	NA	NA	NA
T - Warranty	NA	NA	NA	NA	NA	NA	NA
Wtd Avg	3.9	18%	2.0	0.4	3%	0.1	100.00%

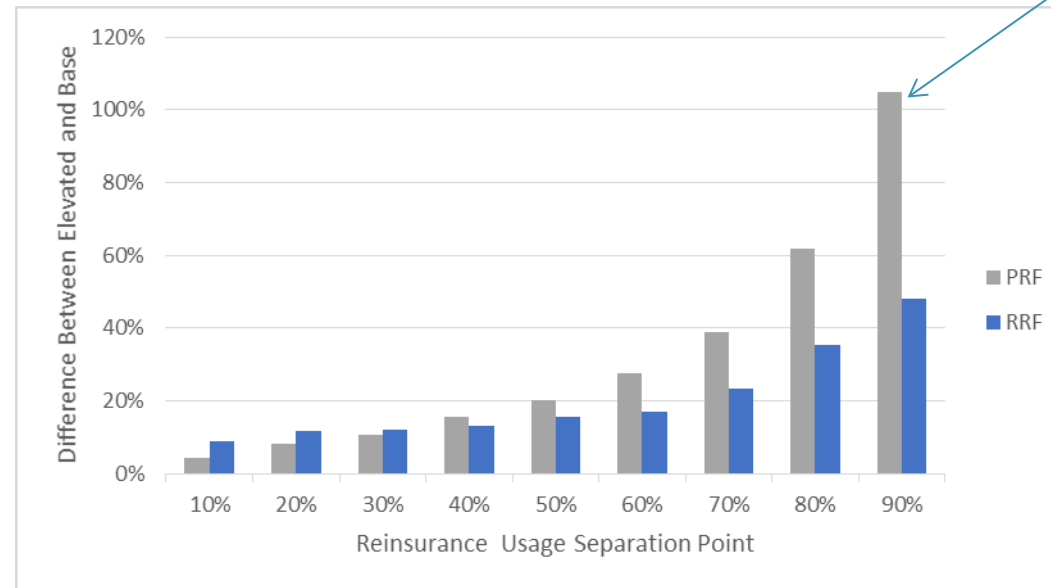
NVA –
Slope
significantly >0,
for some LOBs.
Almost always
>0

PVA –
Slope NOT
significantly >0,
for essentially
any LOBs.
Average near 0.

5. Variation of Risk as Reinsurance Usage Increases

5. Indicated Risk, as % of net volume, increases as reinsurance usage increase

PRF and RRF Variations by Reinsurance Usage
Differences in Indications between Elevated Usage vs.
Base Usage
All LOBs combined



Indicated premium risk charge for companies with 90% or more ceded is 105% (of net premium) higher than for all companies with less than 90% ceded.

6. Time Horizon

6. Time Horizon

Calibration of One-Year Time Horizon

Reserve Development Following “Bad” Year-1 vs.
Reserve Development Following “Normal” Year.

	Reserve Development Years 2-10		
LOBs	Year 1 RRR Normal (RRR≤87.5th %-ile)	Year 1 RRR High (RRR>87.5th %-ile)	Difference
All Lines	5.0%	15.0%	10.0%
Excluding "Asbestos" LOBs	0.7%	7.8%	7.1%

15% development following “bad” year versus 5% development following “Normal” Year.

Thus, Year-1 adverse development leads to 10% higher adverse development in later years.

Excluding asbestos LOBs, the difference is 7.8% versus 0.7%.

Given this observation, calibrating to 1-Year time horizon from 1-Year runoff data may not produce the desired safety level.

7. LOB Calibration Considerations

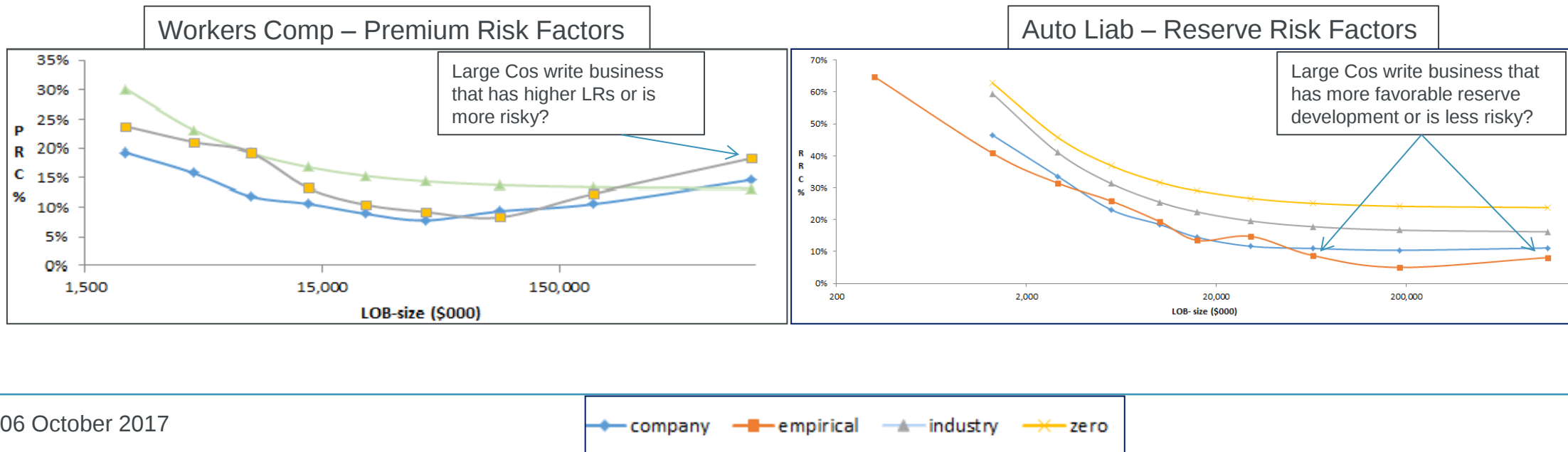
7. LOB Calibration

Four of Many Considerations

- LOB-Size
- Type of Company/Minor Lines
 - Reinsurer, medical malpractice specialist, personal lines specialist, etc.
 - “Minor line” = LOB as % of total company less than some threshold (e.g., 5%)
- Years of experience available in calibration data
- Company or LOB Age

7.1 LOB-Size Matters

- Indicated risk charge (87.5th percentile) varies with size
- Pattern appears to depend on factors in addition to size
- Standard formulas generally choose risk charge that does not vary with size, e.g., based on median or based on “large enough” companies



7.2 Type of Company Matters

- Risk charge varies by type of company
 - Reinsurer, medical malpractice specialist, personal lines specialist, etc.
- Calibrating on data points that exclude “minor lines” removes much (but not all) of the effect
 - “Minor line” = LOB as % of total company less than some threshold (e.g., 5%)

7.2 Type matters: Reinsurers

Sample Lines of Business (LOB)		Including Minor Lines			Excluding Minor Lines		
		(1)	(2)	(3)	(4)	(5)	(6)
		Specialists	Non-Specialists	Difference	Specialists	Non-Specialists	Difference
A	Homeowners/Farmowners	17%	22%	-6%	13%	21%	-8%
B	Priv. Passenger Auto Liability	25%	16%	9%	18%	15%	2%
C	Commercial Auto Liability	31%	18%	12%	18%	18%	0%
D	Workers Compensation	28%	15%	13%	16%	14%	2%
E	Commercial Multiperil	29%	18%	11%	25%	14%	11%
H	Other Liability	28%	13%	15%	18%	13%	4%
N&P	Reinsurance A & C	44%	70%	-26%	40%	41%	-1%
O	Reinsurance B	28%	53%	-25%	26%	29%	-3%

Non-specializing lines:

Excluding minor lines reduces differences.

Reinsurers have higher indicated risk charges for non-specializing lines than do non-reinsurers.

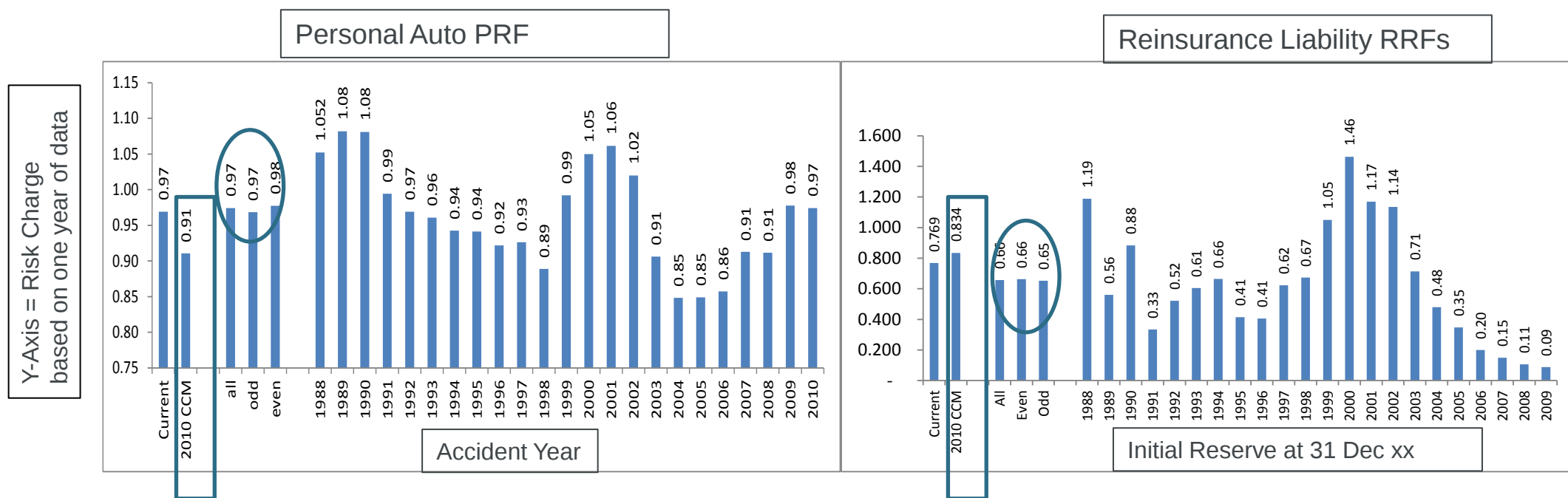
Specializing LOBs

Large difference in risk charges before minor lines adjustment.

Much smaller difference in risk charges after minor lines adjustment.

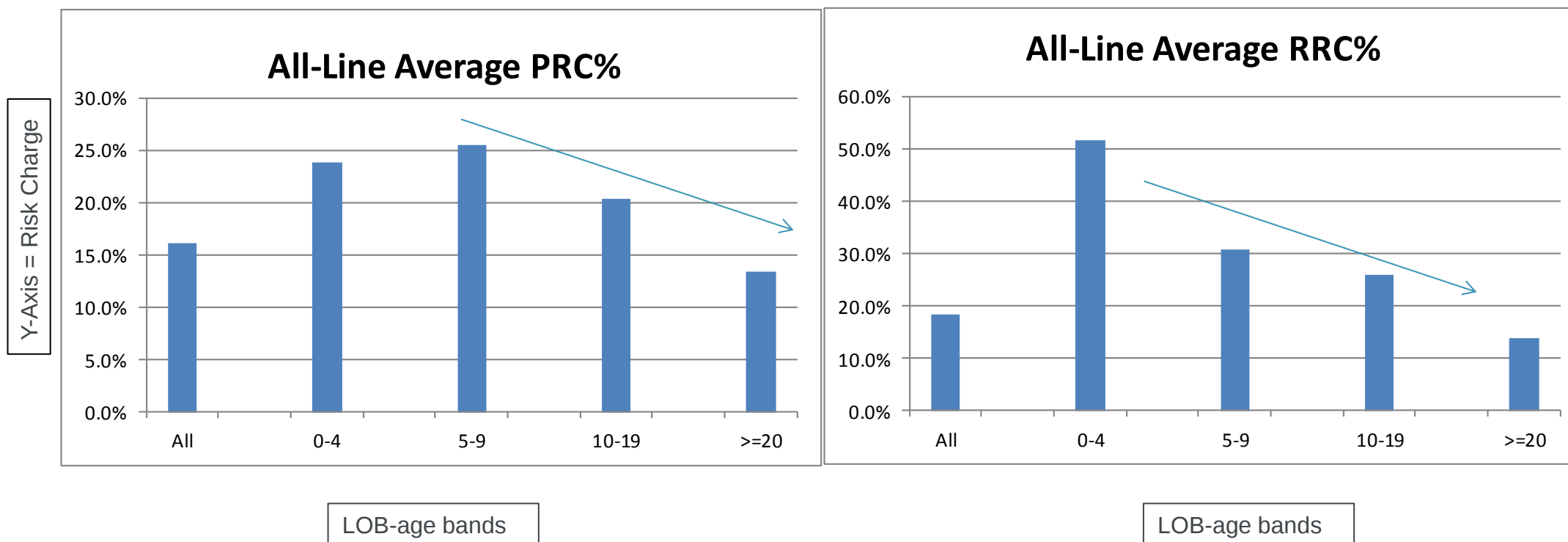
7.3 Time Scale Matters

- PRF and RRF by AY show UW cycle effects
- Ten consecutive years does not produce stable result (CCM column)
- Even/Odd test over 24 AYs appears reasonably stable



7.4 Mature Companies = Lower Risk

- Our calibration excludes data points from companies with less than five years of non-zero net earned premium
- Indicated risk charges decline for business with longer history



Questions?

Comments / suggestions
for the Working Party?



Institute
and Faculty
of Actuaries

DCWP: The People The Work Product



DCWP Publications To Date

Overview of Dependencies and Calibration in the RBC Formula (**Report 1**)

www.casact.org/pubs/forum/12wforum/DCWP_Report.pdf

2011 Research – Short Term Project (**Report 2**)

www.casact.org/pubs/forum/12wforum/RBC_URWP_Report.pdf

Solvency II Standard Formula and NAIC RBC (**Report 3**)

<http://www.casact.org/pubs/forum/12fforumpt2/RBC-DCWPRpt3.pdf>

A Review of Historical Insurance Company Impairments (**Report 4**)

<http://www.casact.org/pubs/forum/12fforumpt2/RBC-DCWPRpt4.pdf>

An Economic Basis for P/C Insurance RBC Measures (**Report 5**)

<http://www.casact.org/pubs/forum/13sumforum/01RBC-econ-report.pdf>

Premium Risk Charges – Improvements to Current Calibration Method (**Report 6**)

<http://www.casact.org/pubs/forum/13fforum/01-Report-6-RBC.pdf>

DCWP Publications To Date (con't)

Reserve Risk Charges – Improvements to Current Calibration Method (**Report 7**)

<http://www.casact.org/pubs/forum/14wforum/Report-7-RBC.pdf>

Differences in Premium Risk Factors by Type of Company (**Report 8**)

<http://www.casact.org/pubs/forum/14spforum/01-RBC-Dependencies-Calibration-Working-Party.pdf>

Differences in Premium and Reserve Risk Charges by Ceded Reinsurance Usage (**Report 9**)

http://www.casact.org/pubs/forum/14fforumv2/DCWP_Report.pdf

Reserve Risk Charges – Standard Formula vs. Individual Company Assessments (**Report 10**)

<http://www.casact.org/pubs/forum/15wforum/DCWP-Report.pdf>

RBC UW Risk Safety Levels – Actual vs. Expected (**Report 11**)

<http://www.casact.org/pubs/forum/16wforum/DCWP-Report.pdf>

Insurance Risk-Based Capital with a Multi-Period Time Horizon (**Report 12**)

<http://www.casact.org/pubs/forum/16spforum/Working-Party-Report.pdf>

DCWP Reports in Preparation

- RBC LOB Diversification – Current RBC Approach vs. Correlation Matrix Approach (**Report 13**)
- RBC Calibration of LOB Diversification in Underwriting Risk Charges (**Report 14**)

DCWP Working Party Members (2010-2017)

	Allan M. Kaufman, Chair	
<i>Karen H. Adams</i>	Jed Nathaniel Isaman	<i>Douglas Robert Nation</i>
Natalie S. Atkinson	Shira L. Jacobson	G. Chris Nyce
Emmanuel Bardis	<i>Shiwen Jiang</i>	Jonathan Norton
Jess B. Broussard	James Kahn	<i>Jeffrey J. Pfluger</i>
Robert P Butsic	Alex Krutov	Yi Pu
Christian Citarella	Terry T. Kuruvilla	Ashley Arlene Reller
Pablo Castets	<i>Apundee Singh Lamba</i>	David A. Rosenzweig
Joseph F. Cofield	<i>Giuseppe F. LePera</i>	David L. Ruhm
<i>Jose R. Couret</i>	Zhe Robin Li	Andrew Jon Staudt
Orla Donnelly	Lily (Manjuan) Liang	<i>Timothy Delmar Sweetser</i>
Chris Dougherty	Yuning Liu	Anna Marie Wetterhus
Nicole Elliott	Kean Mun Loh	Jianwei Xie
Brian A. Fannin	Thomas Toong-Chiang Loy	<i>Ji Yao</i>
<i>Sholom Feldblum</i>	Eduardo P. Marchena	Ronald Wilkins
Kendra Felisky	Mark McCluskey	Jennifer X. Wu
Dennis A. Franciskovich	James P. McNichols	<i>Jianhui (James) Yu</i>
Timothy Gault	Glenn G. Meyers	Linda Zhang
	Daniel M. Murphy*	Christina Tieyan Zhou
Actuarial Students—Damon Chom and Dean Guo		
CAS Staff Support: Karen Sonnet, Dave Core		

Bold = author of DCWP report

Italics = supported but not authored one of the subject-specific DCWP reports 3-14.

*Underwriting Risk Working Party chair

Work Stream Leaders

Work Stream	Leader	Team
Overview Reports 1 and 2	Rept-1 A. Kaufman Rept-2 D. Murphy	Working Party members listed on prior slide
3. Solvency II Formula and RBC	Joe Cofield	Christina Zhou
4. Insolvency Risk Factors-Univariate	Ed Marchena	
5. Consumer Value Risk Metric	Bob Butsic	Sholom Feldblum, Glen Meyers
6. Premium Risk Factors	Jennifer Wu, Dennis Franciskovich	Karen Adams, Franco LePera, Daniel Murphy, Tim Sweetser
7. Reserve Risk Factors	Jennifer Wu	Karen Adams, Dennis Franciskovich, Franco LePera, Daniel Murphy, Tim Sweetser
8. Risk Charge by Type of Company	Ashley Reller	Karen Adams
9. Reinsurance Usage and Risk Charges	Jonathan Norton	

Work Stream Leaders (con't)

Work Stream	Leader	Team
10. Rsv Risk Charge - Individual Co Model vs. RBC	Manolis Bardis	Christian Citarella, Glen Meyers, Linda Zhang, Damon Chom
11. Actual vs. Expected Analysis	Natalie Atkinson	
12. Analysis Investment Income Offsets	Natalie Atkinson James Yu	
13. Impact Analysis	Ron Wilkinson	Ji Yao, Damon Chom, Dean Guo
14. Dependency	Kean Mun Loh, Apundee Lamba	Shiwen Jiang, Glen Meyers, Dan Murphy, Damon Chom
15. Solvency II LOB Risk Factor Calibration Approach	Tim Sweetser, Ron Wilkins	Jeff Pflugger, Tim Sweetser, Glen Meyers
16. Insolvency risk Factors- Regression	Jose Couret	
17. Combined Ratio	Douglas Nation	



Institute
and Faculty
of Actuaries

Supporting Appendices



Source of Loss Ratio Data

NAIC Annual Statement Schedule P – Part 1

ANNUAL STATEMENT FOR THE YEAR December 31, 2010 OF THE SAMPLE Insurance Co. (NAIC #XYZ)

SCHEDULE P - PART 1 - Private Passenger Auto Liability (\$000 Omitted)

	1	2	3	4	5	6	7	8	9	10	11	12		
	Premiums Earned			Loss and Loss Expense Payments										
Years in Which Premiums				Loss Payments			Defense and Cost Containment Payments		Adjusting and Other Payments		Total Net	Number of Claims		
Were Earned and Losses Were Incurred	Direct and Assumed	Ceded	Net (Cols 1-2)	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Salvage and Subrogation on Received	Paid (Cols 4- 5 + 6-7 + 8-9)	Reported Direct and Assumed		
1 Prior	XXX	XXX	XXX	120	57	65	32	0	0	0	97	XXX		
2 2001	14,505	7,379	7,126	11,333	5,701	4,502	2,658	832	0	665	8,308	5,060		
3 2002	14,401	7,003	7,399	9,894	4,745	4,234	1,638	774	0	604	8,519	4,395		
4 2003	12,897	4,360	8,537	5,999	1,850	2,527	406	1,119	0	442	7,329	3,045		
5 2004	11,049	158	10,891	3,880	0	1,756	0	1,152	0	290	6,788	2,228		
6 2005	10,098	140	9,957	3,249	0	1,606	0	1,197	0	120	6,052	1,854		
7 2006	8,830	171	8,659	3,683	25	1,645	0	1,229	0	153	6,532	1,652		
8 2007	7,558	158	7,400	3,021	72	1,240	0	1,094	0	143	5,283	1,414		
9 2008	6,410	143	6,266	2,809	36	1,039	0	1,013	0	116	4,826	1,241		
10 2009	5,837	162	5,675	2,327	149	763	0	991	0	148	3,931	1,321		
11 2010	8,247	196	8,051	1,453	0	464	0	871	0	0	2,788	1,673		
12 Totals	XXX	XXX	XXX	47,709	12,695	19,842	4,734	10,271	0	2,681	60,453	XXX		

	13	14	15	16	17	18	19	20	21	22	23	24	25
	Losses Unpaid			Defense and Cost Containment Unpaid						Adjusting & Other		Total Net Losses and Expenses	Number of Claims Including Direct and Assumed
	Case Basis	Bulk + IBNR		Case Basis	Bulk + IBNR								
Years in Which Losses	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Direct and Assumed	Ceded	Salvage and Subrogation		
1 Prior	171	83	0	0	0	0	28	15	0	0	0	101	44
2 2001	66	33	0	0	0	0	29	15	0	0	0	48	17
3 2002	122	61	0	0	0	0	35	18	0	0	0	78	23
4 2003	103	52	0	0	0	0	49	24	0	0	0	76	22
5 2004	61	0	0	0	0	0	27	0	0	0	0	89	18
6 2005	146	0	0	0	0	0	29	0	0	0	0	176	24
7 2006	144	0	0	0	0	0	29	0	0	0	0	38	174
8 2007	190	0	49	20	0	0	49	0	0	0	0	65	268
9 2008	271	0	97	28	0	0	80	0	0	0	0	75	419
10 2009	525	0	852	98	0	0	117	0	7	0	91	904	298
11 2010	1,857	0	839	200	0	0	791	0	44	0	122	3,130	1,048
12 Totals	3,458	229	1,336	345	0	0	1,264	71	51	0	399	5,463	1,723

	26	27	28	29	30	31	32	33	34	35	36	
	Total Losses and Loss Expenses Incurred			Loss and Loss Expense Percentage (Incurred/Premiums Earned)			Nontabular Discount		Inter-Company Pooling Participation		Net Balance Sheet Reserves After Discount	
Years in Which Losses	Direct and Assumed	Ceded	Net	Direct and Assumed	Ceded	Net	Loss	Expenses	Losses Unpaid	Loss Expenses Unpaid		
1 Prior	XXX	XXX	XXX	XXX	XXX	XXX	0	0	XXX	88	14	
2 2001	16,763	8,407	8,956	113	111	114	0	0	33	15		
3 2002	15,060	6,462	8,597	102	90	113	0	0	60	18		
4 2003	9,737	2,332	7,405	74	52	85	0	0	52	24		
5 2004	6,877	0	6,877	61	0	62	0	0	61	27		
6 2005	6,227	0	6,227	60	0	61	0	0	146	29		
7 2006	6,731	25	6,705	74	14	76	0	0	144	29		
8 2007	5,643	92	5,552	78	57	73	0	0	219	49		
9 2008	5,309	64	5,244	81	44	82	0	0	339	80		
10 2009	5,082	247	4,835	82	149	80	0	0	780	124		
11 2010	6,118	200	5,918	72	99	72	0	0	2,296	835		
12 Totals	XXX	XXX	XXX	XXX	XXX	XXX	0	0	XXX	4,220	1,243	

LR for risk data is circled above

Source of Reserve Runoff Data

NAIC Annual Statement Schedule P – Part 2 and 3

Section 1 - SCHEDULE P - PART 2 - Private Passenger Auto Liability												
Years in Which Losses Were Incurred	1	2	3	4	5	6	7	8	9	10	DEVELOPMENT	
	INCURRED NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END (\$000 OMITTED)										One Year	Two Year
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
1 Prior	5,047	5,932	7,162	7,712	7,995	7,995	7,999	7,937	7,852	7,878	(14)	(58)
2 2001	5,170	5,331	6,267	7,035	7,216	7,394	7,480	7,539	7,514	7,524	11	(15)
3 2002	XXX	6,789	6,114	6,926	7,651	7,704	7,830	7,796	7,827	7,823	(4)	26
4 2003	XXX	XXX	7,510	6,022	6,038	6,184	6,063	6,136	6,269	6,286	17	150
5 2004	XXX	XXX	XXX	7,344	5,455	5,799	5,804	5,855	5,725	5,725	60	121
6 2005	XXX	XXX	XXX	XXX	6,527	5,845	5,399	4,929	4,972	5,031	59	101
7 2006	XXX	XXX	XXX	XXX	XXX	5,499	5,421	5,319	5,340	5,477	137	158
8 2007	XXX	XXX	XXX	XXX	XXX	4,428	4,488	4,380	4,457	77	(30)	
9 2008	XXX	XXX	XXX	XXX	XXX	XXX	3,887	4,070	4,231	161	344	
10 2009	XXX	XXX	XXX	XXX	XXX	XXX	XXX	3,812	3,837	25	XXX	
11 2010	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	5,004	XXX	XXX	
12 Total	10,218	18,032	27,053	35,038	41,822	46,663	50,439	53,635	57,742	63,274	529	798

Section 2 - SCHEDULE P - PART 3 - Private Passenger Auto Liability												
Years in Which Losses Were Incurred	1	2	3	4	5	6	7	8	9	10	11	12
	CUMULATIVE PAID NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END (\$000 OMITTED)										Number of Claims Closed With Loss Payment	Number of Claims Closed Without Loss Payment
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
1 Prior	0	2,476	4,478	6,779	6,492	6,913	7,314	7,571	7,680	7,777	2,387	588
2 2001	1,490	3,183	4,593	6,716	6,745	7,028	7,393	7,477	7,551	7,493	2,551	2,493
3 2002	XXX	2,453	4,163	6,336	6,154	6,891	7,244	7,524	7,650	7,745	2,157	2,205
4 2003	XXX	XXX	2,080	3,687	4,503	5,030	5,509	5,920	6,167	6,210	1,373	1,650
5 2004	XXX	XXX	XXX	2,138	3,485	4,182	4,760	5,178	5,465	5,636	900	1,311
6 2005	XXX	XXX	XXX	XXX	1,857	2,940	3,749	4,248	4,654	4,855	769	1,000
7 2006	XXX	XXX	XXX	XXX	XXX	1,823	3,467	4,289	4,828	5,303	770	939
8 2007	XXX	XXX	XXX	XXX	XXX	XXX	1,781	3,265	3,714	4,189	625	734
9 2008	XXX	XXX	XXX	XXX	XXX	XXX	XXX	1,704	3,196	3,812	540	570
10 2009	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	1,523	2,940	389	834
11 2010	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	1,917	227	398

Section 3 - Reserve by AY at each Calendar Year End ("Reserve Triangle")										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Prior	5,047	3,456	2,664	1,933	1,504	1,082	688	366	212	101
2001	3,680	2,148	1,704	1,319	887	648	452	255	121	48
2002	XXX	4,316	1,961	1,590	1,390	1,013	786	293	137	78
2003	XXX	XXX	5,420	2,336	1,535	1,154	574	216	102	76
2004	XXX	XXX	XXX	5,206	3,009	1,857	1,019	426	200	89
2005	XXX	XXX	XXX	XXX	4,870	2,908	1,650	682	308	176
2006	XXX	XXX	XXX	XXX	XXX	3,676	1,954	1,030	512	174
2007	XXX	XXX	XXX	XXX	XXX	XXX	2,648	1,223	666	268
2008	XXX	XXX	XXX	XXX	XXX	XXX	XXX	2,183	875	419
2009	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	2,289	897
2010	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	3,085
Total	8,728	9,920	11,829	12,394	13,181	12,339	9,768	6,673	5,421	5,412

Section 4 - RRR Calculation										
Row	Item	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Res by CY	8,728	9,920	11,829	12,394	13,181	12,339	9,768	6,673	5,421
2	Mature incurred	15,403	23,226	29,511	35,237	40,286	45,744	50,202	54,433	58,270
3	Initial incurred	10,218	18,032	27,053	35,038	41,822	46,663	50,439	53,635	57,742
4	Runoff(2)-(3)	5,185	5,194	2,458	199	(1,554)	(3,191)	(2,377)	798	529
5	RRR(4)/(1)	0.594	0.524	0.208	0.016	(0.118)	(0.074)	(0.024)	0.120	0.097

Diversification Analysis - Apply Slide 21, 24 and 25

Approach to each Div/Size Band

Diversif. Band Quintiles	Observed Risk- Part 1				
	Size Band (Quintiles)				
	A	B	C	D	E
0	56.2%	29.0%	25.9%	27.2%	36.6%
1	44.7%	20.8%	25.1%	21.8%	38.5%
2	42.1%	19.4%	15.2%	16.5%	15.0%
3	44.1%	20.7%	17.2%	17.9%	16.6%
4	32.8%	13.7%	18.1%	18.2%	15.7%
5	55.9%	22.0%	15.4%	16.4%	15.3%

Avg Yellow = 16.8%

Diversif. Band Quintiles	Modeled Risk With No diversification Credit-Part 2				
	Size Band (Quintiles)				
	A	B	C	D	E
0	27.8%	28.5%	28.9%	31.1%	30.0%
1	26.3%	27.6%	27.6%	31.6%	31.5%
2	25.7%	25.3%	23.9%	24.1%	26.0%
3	23.0%	24.4%	23.3%	23.6%	25.4%
4	22.5%	23.9%	23.2%	24.0%	24.1%
5	23.9%	23.5%	22.9%	23.2%	24.5%

Avg Yellow = 23.8%

Diversif. Band Quintiles	Current Average Diversification Credit-Part 3				
	Size Band (Quintiles)				
	A	B	C	D	E
0	0.0%	0.0%	0.0%	0.0%	0.0%
1	4.1%	4.4%	4.4%	4.3%	4.2%
2	9.4%	9.5%	9.5%	9.6%	9.6%
3	13.2%	13.2%	13.3%	13.2%	13.3%
4	16.2%	16.3%	16.5%	16.6%	16.6%
5	20.0%	20.2%	20.2%	20.5%	21.2%

Avg Yellow = 16.8%

Diversif. Band Quintiles	Indicated Diversification Credit-Part 4				
	Size Band (Quintiles)				
	A	B	C	D	E
0	-102.0%	-1.7%	10.4%	12.5%	-22.0%
1	-69.5%	24.5%	9.0%	31.0%	-22.3%
2	-63.4%	23.2%	36.6%	31.6%	42.1%
3	-91.8%	15.4%	26.1%	24.2%	34.7%
4	-45.8%	42.8%	21.9%	24.1%	35.0%
5	-133.5%	6.4%	32.7%	29.3%	37.4%

Avg Yellow = 29.5%

Row zero values for indicated diversification are not zero because mono-line company risk charges are different from average.

Size Bands:
A-smallest 20%
E-largest 20%

Small company indications are unusual because small companies have much higher than average indicated risk charges.

- Part 1- 87.5th percentile all-lines LR by Div/Size Band
- Part 2 - Apply RBC Formula without diversification credit
- Part 3- Average (company weighted) diversification credit
- Part 4 = 100% - Part 1/Part 2
- Part 5 - Indicated maximum credit, replacing 30% Maximum

Diversif. Band Quintiles	Indicated Maximum Diversification Credit-Part 5				
	Size Band (Quintiles)				
	A	B	C	D	E
0	NA	NA	NA	NA	NA
1	-513.5%	167.1%	61.4%	218.5%	-159.0%
2	-203.2%	73.4%	115.6%	98.9%	131.1%
3	-208.9%	35.0%	58.9%	54.9%	78.1%
4	-84.6%	78.8%	39.9%	43.7%	63.3%
5	200.3%	9.6%	48.5%	42.8%	52.9%

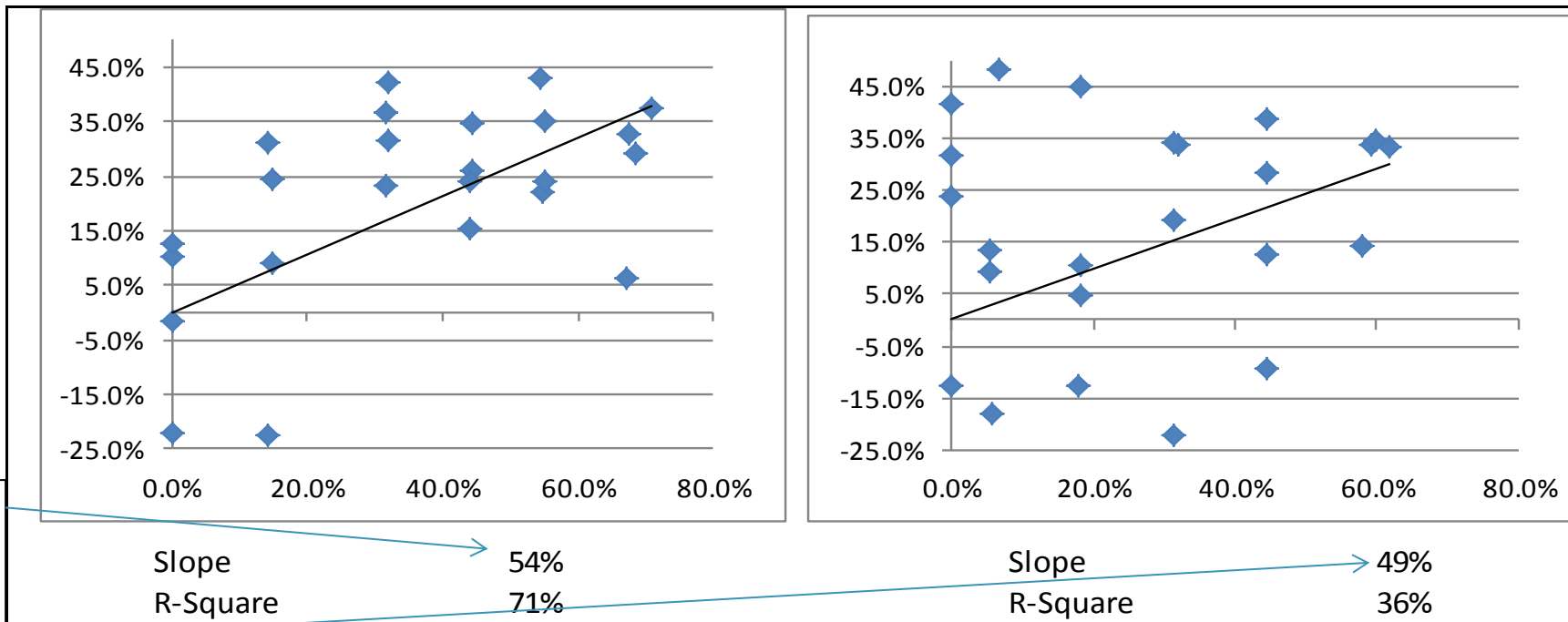
Avg Yellow = 53.7%

Row 1 and 2 values are unusual because risk charges for companies with low levels of diversification differ from average.

Diversification Graphical Analysis – Variations by Co Size and Co Diversification

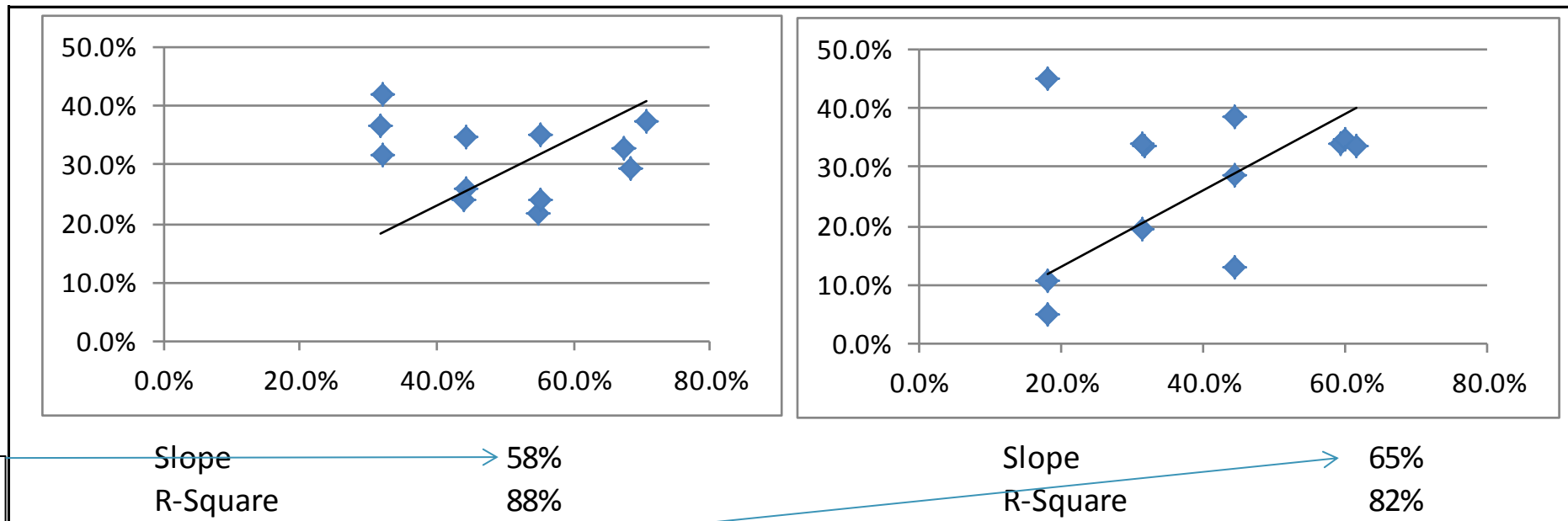
All Companies excluding smallest
Premium

Reserves

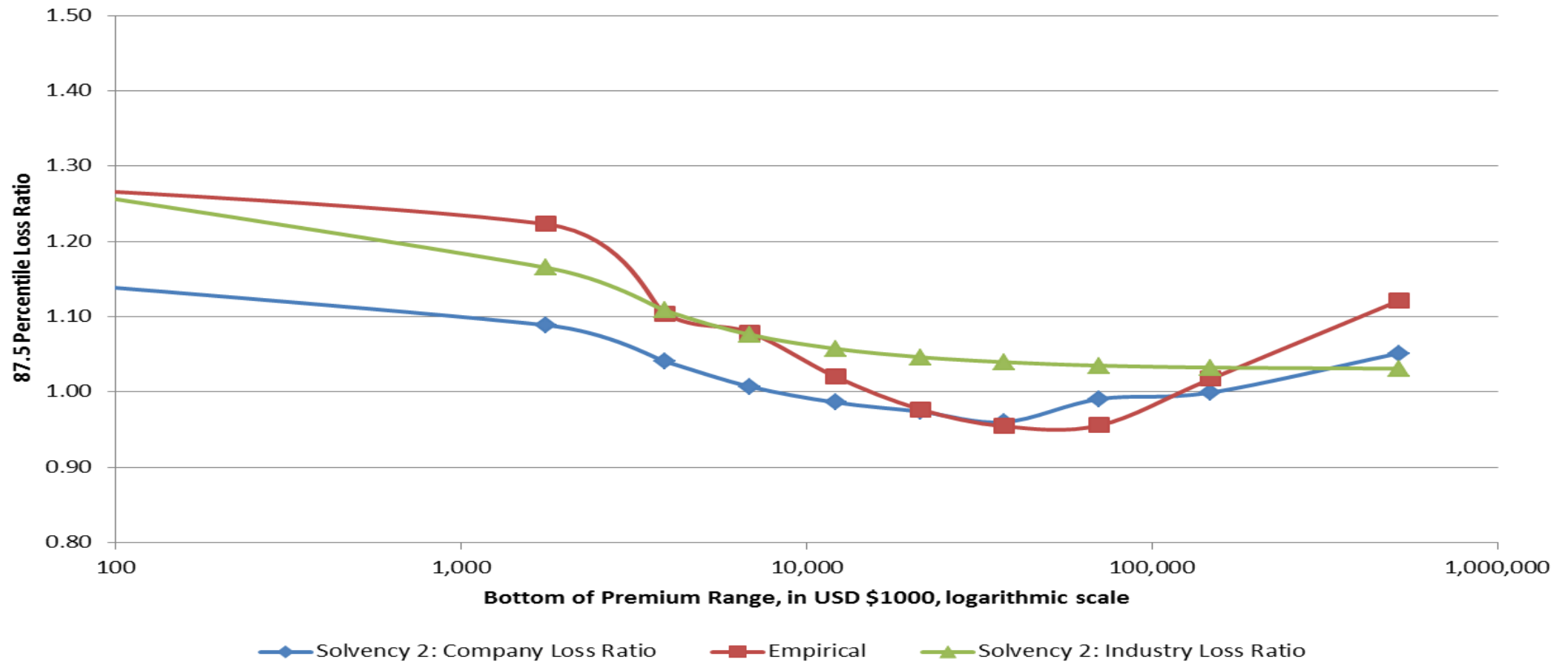


Diversification Graphical Analysis – Variations by Co Size and Co Diversification

**Largest Three Size Bands/Three Most Diversification Bands
Premium
Reserves**



LOB-Size Matters: PRF for WCA



LOB-Size Matters: RRF for PPA

