

Integrating Reserve Variability and ERM: A Case Study



**Integrating Reserve Variability and ERM:
A Case Study**

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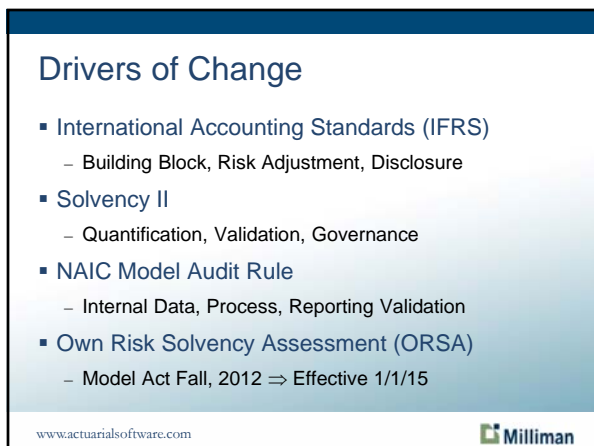
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What are the Issues?


- How good are your estimates (mean, std. dev., etc.)?
- When will you know if your estimate is good?
- How do you compare actual outcomes to your estimate?
 - How far apart and still reasonable?
- Can you manage reserve risk:
 - Without measuring it first?
 - If the assumptions are not consistent over time?
- Will retrospective testing improve your processes?
 - Are the inevitable deviations from the expectations understood?
 - Is there a difference between predicting & explaining?
- What metrics are useful for management?
- Should we integrate reserving into ERM?
 - Analysis of change, risk capital, earnings, etc.

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Drivers of Change

- International Accounting Standards (IFRS)
 - Building Block, Risk Adjustment, Disclosure
- Solvency II
 - Quantification, Validation, Governance
- NAIC Model Audit Rule
 - Internal Data, Process, Reporting Validation
- Own Risk Solvency Assessment (ORSA)
 - Model Act Fall, 2012 ⇒ Effective 1/1/15

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Integrating Reserve Variability and ERM: A Case Study


Integrated ERM Framework

- Conduct deterministic analysis to get a best estimate (BE) or central estimate
- Conduct stochastic modeling of unpaid claim liabilities
 - Multiple models weighted to address model risk
- Set threshold for action based on deviation from expected
 - Strategic allocation of actuarial talent during high pressure season
- Automatically notify key personnel of unusual values at an early stage of the reserving process
 - Facilitate prompt investigation of potential data inaccuracies
 - Make changes to the assumption set as needed, maintaining consistency of approach


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Back Testing

- Goal: Compare actual (A) to expected (E)



- Deriving E requires assumption consistency
- Assess materiality of difference (A - E)
 - Expected (distributional) vs. Actual (one observation)
- Caveats:
 - Model assumptions require validation and should address model risk
 - Does not address AY=CY. New exposures have been earned!
 - Works well for gross but net (or R/I recoveries) requires more effort
 - May need to "shift" mean of resulting distribution to replicate BE



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What can be measured without an uncertainty analysis?


AY	Age	Actual		Expected		Actual		Expected	
		Paid	Paid	Incurred	Incurred	Incurred	Incurred		
2004	120	543	577	(47)	152				
2005	108	2,387	1,043	1,040	503				
2006	96	1,177	1,636	851	1,193				
2007	84	5,403	4,540	2,954	2,064				
2008	72	14,120	10,630	9,035	6,013				
2009	60	23,636	23,300	16,524	11,898				
2010	48	51,020	44,746	36,454	29,808				
2011	36	75,813	62,082	61,541	44,977				
2012	24	88,832	79,335	83,154	67,322				
2013	12	99,123	-	178,539	-				
CY 2013		362,054		390,045					
AY<CY		262,931	227,890	211,506	163,930				

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Imagine the following...

- The date is 2 January 2014
- Complete loss data is available as of 31 December 2013
- Company A writes 3 homogenous lines of business (CA, PPA, and HO), with triangular data going back to Accident Year 2004 (source: SNL Financial)
- Company A performs a full review of unpaid claim liabilities annually, including an uncertainty analysis using multiple models to address model risk


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Imagine the following...

- Company A has an integrated risk management framework, including reserving risk Key Performance Indicators (KPIs), based on the realization of paid (and incurred) loss relative to outcomes of their models and pre-defined thresholds

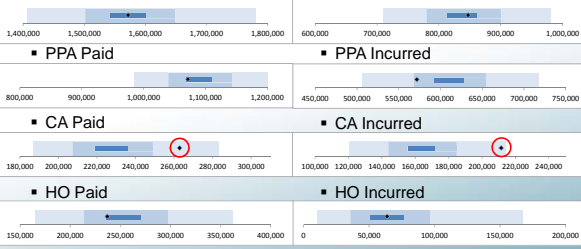



- Management would like to receive the actuary's best estimate as of 31 December 2013 by 23 January 2014 (3 weeks)

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Monitor/Control Reserving Risk
Compare actual to expected ($\Sigma AY < CY$)

- Aggregate Paid Loss
- Aggregate Incurred Loss
- PPA Paid
- PPA Incurred
- CA Paid
- CA Incurred
- HO Paid
- HO Incurred



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Integrating Reserve Variability and ERM: A Case Study

Integrated ERM Framework

Automated E-Mail to the CFO

2013 Aggregate Paid & Incurred Claims Accrued for AY < CY

From: MillimanGRC@YourCompany.com
To: CFO@YourCompany.com
Cc:
Subject: 2013 Aggregate Paid & Incurred Claims Accrued for AY < CY

Sent: Thu, 1/2/2014 @ 10:56am

As CFO, we are required to report to you the results of the Aggregate Paid and Incurred claims data relative to the actuarial assumptions and thresholds. The 2013 Aggregate paid and incurred claims have not breached any thresholds.

Milliman GRC

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Monitor/Control Reserving Risk

Do outcomes tell us something? ($\Sigma AY < CY$)

	Number					Percentage						
	25<X<75	5<X<95	<5	or	>95	25<X<75	5<X<95	<5	or	>95		
HIO	10	13	18	20	2	0	50.0%	65.0%	90.0%	100.0%	10.0%	0.0%
PPA	10	14	18	20	2	0	50.0%	70.0%	90.0%	100.0%	10.0%	0.0%
CA	10	5	18	14	2	6	50.0%	25.0%	90.0%	70.0%	10.0%	30.0%
Agg	10	16	18	20	2	0	50.0%	80.0%	90.0%	100.0%	10.0%	0.0%
Total	40	48	72	74	8	6	50.0%	60.0%	90.0%	92.5%	10.0%	7.5%

- Overall actual results are consistent with expectations
 - Includes both AY and Total ($\Sigma AY < CY$) outcomes (20 outcomes each)
 - Comparison of aggregate accruals requires correlation assumptions
 - Includes both LoB and Aggregate outcomes (80 outcomes total)
 - CA could be problematic
 - Internal process (data quality / claims adjusting / reinsurance)
 - Width of distribution or some other modeling assumption
 - Random occurrence

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Monitor/Control Reserving Risk

One-year time horizon reserve changes ($\Sigma AY < CY$)

- Given the actual losses paid in CY 2013, we can obtain a preliminary estimate of the amount by which reserves for AY 2012 and prior (or $AY < CY$) will change
 - All the necessary information is contained within the prior deterministic analysis and uncertainty analysis (does not require an update with new data)
 - Provides an early warning of impact on financial results
 - Provides a measure of the performance of the actuarial function

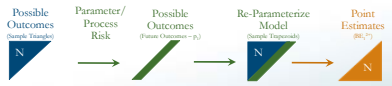
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Monitor/Control Reserving Risk

One-year time horizon reserve changes ($\Sigma AY < CY$)

- Calculate, separately for each LOB:
 - “Conditional Reserve @ 31 December 2013” = Nth Percentile


 - Example: If CY Paid fell into the 15th percentile of the distribution of expected CY Paid, the Conditional Reserve would be the 15th percentile of the distribution of reserves @ 31 December 2013
 - “Expected Reserve @ 31 December 2013” = Expected Reserve @ 31 December 2012 less CY 2013 Paid
 - This is the reserve @ 31 December 2013 if we did not change Ultimates at all
 - Difference between Conditional Reserve and Expected Reserve represents the estimated reserve change

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Monitor/Control Reserving Risk

One-year time horizon reserve changes ($\Sigma AY < CY$)

AY	CA			PPA			HCO			Total Change	
	Expected Reserve	Conditional Reserve	Change	Expected Reserve	Conditional Reserve	Change	Expected Reserve	Conditional Reserve	Change		
2004	413	547	(67)	2,737	2,493	(243)	392	25	(367)	(679)	
2005	(146)	2,194	2,340	6,210	6,674	464	979	744	(235)	2,769	
2006	2,500	1,533	(967)	9,566	8,940	(626)	1,559	1,511	(49)	(1,642)	
2007	3,265	4,927	1,722	19,331	17,337	(1,994)	2,013	114	(1,899)	(2,171)	
2008	5,828	12,825	6,997	36,672	33,136	(3,535)	2,897	4,499	1,602	5,064	
2009	119,494	201,716	84,222	73,732	74,597	865	6,065	4,315	(1,698)	(442)	
2010	44,250	57,573	13,323	156,541	153,517	(3,024)	12,219	14,416	2,197	12,496	
2011	80,777	113,108	32,331	319,636	303,909	(15,727)	25,577	22,449	(3,129)	13,475	
2012	146,195	171,586	25,391	587,371	588,683	1,313	65,979	59,340	(6,639)	20,065	
2013											
AY < CY	302,716	384,469	81,754	1,211,797	1,189,486	(22,310)	117,621	107,412	(10,209)	49,234	

- AYs 2010-12 should also drive reserves up
 - Most of this increase is driven by CA

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Integrated ERM Framework

Automated E-Mail to the CEO/CFO

2013 Aggregate Paid Claims Accrued for AY < CY

From: MillimanGRC@YourCompany.com Sent: Thu 1/2/2014 @ 10:55am
To: CEO@YourCompany.com, CFO@YourCompany.com
Subject: 2013 Aggregate Paid Claims Accrued for AY < CY

As a preliminary monitoring tool, based on our conditional reserves given the possible outcomes on a one-year time horizon basis, the actual claim payments in 2013 suggest that the reserves for accident year 2012 and prior will increase by \$49, 234,000. The actual reserve change will depend on a deeper review of the data and assumptions used to estimate unpaid claims, so this is only intended to alert you to the potential impact on our financial results.

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Monitor/Control Reserving Risk

- Focus on Commercial Auto (CA)

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Monitor/Control Reserving Risk

Compare CA actual to expected ($\Sigma AY < CY$)

- CA

AY	Age	Actual Paid	Expected Paid	Modelled Percentile	Actual Incurred	Expected Incurred	Modelled Percentile
2004	120	543	577	57.5%	(47)	152	48.2%
2005	108	2,387	1,043	91.8%	1,040	503	81.9%
2006	96	1,177	1,636	35.6%	851	1,193	43.6%
2007	84	5,403	4,540	74.1%	2,954	2,064	79.5%
2008	72	14,120	10,630	93.5%	9,035	6,013	92.5%
2009	60	23,636	23,300	56.2%	16,524	11,898	95.0%
2010	48	51,020	44,746	88.8%	36,454	29,808	91.6%
2011	36	75,813	62,082	96.9%	61,541	44,977	99.0%
2012	24	88,832	79,335	87.0%	83,154	67,322	95.9%
2013	12	99,123	-	-	178,539	-	-
CY 2013		362,054	-	-	390,045	-	-
AY < CY		262,931	227,890	99.6%	211,506	163,930	99.9%

- AYs 2007-12 are driving high #s
 - Need to check assumptions (i.e., IELRs, LDFs, weights, etc.)

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Monitor/Control Reserving Risk

Compare CA actual to expected ($\Sigma AY < CY$)

- CA Paid

- CA Incurred

- AYs 2007-12 are driving high #s
 - Need to check all assumptions

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Integrated ERM Framework

Non-Life Reserve Risk KPI: Observation (LOB: CA)

- Threshold breached
- Are expectations from the 2012 model biased low?
- **Check 2011**
- Are we aware of all internal process changes?
- Are we underestimating uncertainty?

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Integrated ERM Framework

Automated E-Mail to the Chief Actuary

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Integrated ERM Framework

Non-Life Reserve Risk KPI: CA Paid (AY<CY) Output

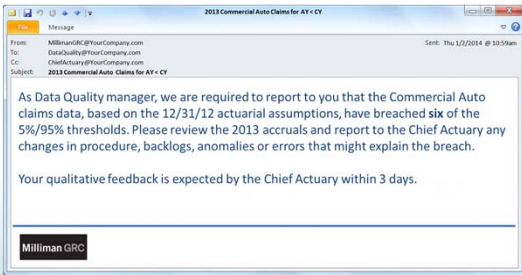
- ← Risk Owner
- ← Risk Reviewer
- ← Thresholds
- ← Realized Values
- ← AY / UY Details

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Integrated ERM Framework

Automated E-Mail to Data Quality Department




From: MillimanGRC@YourCompany.com
To: DataQuality@YourCompany.com
Cc: ChiefActuary@YourCompany.com
Subject: 2013 Commercial Auto Claims for AY <CY>

Sent: Thu 1/2/2014 @ 10:59am

As Data Quality manager, we are required to report to you that the Commercial Auto claims data, based on the 12/31/12 actuarial assumptions, have breached six of the 5%/95% thresholds. Please review the 2013 accruals and report to the Chief Actuary any changes in procedure, backlogs, anomalies or errors that might explain the breach.

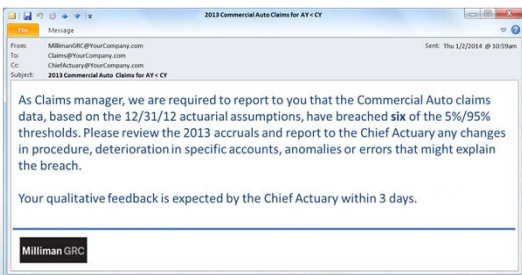
Your qualitative feedback is expected by the Chief Actuary within 3 days.

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Integrated ERM Framework

Automated E-Mail to Claims Department




From: MillimanGRC@YourCompany.com
To: Claims@YourCompany.com
Cc: ChiefActuary@YourCompany.com
Subject: 2013 Commercial Auto Claims for AY <CY>

Sent: Thu 1/2/2014 @ 10:59am

As Claims manager, we are required to report to you that the Commercial Auto claims data, based on the 12/31/12 actuarial assumptions, have breached six of the 5%/95% thresholds. Please review the 2013 accruals and report to the Chief Actuary any changes in procedure, deterioration in specific accounts, anomalies or errors that might explain the breach.

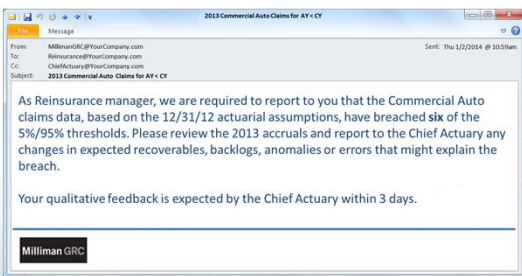
Your qualitative feedback is expected by the Chief Actuary within 3 days.

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Integrated ERM Framework

Automated E-Mail to the Reinsurance Department



From: MillimanGRC@YourCompany.com
To: Reinsurance@YourCompany.com
Cc: ChiefActuary@YourCompany.com
Subject: 2013 Commercial Auto Claims for AY <CY>

Sent: Thu 1/2/2014 @ 10:59am

As Reinsurance manager, we are required to report to you that the Commercial Auto claims data, based on the 12/31/12 actuarial assumptions, have breached six of the 5%/95% thresholds. Please review the 2013 accruals and report to the Chief Actuary any changes in expected recoverables, backlogs, anomalies or errors that might explain the breach.

Your qualitative feedback is expected by the Chief Actuary within 3 days.

Milliman GRC

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Assumption Consistency

We validated last year. Why so far off the mark?

- Choice of 2012 IELR?
 - Management: 52.9%
 - Incurred CL: 57.7%
 - Paid CL: 57.3%
- Heteroscedasticity?
- Shifting mean of distribution?
- Missed CY trend?

AY	Age	Actual Paid	Expected Paid	Model Percentile
2004	120	543	577	57.5%
2005	108	2,387	1,043	91.8%
2006	96	1,177	1,636	35.6%
2007	84	5,403	4,540	74.1%
2008	72	14,120	10,630	93.5%
2009	60	23,636	23,300	56.2%
2010	48	51,020	44,746	88.8%
2011	36	75,813	62,082	96.9%
2012	24	88,832	79,335	87.0%
2013	12	99,123	-	-
CY 2013		362,054	-	-
AY<CY		262,931	227,890	99.6%

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Validation as of 31 December 2012

Assumptions: Each requiring validation

- Long term average LDFs
 - No validated reason to use shorter term averages (e.g., WA of last 5)
 - In this example, model is 100% consistent with calculation of BE
 - If deterministic analysis uses a "picker approach" (to reflect observable trends), need to validate each "pick" and consider shifting output of stochastic uncertainty model.
- Accident year independence
- IELRs used in the BF Method
- Heteroecthesious data (i.e., non-uniform exposures)
 - We use symmetrical triangles (e.g., AY x AY)
 - Exposures are complete (not at interim valuation date) and have not significantly changed over time (e.g., no rapid growth)

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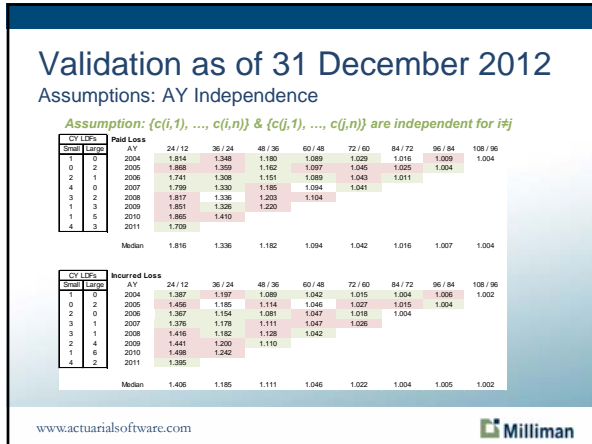
Validation as of 31 December 2012

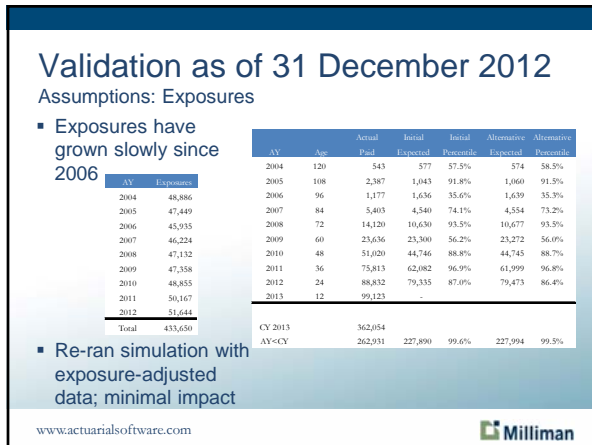
Assumptions: Each requiring validation

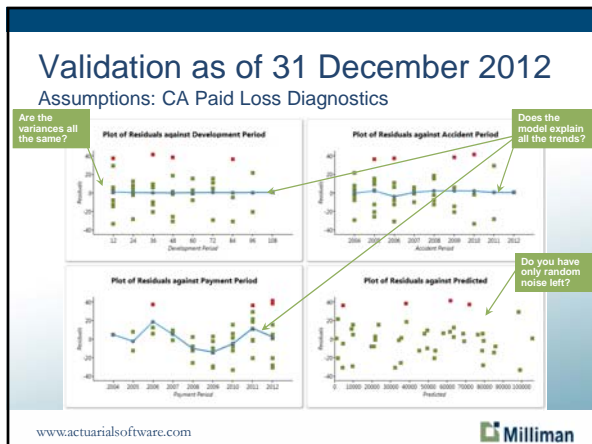
- Heteroscedasticity
 - Residuals assumed to be identically distributed with a mean of zero
 - Residuals by development period more variable than others?
- Gamma used for Process Variance
- Coefficient of Variation of the IELRs used in BF Method
- Weighting of methods

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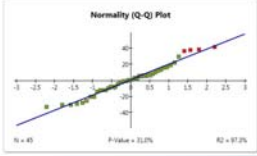
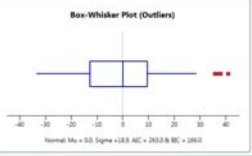





Integrating Reserve Variability and ERM: A Case Study

Validation as of 31 December 2012

Assumptions: CA Paid Loss Diagnostics

- All positive outliers could indicate skewness
- Normality still good though
- We can still check heteroscedasticity


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Validation as of 31 December 2012

Assumptions: Process Variance

- Assumed a Gamma distribution
- Switching to Normal distribution had minimal impact

AY	Age	Actual Paid	Initial Expected	Initial Percentile	Alternative Expected	Alternative Percentile
2004	120	543	577	57.5%	577	47.0%
2005	108	2,387	1,043	91.8%	1,048	92.2%
2006	96	1,177	1,636	35.8%	1,652	32.1%
2007	84	5,403	4,540	74.1%	4,550	72.4%
2008	72	14,120	10,630	93.5%	10,622	93.0%
2009	60	23,636	23,300	56.2%	23,260	55.4%
2010	48	51,020	44,746	88.8%	44,694	89.1%
2011	36	75,813	62,082	96.9%	62,102	97.2%
2012	24	88,832	79,335	87.0%	79,251	87.3%
2013	12	99,123	-	-	-	-
CY 2013		362,054	-	-	-	-
AY<CY		262,931	227,890	99.6%	227,754	99.6%

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Validation as of 31 December 2012

Assumptions: CA BF and Weighting

- BF models
 - IELR consistent with BE
 - CoV (IELR) = 8%
- Weights identical to BE

AY	Coefficient of Variation			
	Chain Ladder (Unshifted) Paid	Chain Ladder (Unshifted) Incurred	ELR CoV	BF (Unshifted) Paid / Incurred
2004	55.9%	56.5%	8.0%	79.8% / 78.6%
2005	49.4%	48.9%	8.0%	57.0% / 56.5%
2006	38.0%	37.3%	8.0%	41.9% / 42.1%
2007	24.4%	24.3%	8.0%	26.9% / 26.8%
2008	16.1%	15.3%	8.0%	17.9% / 17.6%
2009	11.3%	10.1%	8.0%	13.2% / 12.9%
2010	8.1%	6.9%	8.0%	10.6% / 10.0%
2011	7.2%	6.2%	8.0%	9.6% / 8.5%
2012	7.6%	6.6%	8.0%	9.1% / 7.9%
Total	4.9%	4.0%		5.3% / 4.8%

In this case, the use of the BF adds variability to the resulting distribution

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Integrating Reserve Variability and ERM: A Case Study

Validation as of 31 December 2012

Assumptions: Correlation by Segment

Measurement:

- Use of rank or pairwise correlation of paid residuals
- Could have used incurred residuals

Evaluation:

- P-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true.
- Could have used incurred residuals
- Could have used residuals after heteroscedasticity adjustment
- Can validate by tracking over time

ML Copula Rank Correlation			
	CA	PPA	HD
CA	1.000	0.330	0.030
PPA	0.330	1.000	-0.130
HD	0.030	-0.130	1.000

T-Stat Dof: 13

P-Values			
	CA	PPA	HD
CA	1.000	0.060	0.800
PPA	0.060	1.000	0.330
HD	0.800	0.330	1.000

Selected Correlation Matrix			
	CA	PPA	HD
CA	1.000	0.330	0.000
PPA	0.330	1.000	0.000
HD	0.000	0.000	1.000

T-Stat Dof: 13

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Any Final Questions?

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