The Actuary & Enterprise Risk Management: Integrating Reserve Variability

Paper Outline

- Introduction
- Notation
- Back-Testing
  - Deterministic Back-Testing
  - Stochastic Back-Testing
  - Stochastic Key Performance Indicators
- Reserving within an ERM Framework
- Enterprise Risk Management in Action – A Case Study
  - Introduction
  - Basis of Underlying Data
  - Validation of the Prior Analysis
  - Implied Expected Values from Multiple Methods
  - Advantages of Using the ODP Bootstrap
  - ERM Governance Elements and Automatic Alert System
  - Using Back-Testing Diagnostics to Assess Uncertainty
  - The Feedback Loop
- Conclusions

Companion Files:
- Used to create all tables & graphs in paper

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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?
- Can back-testing help get more value from your approach?
  - Are the inevitable deviations from the expectations understood?
  - Is there a difference between predicting & explaining?
- What metrics are useful for management?
- Can your reserving process enhance your ERM framework?
  - Analysis of change, risk capital, earnings, etc.

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Drivers of Change

- IFRS 4 (Insurance Contracts) Phase II
  - 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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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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Deterministic Back-Testing

- Key Question: Is outcome better or worse than expected?
- Point estimate is sole source of "Expectation" from which to test deviations
- Expectation can be expressed as cumulative or incremental
- Multiple methods requires *consistency of expectations*
- Focused more on ***direction*** and ***magnitude*** of outcome than ***significance***
- Can include "ranges" (e.g., weighted, method or possible), but still more about direction and magnitude than significance

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Deterministic Back-Testing

Sample Insurance Company
Consolidation of All Segments
Deterministic Actual vs. Expected as of December 31, 2015

AY	Age	Actual Paid	Expected Paid	Difference	Actual Incurred	Expected Incurred	Difference
2006	120	3,069	3,701	(632)	1,863	2,158	(295)
2007	108	5,905	7,405	(1,500)	3,145	2,794	351
2008	96	8,986	10,073	(1,087)	3,553	6,142	(2,589)
2009	84	18,992	19,027	(35)	9,872	11,285	(1,413)
2010	72	51,003	47,151	3,852	25,942	26,873	(931)
2011	60	105,067	103,127	1,940	52,012	54,534	(2,522)
2012	48	202,932	194,479	8,453	106,624	106,020	604
2013	36	334,434	325,644	8,790	189,908	192,143	(2,235)
2014	24	841,484	833,793	7,691	454,217	479,073	(24,856)
2015	12	1,798,138			2,528,235		
Totals		3,370,010			3,375,371		
AY<CY		1,571,872	1,544,400	27,471	847,136	881,022	(33,886)

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Stochastic Back-Testing

- Key Question: Is outcome ***significantly*** different than expected?
- Distribution of possible outcomes is source of "Expectation" from which to test deviations
- Expectation can be expressed as cumulative or incremental
- Multiple models encourages *assumption consistency*
  Focused on ***significance*** of outcome
- Distribution can be used to pre-define KPI thresholds

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Stochastic Back-Testing

- 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
  - Works best for high frequency segments
  - May need to "shift" mean of resulting distribution to replicate BE
  - Paid ODP Bootstrap may underestimate reserve risk

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Stochastic Back-Testing

Sample Insurance Company
Aggregation of All Segments
Stochastic Actual vs. Expected as of December 31, 2015

AY	Age	Actual Paid	Expected Paid	Percentile	Actual Incurred	Expected Incurred	Percentile
2006	120	3,069	4,077	31.8%	1,863	2,115	49.8%
2007	108	5,905	6,163	47.9%	3,145	1,819	80.6%
2008	96	8,986	10,176	33.6%	3,553	6,026	20.9%
2009	84	18,992	20,033	39.0%	9,872	10,399	46.3%
2010	72	51,003	48,298	71.6%	25,942	25,562	55.3%
2011	60	105,067	104,415	54.3%	52,012	53,101	44.8%
2012	48	202,932	196,083	74.2%	106,624	104,075	61.7%
2013	36	334,434	331,701	57.1%	189,908	185,173	64.0%
2014	24	841,484	839,689	52.8%	454,217	469,822	29.3%
2015	12	1,798,138			2,528,235		
Totals		3,370,010			3,375,371		
AY<CY		1,571,872	1,560,637	61.2%	847,136	858,093	37.6%

Note: Total Unpaid by AY is same for Deterministic and Stochastic, but incremental expectation is different.

Consistency of Expectations

- Starts with assumption consistency between & among methods
- Weighting of estimates to address model risk is partial acceptance or rejection of various assumptions
- Shifting is also a partial acceptance or rejection of assumptions
- Future expectation for each data element (e.g., incremental paid) is therefore a weighted average of that element from each model given weight
- This is true for both deterministic and stochastic analysis
- **IN CONTRAST:** A single model approach for variance (e.g., use Mack) is at best a partial rejection of assumptions used for mean, and at worst involves using ***completely different*** assumptions compared to the mean.

Reserving Within an ERM Framework

- ERM is a continuous process;
- ERM adopts a holistic view to risk and assesses risk from the perspective of the company's aggregate position as well as from a standalone perspective;
- ERM is concerned with all risks, including those that are unquantifiable or difficult to quantify;
- ERM considers uncertainty from both a positive and negative viewpoint;
- ERM aims to achieve greater value for all stakeholders by assisting in achieving an appropriate risk-reward balance; and
- ERM considers both the short term and the long term aspects of risk

Source: IAA. 2016. *Actuarial Aspects of ERM for Insurance Companies*

Reserving Within an ERM Framework

- ERM components include: governance, strategy, identification, assessment, measurement, response, monitoring, and reporting
- ERM does not change how actuarial function manages reserving risk
- Rather, ERM formalizes the governance around the actuarial process:
  - Clear assignment of risk ownership;
  - Auditable controlling of both the model(s) and conclusions;
  - Metrics used to identify deviations from prior expectations;
  - Efficient allocation of actuarial resources;
  - Assess whether deviations are mean estimation error, variance estimation error, or random error;
  - Key performance indicators that management can use; and
  - Expanded discussion with parties outside of the actuarial function

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Imagine the following…

- The date is 4 January 2016
- Complete loss data is available as of 31 December 2015
- Company writes 3 homogenous lines of business (CA, PPA, and HO), with triangular data going back to Accident Year 2006 (source: SNL Financial)
- Company 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 has an integrated risk management framework, including reserving risk Key Performance Indicators (KPIs), based on the realization of incremental 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 27 January 2016 (3 weeks)

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Monitor/Control Reserving Risk

Compare actual to expected (ΣAY<CY)

- Aggregate Paid Loss
- Aggregate Incurred Loss

- PPA Paid
- PPA Incurred

- CA Paid
- CA Incurred

- HO Paid
- HO Incurred

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Monitor/Control Reserving Risk

Compare actual to expected (ΣAY<CY)

- Aggregate

NOTE: Comparison of aggregate accruals requires correlation assumptions

Sample Insurance Company
Aggregation of All Segments
Stochastic Actual vs. Expected as of December 31, 2015

AY	Age	Actual Paid	Expected Paid	Percentile	Actual Incurred	Expected Incurred	Percentile
2006	120	3,069	4,077	31.8%	1,863	2,115	49.8%
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2015	12	1,798,138			2,528,235		
Totals		3,370,010			3,375,371		
AY<CY		1,571,872	1,560,637	61.2%	847,136	858,093	37.6%

- Several of the 20 observable outcomes are near the thresholds
  - 20 observable outcomes = (9 AYs + 1 ΣAY<CY) for paid and incurred
- AY 2015 could be addressed if pricing risk was included in analysis

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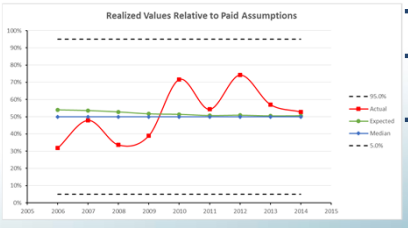
Integrated ERM Framework

Non-Life Reserve Risk KPI: Observation (Aggregate)



- No extreme thresholds breached
- Are we overestimating uncertainty?
- Are the 80th / 20th percentile values surprising, given that we have 9 AY observations?

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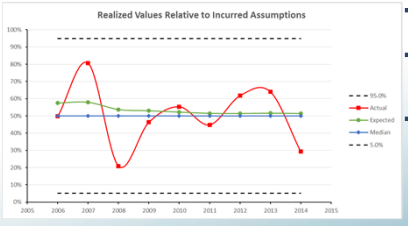
Integrated ERM Framework

Non-Life Reserve Risk KPI: Observation (Aggregate)



- No extreme thresholds breached
- Are we overestimating uncertainty?
- Are the 80th / 20th percentile values surprising, given that we have 9 AY observations?

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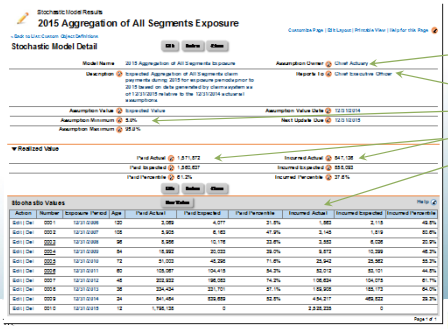
Integrated ERM Framework

Non-Life Reserve Risk KPI: Aggregate Paid



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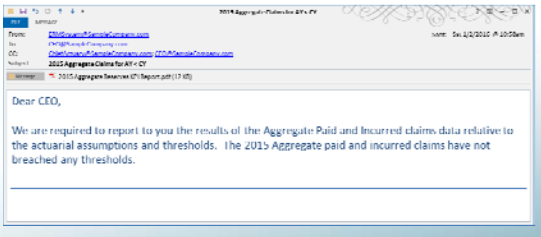
Integrated ERM Framework

Automated E-Mail to the CEO



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Monitor/Control Reserving Risk

Do outcomes tell us something? (ΣAY<CY)

Sample Insurance Company
Summary of Theshold Activity by Segment as of December 31, 2015

	Number						Percentage					
	25% < X < 75%		5% < X < 95%		5% > X > 95%		25% < X < 75%		5% < X < 95%		5% > X > 95%	
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
PPA	10	14	18	18	2	2	50.0%	70.0%	90.0%	90.0%	10.0%	10.0%
CA	10	5	18	14	2	6	50.0%	25.0%	90.0%	70.0%	10.0%	30.0%
HO	10	12	18	20	2	0	50.0%	60.0%	90.0%	100.0%	10.0%	0.0%
AGG	10	18	18	20	2	0	50.0%	90.0%	90.0%	100.0%	10.0%	0.0%
Total	40	49	72	72	8	8	50.0%	61.3%	90.0%	90.0%	10.0%	10.0%

- Overall actual results are consistent with expectations
  - Includes both AY and Total (ΣAY<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 (ΣAY<CY)

- Given the actual losses paid in CY 2015, we can obtain a preliminary estimate of the amount by which reserves for AY 2014 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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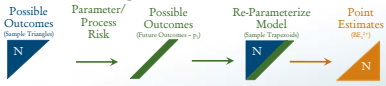
Monitor/Control Reserving Risk

One-year time horizon reserve changes (ΣAY<CY)

- Calculate, separately for each LOB:
  - "Conditional Reserve @ 31 December 2015" = 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 2015
  - "Expected Reserve @ 31 December 2015" = Expected Reserve @ 31 December 2014 less CY 2015 Paid
    - This is the reserve @ 31 December 2015 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 (ΣAY<CY)

Sample Insurance Company
Aggregation of All Segments
Summary of Conditional Reserves as of December 31, 2015

	Private Passenger Auto			Commercial Auto			Homeowners			Total
AY	Conditional Reserve	Expected Reserve	Change	Conditional Reserve	Expected Reserve	Change	Conditional Reserve	Expected Reserve	Change	Change
2006	2,680	2,991	(311)	643	603	40	-	747	(747)	(1,018)
2007	7,248	5,498	1,750	3,257	4,242	(985)	164	721	(557)	208
2008	8,654	10,061	(1,406)	1,675	2,582	(907)	1,367	1,640	(272)	(2,586)
2009	15,635	19,472	(3,836)	5,593	4,121	1,472	(1,153)	1,793	(2,946)	(5,311)
2010	31,595	38,066	(6,470)	13,946	6,632	7,313	3,722	340	3,381	4,224
2011	73,359	71,302	2,057	20,073	19,441	630	3,979	6,894	(2,915)	(228)
2012	151,670	156,061	(4,390)	57,978	45,442	12,536	12,839	9,468	3,370	11,516
2013	292,882	322,812	(29,930)	110,701	81,627	29,075	21,590	26,615	(5,024)	(5,880)
2014	581,448	574,019	7,430	170,589	147,146	23,442	59,458	80,333	(20,875)	9,997
2015										
Totals	1,165,174	1,200,281	(35,107)	384,456	311,837	72,619	101,967	128,553	(26,586)	10,926
AY<CY	1,159,897	1,200,281	(40,385)	390,213	311,837	78,376	96,676	128,553	(31,876)	6,115

- AYs 2012-14 should also drive reserves up
  - Most of this increase is driven by CA

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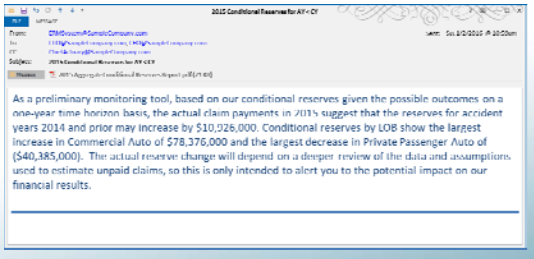
Integrated ERM Framework

Automated E-Mail to the CEO/CFO



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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 (ΣAY<CY)

- CA

Sample Insurance Company
Commercial Auto
Stochastic Actual vs. Expected as of December 31, 2015

AY	Age	Actual Paid	Expected Paid	Percentile	Actual Incurred	Expected Incurred	Percentile
2006	120	543	571	57.9%	(47)	154	0.0%
2007	108	2,387	3,131	21.8%	1,040	448	82.8%
2008	96	1,177	1,665	33.5%	851	1,167	44.5%
2009	84	5,403	5,044	63.1%	2,954	1,669	86.1%
2010	72	14,120	11,061	91.1%	9,035	5,606	94.2%
2011	60	23,636	23,276	56.1%	16,524	11,960	93.9%
2012	48	51,020	45,272	86.7%	36,454	29,103	92.7%
2013	36	75,813	62,481	96.5%	61,541	44,392	99.3%
2014	24	88,832	79,698	86.1%	83,154	66,555	97.0%
2015	12	99,123			178,539		
Totals		362,054			390,045		
AY<CY		262,931	232,199	98.9%	211,506	161,054	100.0%

- AYs 2009-14 are driving high #s
  - Need to check assumptions (i.e., IELRs, LDFs, weights, etc.)

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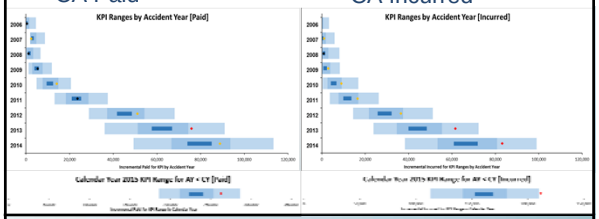
Monitor/Control Reserving Risk

Compare CA actual to expected (ΣAY<CY)

- CA Paid
- CA Incurred



- AYs 2009-14 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 2014 model biased low?

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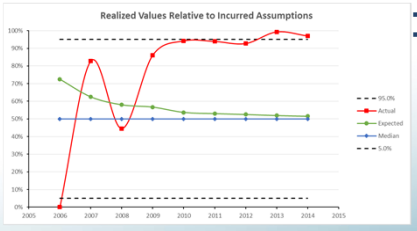
The Actuary & Enterprise Risk Management: Integrating Reserve Variability

Integrated ERM Framework

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



- Threshold breached
- Are expectations from the 2014 model biased low?
  Check 2013

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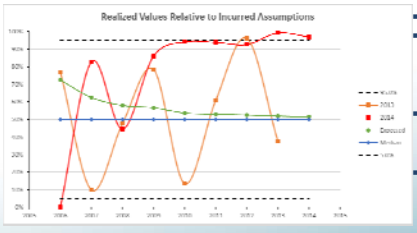
Integrated ERM Framework

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



- Threshold breached
- Are expectations from the 2014 model biased low?
  Check 2013
- 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

Dear Chief Actuary,

We are required to report to you, based on the 12/31/2014 actuarial assumptions and the 5%/95% thresholds, that there are two Private Passenger Auto breaches, six Commercial Auto breaches and zero Homeowners breaches. The Data Quality, Claims Adjustment and Reinsurance departments have also been informed. Please review the 2015 paid accruals, the 12/31/2014 actuarial assumptions, and non-actuarial input.

Please determine if the breach is the result of a misestimated mean, misestimated variability or due to external circumstances and report your findings to the CEO and CRO.

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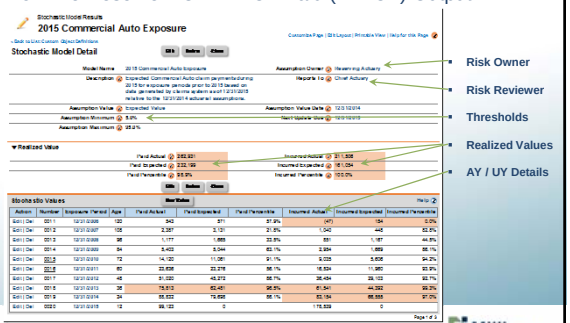
Integrated ERM Framework

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



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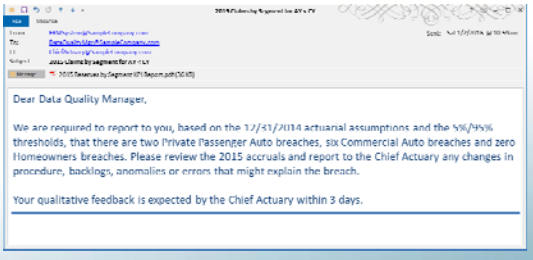
Automated E-Mail to Data Quality Department



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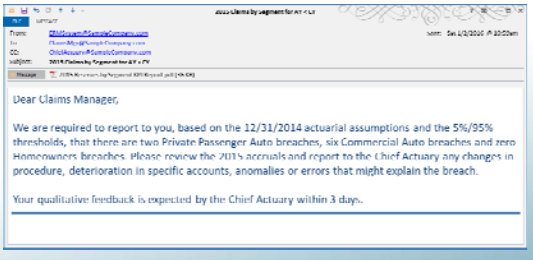
Automated E-Mail to Claims Department



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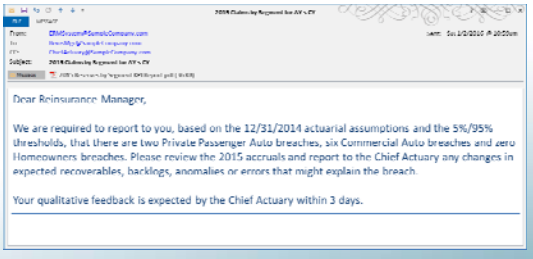
Automated E-Mail to the Reinsurance Department



Dear Reinsurance Manager,

We are required to report to you, based on the 12/31/2014 actuarial assumptions and the 5%/95% thresholds, that there are two Private Passenger Auto breaches, six Commercial Auto breaches and zero Homeowners breaches. Please review the 2015 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.

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Validation as of 31 December 2014

- We validated last year
- Why so far off the mark?
- Need systematic review of assumptions

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Validation as of 31 December 2014

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?
- 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)
- Exposure Growth?

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Validation as of 31 December 2014

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
- IELRs & CoVs used in BF Models
- Weighting of models
- Shifting mean of distribution
- Missed CY trend?

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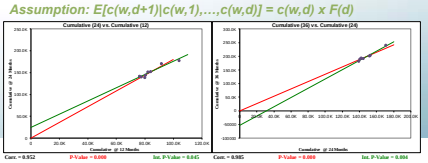
Validation as of 31 December 2014

Assumptions: LDF Validation (Paid)

Sample Insurance Company
Commercial Auto -- Paid Data
Chain Ladder Development as of December 31, 2014

AY	12	24	36	48	60	72	84	96	108
2006	77,401	140,425	189,316	223,326	243,182	250,182	254,305	256,672	257,689
2007	76,085	142,122	193,196	224,406	246,220	257,226	263,698	264,871	
2008	79,850	139,041	181,905	209,366	228,012	237,792	240,300		
2009	80,323	144,482	192,134	227,723	249,165	259,339			
2010	83,919	152,487	203,761	245,150	270,525				
2011	82,001	151,768	201,189	245,541					
2012	91,514	170,696	240,652						
2013	103,957	177,709							
2014	105,547								
	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
ATA	1.805	1.347	1.184	1.095	1.039	1.018	1.007	1.004	1.002
CDF	3.385	1.875	1.392	1.176	1.074	1.033	1.015	1.008	1.004
Unpaid	0.705	0.467	0.282	0.149	0.069	0.032	0.015	0.008	0.004

Assumption: E[c(w,d+1)|c(w,1),…,c(w,d)] = c(w,d) x F(d)



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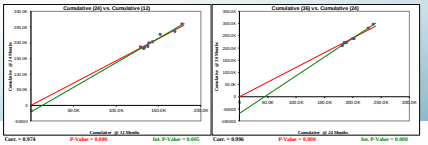
Validation as of 31 December 2014

Assumptions: LDF Validation (Incurred)

Sample Insurance Company
Commercial Auto – Incurred Data
Chain Ladder Development as of December 31, 2014

AY	12	24	36	48	60	72	84	96	108
2006	133,521	185,161	221,635	241,420	251,646	255,508	256,596	258,041	258,524
2007	128,727	187,403	222,093	247,345	258,712	265,636	269,558	270,758	
2008	132,567	181,263	209,262	226,237	236,863	241,107	242,171		
2009	137,295	188,962	222,624	247,335	258,856	265,496			
2010	142,862	202,363	239,239	269,940	281,376				
2011	138,650	199,791	239,719	266,101					
2012	151,778	227,353	282,394						
2013	169,171	235,983							
2014	177,611								
	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
ATA	1.418	1.193	1.106	1.045	1.022	1.008	1.005	1.002	1.001
CDF	2.029	1.431	1.200	1.085	1.038	1.016	1.008	1.003	1.001
Unpaid	0.507	0.301	0.166	0.078	0.037	0.016	0.008	0.003	0.001

Assumption: E[c(w,d+1)|c(w,1),…,c(w,d)] = c(w,d) x F(d)



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Validation as of 31 December 2014

Assumptions: AY Independence

Assumption: {c(i,1), …, c(i,n)} & {c(j,1), …, c(j,n)} are independent for i≠j

Test of the Independence Between Accident Years (Paid)

AY	12	24	36	48	60	72	84	96
2006	1.81	1.35	1.18	1.09	1.03	1.02	1.01	1.00
2007	1.87	1.36	1.16	1.10	1.04	1.03	1.00	
2008	1.74	1.31	1.15	1.09	1.04	1.01		
2009	1.80	1.33	1.19	1.09	1.04			
2010	1.82	1.34	1.20	1.10				
2011	1.85	1.33	1.22					
2012	1.87	1.41						
2013	1.71							
Median	1.82	1.34	1.18	1.09	1.04	1.02	1.01	1.00

CY	
Small	Large
1	0
0	2
2	1
4	0
3	2
1	3
1	5
4	3

Test of the Independence Between Accident Years (Incurred)

AY	12	24	36	48	60	72	84	96
2006	1.39	1.20	1.09	1.04	1.02	1.00	1.01	1.00
2007	1.46	1.19	1.11	1.05	1.03	1.01	1.00	
2008	1.37	1.15	1.08	1.05	1.02	1.00		
2009	1.38	1.18	1.11	1.05	1.03			
2010	1.42	1.18	1.13	1.04				
2011	1.44	1.20	1.11					
2012	1.50	1.24						
2013	1.39							
Median	1.41	1.19	1.11	1.05	1.02	1.00	1.01	1.00

CY	
Small	Large
1	0
0	2
2	0
3	1
3	1
2	4
1	6
4	2

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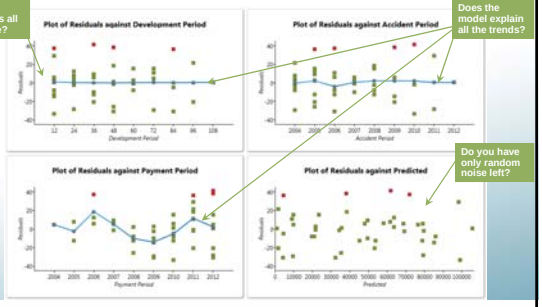
Validation as of 31 December 2014

Assumptions: CA Paid Diagnostics

Are the variances all the same?

Does the model explain all the trends?

Do you have only random noise left?



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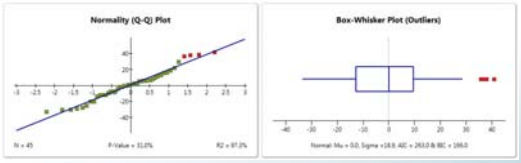
Validation as of 31 December 2014

Assumptions: CA Paid 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 2014

Assumptions: BF Initial Expected Loss Ratio

- Choice of 2014 IELR?
  - Management: 52.9%
  - Incurred CL: 57.7%
  - Paid CL: 57.3%

Sample Insurance Company
Commercial Auto

AY	Paid CL ULR	Inc CL ULR	Management IELR	Selected ULR
2006	73.2%	73.2%	73.3%	73.2%
2007	76.0%	77.3%	77.4%	76.7%
2008	64.5%	64.5%	64.6%	64.5%
2009	62.8%	63.2%	63.2%	63.0%
2010	60.4%	60.7%	60.8%	60.6%
2011	53.2%	53.2%	53.4%	53.2%
2012	57.9%	58.5%	58.5%	58.2%
2013	54.5%	55.3%	54.7%	54.9%
2014	57.3%	57.7%	52.9%	54.7%

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Validation as of 31 December 2014

Assumptions: BF IELR and Weights

Sample Insurance Company
Commercial Auto
Calculation of Weighted Ultimate as of December 31, 2014

		Ultimate Values by Method				Weights by Method				Weighted
AY	Age	Paid CL	Inc CL	Paid BF	Inc BF	Paid CL	Inc CL	Paid BF	Inc BF	Ultimate
2006	108	258,835	258,835	258,837	258,836	50.0%	50.0%	0.0%	0.0%	258,835
2007	96	267,103	271,591	267,143	271,592	50.0%	50.0%	0.0%	0.0%	269,347
2008	84	243,981	244,137	243,991	244,141	50.0%	50.0%	0.0%	0.0%	244,059
2009	72	267,942	269,784	267,999	269,783	50.0%	50.0%	0.0%	0.0%	268,863
2010	60	290,475	292,079	290,608	292,092	50.0%	50.0%	0.0%	0.0%	291,277
2011	48	288,645	288,592	288,785	288,669	50.0%	50.0%	0.0%	0.0%	288,618
2012	36	335,023	338,775	335,956	338,702	25.0%	25.0%	25.0%	25.0%	337,114
2013	24	333,220	337,698	333,662	336,635	0.0%	0.0%	50.0%	50.0%	335,149
2014	12	357,305	360,286	338,097	344,953	0.0%	0.0%	50.0%	50.0%	341,525
Totals		2,642,529	2,661,779	2,625,078	2,645,402					2,634,788

- Optimism Regarding AY 2014 ULR
  - In this example, IELR based on published figures (selected ultimate)
  - IELR is an important assumption which requires additional validation
    - Consider renewal study performed by Underwriting
    - Consider actuarial analysis of average rate achieved
  - Sensitivity tests confirm that this assumption is only a partial explanation

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Validation as of 31 December 2014

Assumptions: BF Initial Expected Loss Ratio

- 2014 IELR
  - No longer 52.9%
  - Used 57.5%
- Explains AY 2014 deviation only
- Still breach LoB threshold

AY	Age	Actual Paid	Initial Expected	Initial Percentile	Alternative Expected	Alternative Percentile
2004	120	543	577	57.5%	566	57.8%
2005	108	2,387	1,643	91.8%	1,064	91.4%
2006	96	1,177	1,636	35.6%	1,639	35.2%
2007	84	5,403	4,540	74.1%	4,569	73.3%
2008	72	14,120	10,630	93.5%	10,650	93.1%
2009	60	23,636	23,300	56.2%	23,359	54.8%
2010	48	51,020	44,746	88.8%	44,662	89.3%
2011	36	75,813	62,082	96.9%	62,032	97.1%
2012	24	88,832	79,335	87.0%	85,452	66.2%
2013	12	99,123	-			
CY 2013		362,054				
AY=CY		262,931	227,890	99.6%	233,994	98.5%

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Validation as of 31 December 2014

Assumptions: BF Coefficient of Variation

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

	Coefficient of Variation				
	Chain Ladder (Unshifted)		IELR	BF (Unshifted)	
AY	Paid	Incurred	CoV	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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Validation as of 31 December 2014

Assumptions: BF Coefficient of Variation (*Alternative*)

- BF models
  - IELR consistent with BE
  - CoV (IELR) = 0%
- Weights identical to BE

	Coefficient of Variation				
	Chain Ladder (Unshifted)		IELR	BF (Unshifted)	
AY	Paid	Incurred	CoV	Paid	Incurred
2004	55.9%	56.5%	0.0%	78.1%	78.5%
2005	49.4%	48.9%	0.0%	56.0%	56.5%
2006	38.0%	37.3%	0.0%	40.5%	40.9%
2007	24.4%	24.3%	0.0%	25.7%	25.0%
2008	16.1%	15.3%	0.0%	16.1%	15.9%
2009	11.3%	10.1%	0.0%	10.4%	10.4%
2010	8.1%	6.9%	0.0%	6.9%	7.0%
2011	7.2%	6.2%	0.0%	5.1%	5.5%
2012	7.6%	6.6%	0.0%	4.0%	4.7%
Total	4.9%	4.0%		3.1%	3.2%

In this case, the use of the BF reduces variability of the resulting distribution

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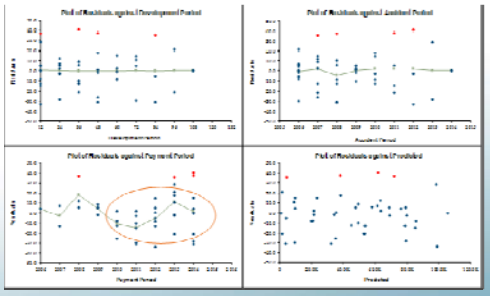
Validation as of 31 December 2014

We validated last year. Why so far off? CY Trend



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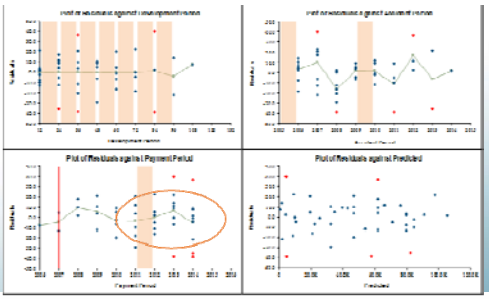
New GLM model with CY Trend:

No Trend for 2006-2011 and 7.3%/6.4% for 2011-2014+



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Monitor/Control Reserving Risk

Impact of change in prior assumption (ΣAY<CY)

Sample Insurance Company
Commercial Auto
Stochastic Actual vs. Expected as of December 31, 2015

AY	Age	Actual Paid	Expected Paid	Percentile	Actual Incurred	Expected Incurred	Percentile
2006	120	543	432	69.4%	(47)	228	2.0%
2007	108	2,387	942	96.6%	1,040	516	86.8%
2008	96	1,177	2,117	14.0%	851	1,181	37.9%
2009	84	5,403	5,001	64.1%	2,954	2,665	64.7%
2010	72	14,120	12,100	82.3%	9,035	6,659	89.8%
2011	60	23,636	27,514	11.8%	16,524	13,869	84.2%
2012	48	51,020	46,010	87.6%	36,454	31,896	87.7%
2013	36	75,813	66,910	94.6%	61,541	50,020	98.5%
2014	24	88,832	88,362	54.1%	83,154	78,184	77.8%
2015	12	99,123			178,539		
Totals		362,054			390,045		
AY<CY		262,931	249,388	86.0%	211,506	185,218	98.7%

- Adding CY trend parameter to model improves fit & results?
  - GLM model also adjusted for exposures
  - Statistics comparable, some better, some not as good

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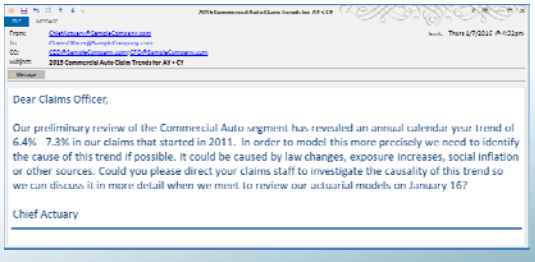
Integrated ERM Framework

Manual E-Mail to the Claims Officer



Dear Claims Officer,

Our preliminary review of the Commercial Auto segment has revealed an annual calendar year trend of 6.4% 7.3% in our claims that started in 2011. In order to model this more precisely we need to identify the cause of this trend if possible. It could be caused by law changes, exposure increases, social inflation or other sources. Could you please direct your claims staff to investigate the causality of this trend so we can discuss it in more detail when we meet to review our actuarial models on January 16?

Chief Actuary

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Validation as of 31 December 2014

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

Rank Correlation of Residuals prior to Hetero Adjustment - Paid

	PPA	CA	HO
PPA	1.000	0.276	-0.142
CA	0.276	1.000	0.027
HO	-0.142	0.027	1.000

P-Values of Rank Correlation of Residuals prior to Hetero Adjustment - Paid

	PPA	CA	HO
PPA	0.000	0.066	0.352
CA	0.066	0.000	0.860
HO	0.352	0.860	0.000

In this case, the calculated correlation is not significantly different from zero.

Assumed Correlation Matrix

	PPA	CA	HO
PPA	1.000	0.276	0.000
CA	0.276	1.000	0.000
HO	0.000	0.000	1.000

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Any Final Questions?

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