

GUY CARPENTER

 **MARSH** MEDICAL RISK
GUY CARPENTER OLIVER WATMAN

4 October 2007

Lemur Insurance Company
Case Study in Operational Risk:
The Elephant in the Room

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 **Marsh is a Marsh Companies**

Outline

- Operational risk in P&C insurance companies
- Lemur Insurance Company overview
- Construction of the Lemur case study
- Lemur's reserves
- Planning implications for Lemur
- Lemur's ICA Modeling
- Moral of the story

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Basel Committee Definition of Operational Risk

Banking Operational Risk

▪ "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk."

▪ They define seven types of operational risk:

- Internal fraud
- External fraud
- Employment practices and workplace safety
- Clients, products and business practices
- Damage to physical assets
- Business disruption and systems failures
- Execution, delivery and process management



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Measurement

Operational Risk

▪ Operational risk is difficult to measure and model

▪ Attempts:

- RAROC: operational risk contribution to required capital by analogy
- PRISM: low, medium, and high adjustment factors (5%-10%-15%)
- Event sets (e.g., ORX, ORIC)
- Distributional models (e.g., g-and-h distribution)

▪ Turning a blind eye toward key operational risks – simply because they are difficult to quantify – defeats the purpose of effective ERM.

This is the elephant in the room.



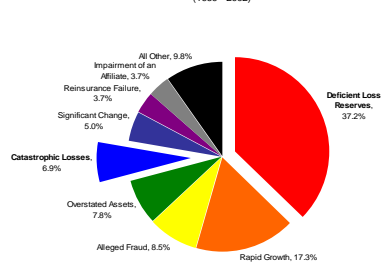
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A.M. Best Study

Operational Risk

Primary Causes of P&C Company Impairments
(1969 - 2002)

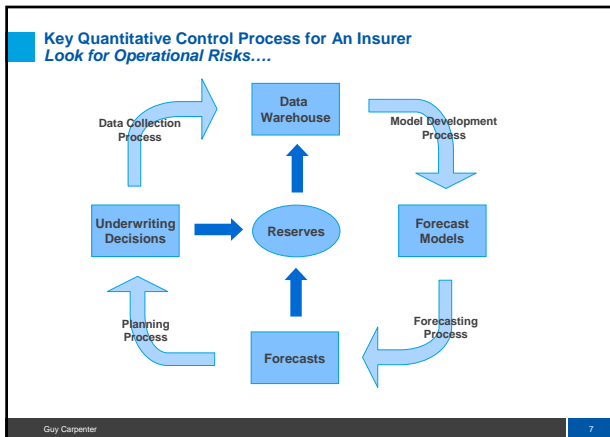


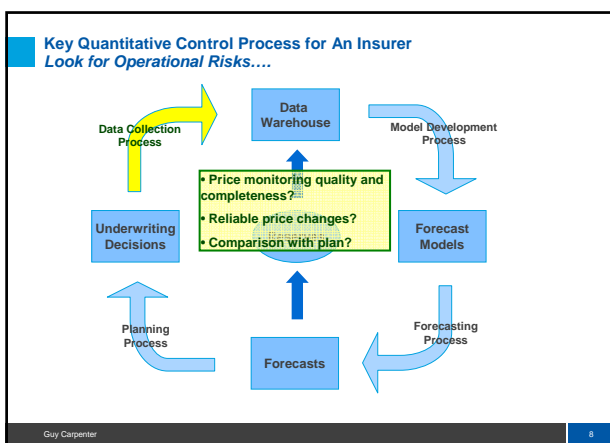
"With the possible exception of insolvency due to catastrophe losses, in A.M. Best's opinion, all the primary causes of insolvencies in this study were related to some form of **mismanagement**."

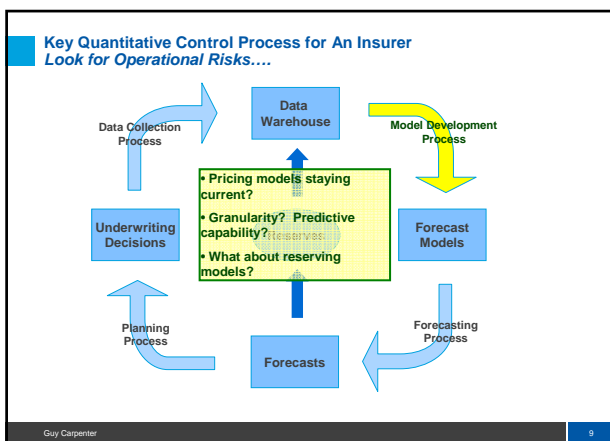
-- A.M. Best

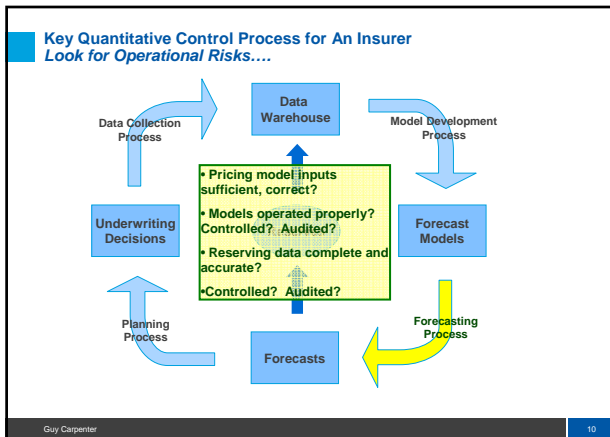
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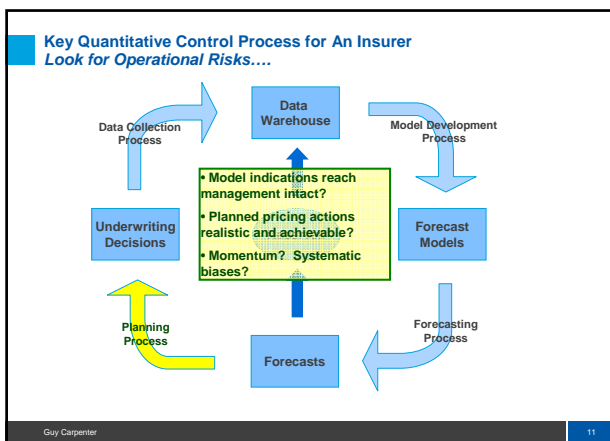
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Proximate Cause
Operational Risk

- Identifying reserve deficiencies as the cause of impairment is like identifying heart stoppage as a cause of death: factually accurate, but not very revealing
- Insufficient reserves are a lagging indicator; they are a symptom of a diseased process of company analyses and management decisions
- And so we present this case study in **Lemur Insurance Company**, highlighting the most significant operational risk an insurance company faces – the loss reserving process

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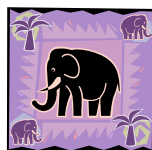
Overview
Lemur Insurance Company (Syndicate!)

- Business:
 - Lemur writes a book of monoline U.S. occurrence General Liability
 - Target loss ratio for a 20% pre-tax ROE ~ 80%
 - No other risks
- Financial condition
 - Plan on writing \$1,100,000 in premium in the upcoming year
 - Surplus position
 - \$487,000 – about 2:1 premium:surplus on next year's plan
 - BCAR ~ 150 based on premium and reserve factors, with minimal other risk
- Management protocol
 - Periodic actuarial reserve reviews using link ratios, Bornhuetter-Ferguson, and expected loss ratios
 - Recorded reserves are based on codified decision rules that weight together the three estimators
 - Annual planning process bridges 'historic' reserving ultimate loss ratios to the plan year with assumptions on trends and pricing

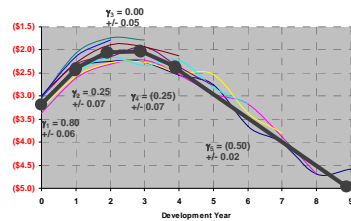
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Paid Loss Triangle Payment pattern

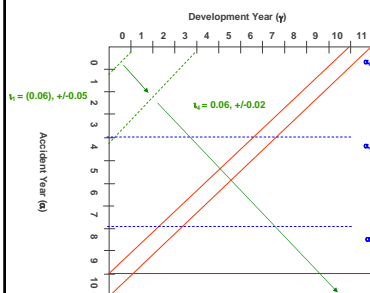


- A generalized least squares model was used to construct a triangle simulation based on real GL data
 - ln(incremental paid loss/exposure) was calculated and charted versus development year; each line is a separate accident year
 - Parameter values and standard errors were estimated
- Accident year and calendar year effects were added:*

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Paid Loss Triangle (cont.) Accident year and calendar year effects

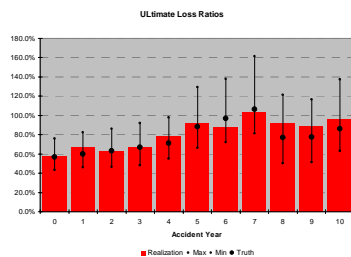


- Added calendar year and accident year effects to the triangle model
 - Simulated 1,000 triangles according to the formula
- $$Y_{ij} = \sum_k \alpha_k + \sum_j \gamma_j + \sum_{k=i+j} \gamma_k$$
- Standard error of the regression was $\sigma = 0.10$
 - Chose 1 simulation as the 'realization'
 - We also know the 'truth'

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Simulation Results Case Study Construction



- 1,000 simulations were performed, each one producing:
 - A future incremental calendar/ accident year incremental paid loss
 - Accident year ultimate losses for each accident year
 - Implied loss trends
- In total, the simulations define a range of possible results

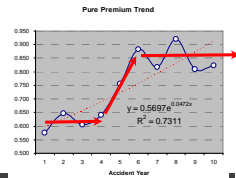
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Realization Case Study Construction

Exposure	Pricing	Earned Premium	Development Year	0	1	2	3	4	5	6	7	8	9	10
800,000	1.000	800,000	0	\$25,868	\$85,220	\$179,481	\$243,771	\$322,805	\$388,558	\$410,363	\$438,343	\$448,078	\$469,897	\$499,952
905,000	0.964	872,260	1	\$49,028	\$109,519	\$206,091	\$400,834	\$495,830	\$517,786	\$548,002	\$586,589	\$603,822	\$619,106	\$624,238
895,000	0.959	858,456	2	\$22,575	\$105,576	\$191,442	\$293,820	\$384,462	\$437,481	\$500,238	\$517,853	\$526,782	\$537,017	\$542,290
830,000	0.981	814,357	3	\$42,845	\$127,464	\$198,592	\$308,223	\$412,775	\$487,880	\$538,288	\$544,987	\$555,641	\$569,558	\$576,809
910,000	0.968	881,156	4	\$44,077	\$188,881	\$288,322	\$413,023	\$505,563	\$562,108	\$610,181	\$650,874	\$677,313	\$693,543	\$698,052
830,000	0.955	792,440	5	\$37,846	\$190,087	\$354,329	\$507,738	\$578,362	\$631,712	\$685,188	\$698,634	\$715,080	\$727,738	\$733,250
745,000	0.920	686,848	6	\$31,348	\$122,282	\$218,727	\$313,387	\$396,236	\$516,588	\$555,809	\$576,113	\$590,052	\$602,735	\$609,478
730,000	0.891	650,367	7	\$31,738	\$117,788	\$214,080	\$318,485	\$440,368	\$527,674	\$598,880	\$627,824	\$653,968	\$668,207	\$671,163
870,000	0.875	757,143	8	\$30,027	\$198,868	\$320,428	\$438,811	\$551,858	\$617,481	\$661,184	\$679,388	\$690,829	\$698,102	\$704,719
1,045,000	0.846	884,530	9	\$52,545	\$151,745	\$453,174	\$538,487	\$670,514	\$738,024	\$797,838	\$828,164	\$844,380	\$852,818	\$860,251
1,100,000	0.896	974,683	10	\$39,771	\$118,112	\$245,987	\$443,888	\$610,959	\$701,031	\$849,844	\$870,622	\$912,829	\$924,878	\$930,816

- One of the 1,000 simulations was selected as the "realization"...this is the 'data' that Lemur sees (yellow)
- For illustration, assume that:
 - Next year's pricing will be down
 - Lemur has mis-identified the loss trend pattern and believes they are in a period of no inflation



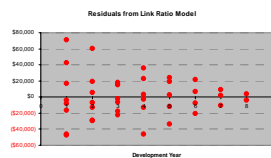
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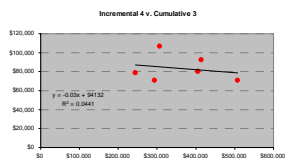
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Model Diagnostics Reserves



- Residuals from the link ratio model exhibit heteroscedasticity
- Heteroscedasticity does not create a bias in estimates, but does bias the estimate of variances (likely over-estimates)



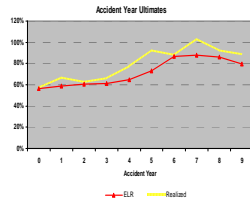
- Link ratio models assume that the next developmental increment is a linear function of the previous cumulative with an intercept of zero
- This assumption is violated here
- Estimates based on this model will be biased

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Loss Ratio and Reserve Picks Reserves

- Lemur estimates reserve needs with a link ratio model, a Bornhuetter-Ferguson model, and an expected loss ratio model.
- The three methods are weighted together as follows:
 - The most recent accident year is booked at the planned loss ratio
 - The three preceding years are recorded at the Bornhuetter-Ferguson indications
 - Older years are a weighted average of the Bornhuetter-Ferguson estimates and link ratio estimates
 - The eighth prior accident year and prior are based solely on link ratio estimates
- The expected loss ratio for an accident year is a straight average of the three previous accident years, adjusted for pricing and trend



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Resulting Reserves Reserves

Accident Year	Reserve Estimates				
	Link Ratio	Born-Frg	ELR	Weighted	Realization
0	\$0	\$0	\$0	\$0	\$7,724
1	\$7,461	\$6,588	(\$64,793)	\$7,461	\$14,475
2	\$24,442	\$23,470	\$2,871	\$24,442	\$24,436
3	\$55,729	\$50,463	\$730	\$54,413	\$50,494
4	\$118,535	\$99,409	\$8,710	\$108,972	\$124,844
5	\$216,506	\$157,818	\$1,042	\$172,490	\$154,887
6	\$216,325	\$244,353	\$284,929	\$244,353	\$296,308
7	\$314,096	\$340,598	\$358,737	\$340,598	\$456,183
8	\$684,924	\$514,742	\$467,801	\$514,742	\$515,788
9	\$902,184	\$727,636	\$717,470	\$717,470	\$807,705
	\$2,540,203	\$2,165,078	\$1,777,496	\$2,184,942	\$2,452,845
			deficiency	(\$267,903)	

- Application of the Lemur's algorithm, with its reliance on expected loss ratios, with a misdiagnosis of trends and perhaps a mis-use of link ratio models results in a serious reserve deficiency at the end of year 9
- Deficiency is 12% of carried reserves; 55% of surplus

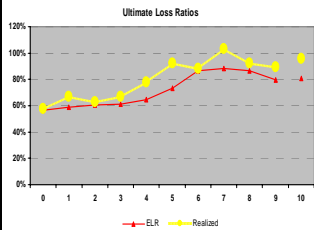
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Loss Ratio Picks Annual Plan

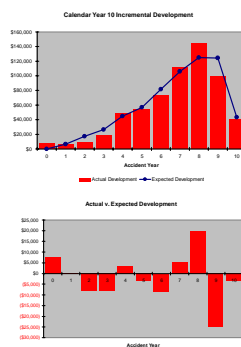


- The loss ratio bridging implies a 10% price increase is needed to achieve targeted loss ratio.
 - Management 'plans' for +10% despite softening market conditions.
 - "Stretch goal"
- The planned loss trend is still flat
- The result is a drastically underestimated accident year ultimate for year 10 – roughly 20%-points low
- Recall that this estimate will now be the ELR for year 10 reserving

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Results as Year 10 Unfolds Annual Plan



At the end of Year 10, Lemur compares Actual v. Plan...

- They know that pricing fell far short of expectations.
 - But the loss ratio was still miraculously on plan!
 - Premium volume was also on plan
- Lemur's actuaries compare actual v. expected development (left):
 - No obvious issues here: reserving prediction errors appear to be random and average close to zero
 - Reserving algorithm is vindicated for another year!

BIG BONUSES ALL AROUND!

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True Position at Year End 10 Annual Plan

	Reserve Estimates Year 10				
	Link	BP	ELR	Wtd	Realization
0	\$0	\$0	(\$7,724)	\$0	\$0
1	\$0	\$0	(\$71,079)	\$0	\$8,190
2	\$6,445	\$6,294	(\$6,038)	\$6,445	\$15,528
3	\$25,724	\$23,756	(\$17,941)	\$25,724	\$31,823
4	\$64,608	\$54,653	(\$39,363)	\$62,119	\$76,771
5	\$133,213	\$100,904	(\$52,308)	\$117,059	\$101,538
6	\$144,585	\$162,909	\$211,859	\$158,328	\$223,238
7	\$225,524	\$234,393	\$247,233	\$234,393	\$344,678
8	\$487,156	\$389,876	\$323,293	\$389,876	\$371,281
9	\$550,142	\$903,541	\$618,270	\$603,541	\$709,505
10	\$682,861	\$744,986	\$748,605	\$748,605	\$891,045
	2320257.14	2321312.89	1954807.51	\$2,346,090	\$2,772,597
deficiency					(\$426,507)

- The bridging methodology has injected a serial correlation into the process that represents high operational risk. Underestimated reserves beget underestimated forecasts beget underestimated reserves...
- Deficiency is now 17% of carried reserves; 77% of surplus

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Case Study Construction

Reserves

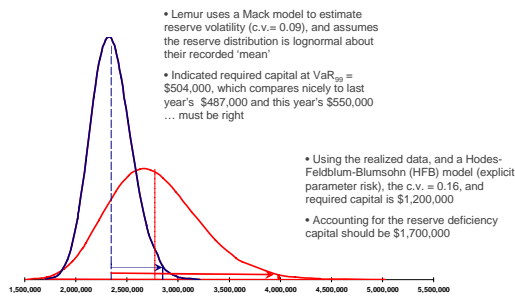
Annual Plan

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Required Capital Lemur's ICA Modeling



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Rating Agency Meeting Lemur's ICA Modeling

Lemur's Message:

- We have a thorough, state-of-the art loss reserving process including:
 - Periodic actuarial analysis,
 - Using several widely accepted models
 - Regular communication with Management
 - Strict controls on booking reserves
- Annual planning process is rigorous and technical
 - Disciplined target setting
 - Fully integrated with reserving

Lemur's Reality

- Reserving process is flawed:
 - "Analysis" is a euphemism for "calculations"
 - Models are accepted, but the output isn't used
 - Communication does not include alternative points of view
 - "Control" is only rote adherence to a weighting algorithm
- Annual planning adds greatly to risk
 - Still ample room for mis-interpretation of key parameters (trend, price)
 - Planned loss ratios are 100% serially correlated with reserves

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Rating Agency Meeting (cont.)

Lemur's ICA Modeling

Lemur's Message:

- We have built a sophisticated internal capital model,
 - Fully supports our current capital position
 - Agrees with BCAR

Lemur's Reality

- Lemur's internal capital model is overly simplistic
 - Is based on the presumption that accounting values are correct
 - Relies on a single methodology that may not be warranted
 - Does not fully treat parameter risk
 - Assumes distributional forms...

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Post Mortem

Lemur's ICA Modeling

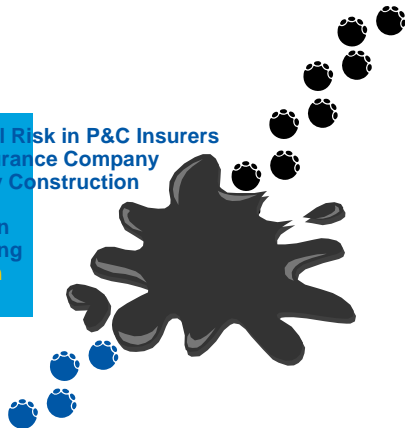
Lemur eventually dies. If the reserve charges didn't kill them outright, the rating downgrades finished the job.

- What is the proximate cause of death?
 - A.M. Best says "inadequate reserves"
 - Underwriters blame the actuarial staff and their inability to peg reserves (after all, they consistently made plan)
 - Actuaries blame Management for their process of establishing a "best estimate"
 - Management points to the inherent volatility in the insurance business
- There are three possibilities:
 1. The models used or available cannot accurately forecast reserves
 2. Models were used improperly
 3. Model results were ignored
- #2 and #3 are pure operational risks

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Conclusion

- Operational risk is real and can be significant. Most company failures can be traced to operational causes
- Most significant operational risk is "corner office" risk, especially in a loss reserving context
- Don't bother with a fancy model if you or your management turns a blind eye to reality and are willing to assume away key parameters
- Actuaries can help:
 - Staunch advocacy of reality; defense of science
 - Reliance on appropriate technique and judgment over rote decision rules or "Management judgment"
 - Incorporate parameter risk in modeling

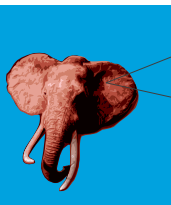
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