



#### Paper Outline Introduction Companion Files: Notation Used to create all tables & Back-Testing graphs in paper 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 2

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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?

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- 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
<ul> <li>Building Block, Risk Adjustment, Disclosure</li> </ul>
<ul> <li>Solvency II</li> </ul>
- Quantification, Validation, Governance
<ul> <li>NAIC Model Audit Rule</li> </ul>
<ul> <li>Internal Data, Process, Reporting Validation</li> </ul>
<ul> <li>Own Risk Solvency Assessment (ORSA)</li> </ul>
– Model Act Fall, 2012 $\Rightarrow$ Effective 1/1/15
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#### Integrated ERM Framework

 Conduct deterministic analysis to get a best estimate (BE) or central estimate

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- 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

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- 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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				urance Company n of All Segmen							
Deterministic Actual vs. Expected as of December 31, 2015											
	Age	Paid	Paid	Difference	Incurred	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						
AY <cy< td=""><td></td><td>1,571,872</td><td>1.544.400</td><td>27,471</td><td>847,136</td><td>881.022</td><td>(33.886)</td></cy<>		1,571,872	1.544.400	27,471	847,136	881.022	(33.886)				



# Stochastic Back-Testing

- Key Question: Is outcome *significantly* different than expected?
- Distribution of possible outcomes is source of "Expectation" from which to test deviations

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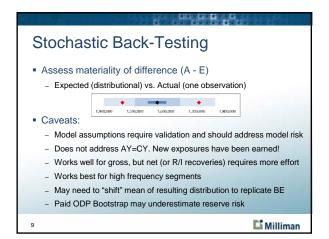
- Expectation can be expressed as cumulative or incremental
- Multiple models encourages assumption consistency Focused on significance of outcome

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Distribution can be used to pre-define KPI thresholds

0% 5% 25% 75% 95% 100%

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				urance Company n of All Segment:							
Stochastic Actual vs. Expected as of December 31, 2015											
			Expected			Expected					
AY	Age	Paid	Paid	Percentile	Incurred	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						
AY <cy< td=""><td></td><td>1,571,872</td><td>1.560.637</td><td>61.2%</td><td>847,136</td><td>858.093</td><td>37.6%</td></cy<>		1,571,872	1.560.637	61.2%	847,136	858.093	37.6%				

#### 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
- <u>IN CONTRAST</u>: 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.

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#### Reserving Within an ERM Framework

ERM is a continuous process;

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- 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

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#### Reserving Within an ERM Framework

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- 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...

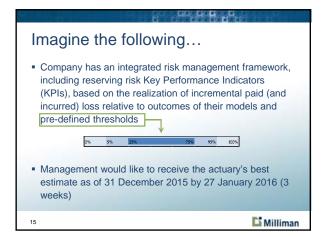
The date is 4 January 2016

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- 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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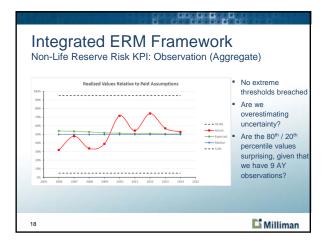


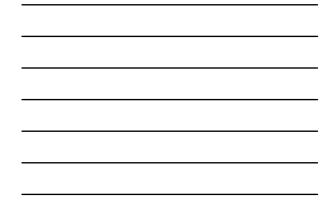
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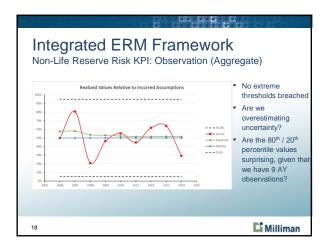
Monitor/Control Res	serving Risk
Compare actual to expected	l (ΣAY <cy)< td=""></cy)<>
<ul> <li>Aggregate Paid Loss</li> </ul>	<ul> <li>Aggregate Incurred Loss</li> </ul>
Calendar Year 2015 KPI Range for AY < CY [Paid]	Calendar Year 2015 KPI Range for AY < CY [Incurred]
0 200,000 KEC000 600,000 KEC000 L000,000 L200,000 L000,000 L000,000 2,000,000 0 Incremental Paid for #19 Range to Galandar Tear	200,000 KK0,000 600,000 KK0,000 L00,000 L200,000 L200,000
PPA Paid	<ul> <li>PPA Incurred</li> </ul>
Calendar Year 2015 KPI Range for AY < CY [Paid]	Calendar Year 2015 KPI Range for AY < CY [Incurred]
0 200,000 400,000 400,000 800,000 1,000,000 1,000,000 0 Revenuente Piete for UP Exage in Colonder Year	100,000 200,000 300,000 400,000 100,000 000,000 900,000 900,000 900,000
<ul> <li>CA Paid</li> </ul>	<ul> <li>CA Incurred</li> </ul>
Calendar Year 2015 KPI Range for AY < CY [Paid]	Calendar Year 2015 KPI Range for AV < CY [Incurred]
HO Paid	HO Incurred
Calendar Year 2015 KPI Range for AY < CY [Paid]	Calendar Year 2015 KPI Range for AY < CY [Incurred]
50,000 190,000 230,000 230,000 230,000 400,000 0	2000 4000 6000 10000 10000 10000 10000 10000 10000 20000
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Monitor/Control Reserving Risk Compare actual to expected (SAY <cy) • Aggregate</cy) 											
	Sample Insurance Company Aggregation of All Segments										
			Stochastic A Actual	Actual vs. Expec Expected		mber 31, 2018 Actual					
	AY		Paid		Percentile	Incurred	Incurred				
NOTE:	2006	120	3.069	4.077	31.8%	1.863	2.115	49-8%			
Comparison of	2000	108	5,905	6,163	47.9%	3,145	1.819	80.6%			
aggregate accruals	2008	96	8,986	10.176	33.6%	3,553	6.026	20.9%			
requires correlation	2009	84	18,992	20.033	39.0%	9.872	10,399	46.3%			
assumptions	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< td=""><td></td><td>1.571.872</td><td>1.560.637</td><td>61.2%</td><td>847.136</td><td>858.093</td><td>37.6%</td></cy<>		1.571.872	1.560.637	61.2%	847.136	858.093	37.6%			
<ul> <li>Several of the 20 observable outcomes are near the thresholds</li> <li>20 observable outcomes = (9 AYs + 1 ΣAY<cy) and="" for="" incurred<="" li="" paid=""> <li>AY 2015 could be addressed if pricing risk was included in analysis</li> </cy)></li></ul>											
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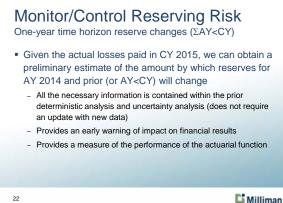



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Action	Number	Exposure Period	Apr	Perd Actual	Perdicipected	Paid Percentile	Incurred Actual	Incurred Expected	Incurred Percentile		
Edit Del	0001	12/31/2/008	120	3,069	4,017	31.8%	0.000	2,118	41.55		
Edt   Del	000 2	12/31 (2007	105	5,905	6,163	47.95	2,145	1,519	51.6%		
Set Del	0004	12/31 (2008	-	0,400	20,022	21.05	4,554	10,200	425		
Edt   Del	000.5	12/31 (2010	72	\$1,003	4.28	71.0%	21,942	25,562	55.2%		
Delli Del	202.6	1231 2011	60	105,067	104,415	54.2%	52,012	\$3,101	44.8%		
	000 7	12/31/2/312	4 8	212,922	196,063	14.25	100,024	104,075	61.7%		
Edij Del						57.1%	454,217	105,173	22		
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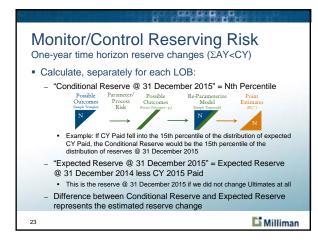






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				onal Reserves a ommercial Auto	egments s of December				
	e Passenger A Expected								
eserve	Reserve	Change	Reserve	Reserve	Change	Reserve	Reserve	Change	Change
2,680						164	747		(1,0)
8,654	10,061	(1,406)	1,675	2,582	(907)	1,367	1,640	(272)	(2,5
15,635	19,472	(3,836)	5,593	4,121	1,472	(1,153)	1,793	(2,946)	(5,3
									4,23
									11.5
292,882	322,812	(29,930)	110,701	81,627	29,075	21,590	26,615	(5,024)	(5,8
581,448	574,019	7,430	170,589	147,146	23,442	59,458	80,333	(20,875)	9,9
,165,174	1,200,281	(35,107)	384,456	311,837	72,619	101,967	128,553	(26,586)	10,9
,159,897	1,200,281	(40,385)	390,213	311,837	78,376	96,676	128,553	(31,876)	6,1
	2,680 7,248 8,654 15,655 31,595 73,359 151,670 292,882 581,448 165,174 159,897	Content         Reserve           2,880         2,991           7,240         2,991           7,240         2,991           7,240         2,991           7,240         2,991           7,240         2,991           7,240         2,991           15,635         19,472           31,595         38,066           7,3359         77,302           151,670         156,061           292,882         322,812           292,484         574,019           165,174         1,200,281           159,897         1,200,281	science         Penetree         Charge           2.860         2.991         (311)           7.248         5.488         1.750           8.654         10.061         (1.408)           15.653         19.472         (3.438)           31.565         36.66         (6.470)           73.369         71.302         2.057           51.670         16.062         (2.930)           524.48         57.4(19)         7.438           195.514         1.900/261         (60.385)           195.514         1.200/261         (40.385)	Charge         Charge         Pearse           2280         2391         (311)         643           7248         5.498         (711)         643           7248         5.498         (711)         5.493           71535         1947         (133)         5.573           71545         1947         (143)         5.573           71545         194.02         2.057         2.057           71547         156.001         6.4300         57371           761,472         2.574         7.430         7.738           714,472         2574.016         7.430         57371           74,538         170,0281         6.5107         384.466           159,474         1.200,281         (65,107)         384.465           159,474         1.200,281         (65,107)         386.243	Chance         Chance         Persone         Resone           2280         2.991         (311)         643         603           7248         5.498         (1710)         3.257         4.262           15455         1.947         (1.730)         3.257         4.262           15455         1.947         (1.330)         5.53         4.111           15455         1.947         (1.330)         5.53         4.111           15457         1.942         2.057         2.0431         5.543         4.114           154,57         1.95.051         (2.130)         5.7378         45.442         5.442         1.74,146           154,142         1.974,016         7.4301         7.7388         1.72,146         1.74,146           154,142         1.202,1281         (6.5107)         3.842,462         3.11,837         1.930,281         4.54,424         3.11,837           159,1697         1.200,281         (6.5107)         3.842,462         3.11,837         1.930,281         4.93,485         3.930,213         3.11,837	Desize         Charge         Rearce         Filterior         Charge           2.880         2.981         (311)         643         663         40           7.248         5.488         1.730         3.257         4.242         (88)           5.485         1.0427         (1.430)         5.633         4.241         (84)           5.455         1.0427         (1.430)         5.633         4.241         (1.420)           31.955         38.066         0.470         13.846         6.632         7.313           515.057         1.52,057         2.507         2.073         16.441         12.358           515.067         1.52,057         1.53,005         1.57,378         45.442         12.339           514.49         0.74,019         1.51,070         1.61,71         1.22,072         2.2073         1.64,14         12.338           514.39         0.74,710         1.51,070         1.51,073         1.64,42         12.338         12.23,073         1.64,444         12.338         12.24,072         12.073         15.441         12.338         12.073         15.441         12.338         12.073         15.041         12.044    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  19.379         6.844           151.670         156.081         (2.930)         57.379         45.442         12.589         12.849         5.468         23.442         53.468         53.337           981.448         574.019         7.401         170.589         147.146         72.349         12.859         53.333           169.147         1.200.281         64.049         311.837         78.376         96.676         128.563</td><td>Catche         Charge         Reacte         Phane         Charge         Peane         Charge           2,280         2,290         0,310         643         603         640         77</td></t<>	Extent         Charge         Reserve         Descrip         List         Searve         Searve         Searve         Searve         Searve         Searve         Searve         Searve         Searve         Searve	Extent         Charge         Reserve         Phanne         Charge         Reserve           2280         2280         2281         611         642         603         60         724           7248         5.448         1700         3.57         4.342         2680         149         7217           15455         1947         1700         3.57         4.342         2680         149         7217           15455         1947         0.430         1.575         1627         1.672         1.153         1.733           31.955         38.066         6.470         1.346         6.632         7.313         3.722         340           37.399         71.300         2.577         2.0073         19.441         1.258         19.379         6.844           151.670         156.081         (2.930)         57.379         45.442         12.589         12.849         5.468         23.442         53.468         53.337           981.448         574.019         7.401         170.589         147.146         72.349         12.859         53.333           169.147         1.200.281         64.049         311.837         78.376         96.676         128.563	Catche         Charge         Reacte         Phane         Charge         Peane         Charge           2,280         2,290         0,310         643         603         640         77



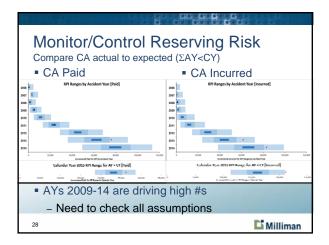


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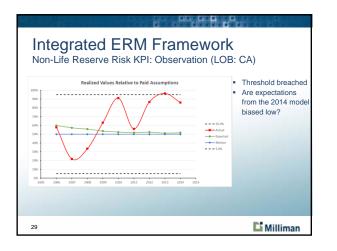
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• CA					urance Company nercial Auto			
			Actual	Expected		Actual		
	AY		Paid	Paid	Percentile	Incurred	Incurred	
	2006	120	543	571	57.9%	(47)	154	0.0%
	2007	108	2.387	3.131	21.8%	1.040	448	82.8
	2008	96	1,177	1.665	33.5%	851	1.167	44.5
	2009	84	5,403	5.044	63.1%	2.954	1.669	86.15
	2010	72	14,120	11.061	91,1%	9,035	5.606	
	2011	60	23,636	23,276	56.1%	16.524	11,960	
	2012	48	51.020	45.272	86,7%	36,454	29,103	
	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< td=""><td></td><td>262,931</td><td>232,199</td><td>98.9%</td><td>211.506</td><td>161.054</td><td>100.05</td></cy<>		262,931	232,199	98.9%	211.506	161.054	100.05



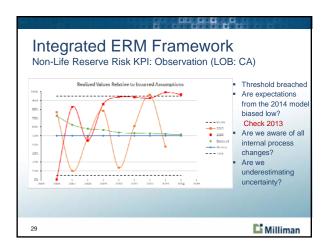








Realized Values Relative to Incurred Assumptions		<ul> <li>Threshold breached</li> <li>Are expectations from the 2014 mode biased low?</li> <li>Check 2013</li> </ul>
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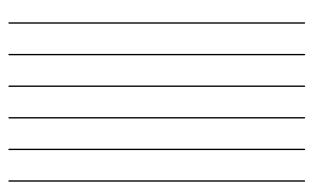
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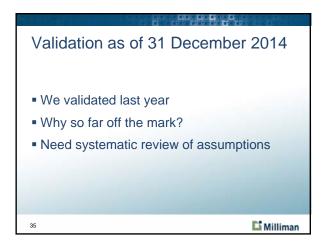
	Namplel company come and familia formany com	2014 Colorado Argeneral Inc AY's CY	Self: Kath/All & Baller
Mirrage 7 2015 Taxa	γλατιμά Company com γ μαρπατεία: Asr < ων εναι by Segment (D'i Report poh (10 kD)		
thresholds, that Homeowners b	d to report to you, based t there are two Private Pa reaches. Please review th	ssenger Auto breaches, si	rial assumptions and the 5%/95% ix Commercial Auto breaches and zero rt to the Chief Actuary any changes in reach.
Your qualitative	feedback is expected by	the Chief Actuary within 3	8 days.





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lu l	Beer My Provide Company com Dari Belsong (Provide Company com	
	2018 Claimving Regeneral for AY's CV	n (33)
thresho Homeov expecte	lds, that there are two Priv whers breaches. Please rev d recoverables, backlogs, a	based on the 12/31/2014 actuarial assumptions and the 5%/95% ate Passenger Auto breaches, six Commercial Auto breaches and aero iew the 2015 accruals and report to the Chief Actuary any changes in nomalies or errors that might explain the breach. ed by the Chief Actuary within 3 days.





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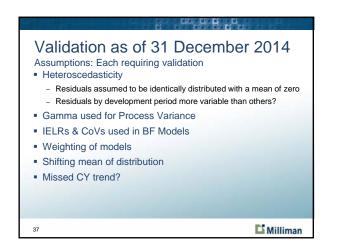
#### Validation as of 31 December 2014

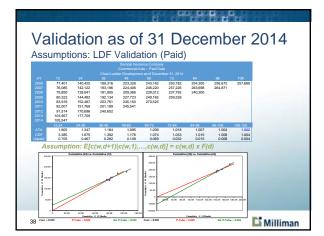
- Assumptions: Each requiring validation
- Long term average LDFs?
  - No validated reason to use shorter term averages (e.g., WA of last 5)
     In this example, model is 100% consistent with calculation of BE
  - If deterministic analysis uses a "picker approach" (to reflect observable trends), need 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?

36

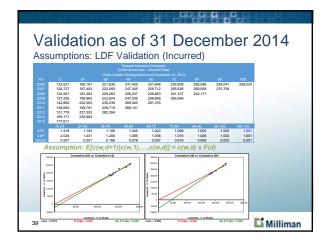
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Page 13 of 19

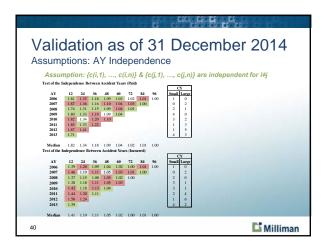


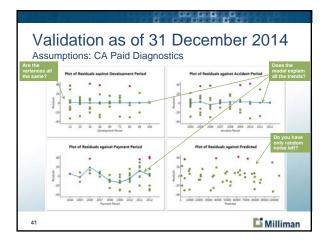


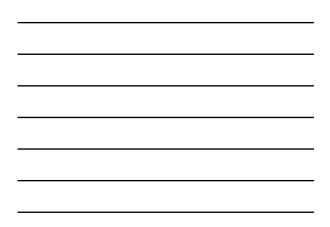


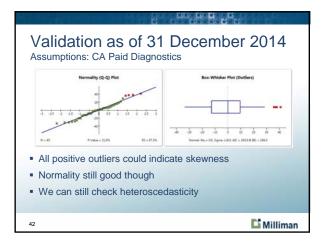














Validation as of Assumptions: BF Initial Ex	-			er 20 <sup>.</sup>	14
Choice of 2014 IELR?			e Insurance C Commercial A		
<ul> <li>Management: 52.9%</li> </ul>		Paid CL ULR	Inc CL ULR	Management IELR	Selected ULR
<ul> <li>Incurred CL: 57.7%</li> </ul>	2006 2007	73.2% 76.0%	73.2% 77.3%		73.2% 76.7%
- Paid CL: 57.3%	2007 2008 2009 2010 2011 2012 2013 2014	76.0% 64.5% 62.8% 60.4% 53.2% 57.9% 54.5% 57.3%	64.5% 63.2% 60.7% 53.2% 58.5% 55.3% 57.7%	64.6% 63.2% 60.8% 53.4% 58.5%	76.7% 64.5% 63.0% 60.6% 53.2% 58.2% 54.9% 54.7%
43				С	illiman


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			Ultimate Value				Weights by			
										Ultimate
2006	108	258,835	258,835	258,837	258,836	50.0%	50.0%	0.0%	0.0%	258,83
2007	96	267,103	271,591	267,143	271,592	50.0%	50.0%	0.0%	0.0%	269,34
2008	84	243,981	244,137	243,991	244,141	50.0%	50.0%	0.0%	0.0%	244,05
2009	72	267,942	269,784	267,999	269,783	50.0%	50.0%	0.0%	0.0%	268,86
2010	60	290,475	292,079	290,608	292,092	50.0%	50.0%	0.0%	0.0%	291,27
2011	48	288,645	288,592	288,785	288,669	50.0%	50.0%	0.0%	0.0%	288,61
2012	36	335,023	338,775	335,956	338,702	25.0%	25.0%	25.0%	25.0%	337,1
2013	24	333,220	337,698	333,662	336,635	0.0%	0.0%	50.0%	50.0%	335,14
2014	12	357,305	360,286	338,097	344,953	0.0%	0.0%	50.0%	50.0%	341,5
Totals		2,642,529	2,661,779	2,625,078	2,645,402					2,634,78
-	In this IELR	n Regar s example is an imp onsider re	e, IELR	based assump	on publi tion whi	ch requi	ires ado			·
		onsider ac		· ·				a partia		

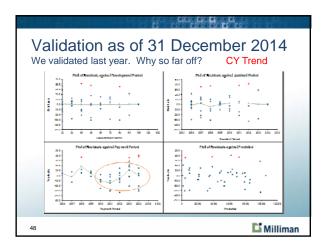
Validation as Assumptions: BF Initial				-	er	201	4
2014 IELR			Actual	Initial	Initial	Alternative	Alternative
	AY	Age	Paid	Expected	Percentile	Expected	Percentile
<ul> <li>No longer 52.9%</li> </ul>	2004	120	543	577	57.5%	566	57.8%
- Used 57.5%	2005	108	2,387	1,043	91.8%	1,064	91.4%
- Used 57.5%	2006	96 84	1,177	1,636	35.6% 74.1%	1,639	35.2%
Explains AY 2014	2007	84 72	5,403 14,120	4,540 10.630	/4.1% 93.5%	4,569	73.3% 93.1%
	2008	60	23.636	23,300	93.5% 56.2%	23,359	54.8%
deviation only	2010	48	51.020	44,746	88.8%	44.662	89.3%
	2011	36	75,813	62,082	96.9%	62,032	97.1%
Still breach LoB	2012	24	88,832	79,335	87.0%	85,452	66.2%
	2013	12	99,123				
threshold							
	CY 2013		362,054				$\sim$
	AY≪CY		262,931	227,890	99.6%	233,994	(98.5%)
45						Ci Mil	liman



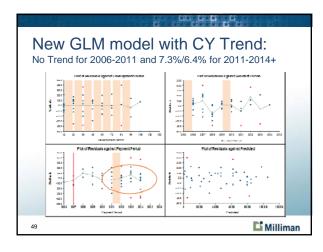
	8	Land Land	- 6	Li a	5 6 <sup>0</sup>	
Validation as of Assumptions: BF Coefficie	-			per 2	2014	4
BF models		-		cient of Variation		
		Chain Ladder Paid	(Unshifted) Incurred	IELR CoV	BF (Unsi Paid	hifted) Incurred
<ul> <li>IELR consistent with BE</li> </ul>						
	2004	55.9%	56.5%	8.0%	79.8%	78.6%
– CoV (IELR) = 8%	2005	49.4% 38.0%	48.9% 37.3%	8.0%	57.0%	56.5% 42.1%
	2006	38.0%	37.3%	8.0%	41.9% 26.9%	42.1%
	2007	24.4%	24.3%	8.0%	20.9%	20.8%
	2009	11.3%	10.1%	8.0%	13.2%	12.9%
- Maighte identical to DE	2010	8.1%	6.9%	8.0%	10.6%	10.0%
<ul> <li>Weights identical to BE</li> </ul>	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%
					1	
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				case, the		
				f the BF ariability		
				resulting		
46					Milli	iman

	a.	. <del>19</del> 94		ц.,					
Validation as of 31 December 2014 Assumptions: BF Coefficient of Variation ( <i>Alternative</i> )									
BF models				cient of Variat					
21 110000		Chain Ladder Paid	(Unshifted) Incurred		BF (Unst Paid	hifted) Incurred			
<ul> <li>IELR consistent with BE</li> </ul>	~	Palu	ncuneu	0.01	Palu	ncurreu			
	2004	55.9%	56.5%	0.0%	78.1%	78.5%			
– CoV (IELR) = 0%	2005	49.4% 38.0%	48.9% 37.3%	0.0%	56.0% 40.5%	56.5% 40.9%			
	2006	24.4%	24.3%	0.0%	40.5%	25.0%			
	2008	16.1%	15.3%	0.0%	16.1%	15.9%			
	2009	11.3%	10.1%	0.0%	10.4%	10.4%			
<ul> <li>Weights identical to BE</li> </ul>	2010	8.1%	6.9%	0.0%	6.9%	7.0%			
- Weights identical to be	2011	7.2%	6.2%	0.0%	5.1%	5.5% 4.7%			
	2012	1.078	0.076	0.076	4.076	4.775			
	Total	4.9%	4.0%		3.1%	3.2%			
					1				
			In this	case, the					
			use c	f the BF					
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imp	aciu	i chan	ge in pi	01 255	umptior	1 (ZA 1-	(01)		
					ercial Auto cted as of Dece				
			Actual	Expected		Actual			
			Paid	Paid		Incurred	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			
	AY <cy< td=""><td></td><td>262,931</td><td>249,388</td><td>86.0%</td><td>211,506</td><td>185,218</td><td>98.7%</td><td></td></cy<>		262,931	249,388	86.0%	211,506	185,218	98.7%	
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<ul> <li>A0</li> </ul>	aaing	j C Y II	ena para	ameter	r to mod	aer imp	roves i	it & resu	IIIS :
	CLA	model	alaa adiu	atad for	ovpoolur	~~			
-	GLIV	model	also adju	sted for	exposure	es			
	Stat	istics co	mparable	some	hattar sc	menot	hoon ac		
_	otat	131103 00	mparabic	, 301110	better, se	ine not	as good		
50								P7	
50								La Milli	mar







Validation as of 31 I Assumptions: Correlation by Seg • Measurement: - Use of rank or pairwise correlation of paid residuals - Could have used incurred residuals	IMENT Rank Correlation of Residuals prior to Hetero Adjustment - Paid PPA CA HO PPA 0.0276 -0.142
	PPA 0.000 0.066 0.352
Evaluation:	CA 0.066 0.000 0.860 HO (0.352) 0.860 0.000
<ul> <li>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.</li> </ul>	In this case, the calculated correlation is not significantly different from zero.
<ul> <li>Could have used incurred residuals</li> </ul>	Assumed Correlation Matrix PPA CA HO
<ul> <li>Could have used residuals after heteroscedasticity adjustment</li> </ul>	PPA CA HO PPA 1.000 0.276 0.0000 CA 0.225 1.000 0.0000 HO 0.000 0.000 1.000
<ul> <li>Can validate by tracking over time</li> </ul>	
52	🕻 Milliman