Don Mango, FCAS, MAAA
Morristown, NJ, USA

GUY CARPENTER

4 October 2007
Lemur Insurance Company
Case Study in Operational Risk:
The Elephant in the Room

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

Operational Risk in P&C Insurers
Lemur Insurance Company
Case Study Construction
Reserves
Annual Plan
ICA Modeling
Conclusion
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

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.

A.M. Best Study

Operational Risk

"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
Key Quantitative Control Process for An Insurer
Look for Operational Risks....

- Data Warehouse
- Model Development Processes
- Forecast Models
- Forecasts
- Reserves
- Underwriting Decisions
- Planning Processes

- Pricing models staying current?
- Granularity? Predictive capability?
- What about reserving models?

- Price monitoring quality and completeness?
- Reliable price changes?
- Comparison with plan?

- Pricing models staying current?
- Granularity? Predictive capability?
- What about reserving models?
Key Quantitative Control Process for An Insurer
Look for Operational Risks....

- Pricing model inputs sufficient, correct?
- Models operated properly? Controlled? Audited?
- Reserving data complete and accurate?
- Controlled? Audited?

- Model indications reach management intact?
- Planned pricing actions realistic and achievable?
- Momentum? Systematic biases?

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 analysis 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

Identifying reserve deficiencies as the cause of impairment is like identifying heart stoppage as a cause of death: factually accurate, but not very revealing...
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
A generalized least squares model was used to construct a triangle simulation based on real GL data.

\[
\ln(\text{incremental paid loss/exposure}) \quad \text{was calculated and charted versus development year, each line is a separate accident year.}
\]

Parameter values and standard errors were estimated:

\[
\begin{align*}
\alpha_0 &= (3.2), +/-0.1 \\
\alpha_4 &= 0.15, +/-0.07 \\
\alpha_8 &= (0.25), +/-0.13 \\
\gamma_1 &= (0.06), +/-0.05 \\
\gamma_4 &= 0.06, +/-0.02 \\
\iota_1 &= (0.06), +/-0.05 \\
\end{align*}
\]

\[
\gamma_5 = (0.50), +/-0.02
\]

\[
\sigma = 0.10
\]

Chose 1 simulation as the 'realization'. We also know the 'truth'.

1,000 simulations were performed, each one producing:

- A future incremental calendar 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.
### Realization

**Case Study Construction**

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

### Operational Risk in P&C Insurers

**Lemur Insurance Company**

**Case Study Construction**

**Reserves**

**Annual Plan**

**ICA Modeling**

**Conclusion**

- 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.
Guy Carpenter
Loss Ratio and Reserve Picks

- 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

![Graph: Bucket Fitted]

Resulting Reserves
Reserves

- Application of the Lemur’s algorithm, with its reliance on expected loss ratios, with a mis-diagnosis 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

![Table: Resulting Reserves](#)

Operational Risk in P&C Insurers
Lemur Insurance Company
Case Study Construction
Reserves
Annual Plan
ICA Modeling
Conclusion
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

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!**

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
Required Capital
Lemur’s ICA Modeling

- Lemur uses a Mack model to estimate reserve volatility (c.v. = 0.09) and assumes the reserve distribution is lognormal about their recorded ‘mean’.
- Indicated required capital at VaR 99 = $504,000, which compares poorly to last year’s $657,000 and this year’s $550,000
- Accounting for the reserve deficiency, capital should be $1,700,000

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
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...

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

Operational Risk in P&C Insurers
Lemur Insurance Company
Case Study Construction
Reserves
Annual Plan
ICA Modeling
Conclusion
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.

For more information, contact:
Don Mango, FCAS, MAAA
+1.973.285.7941
Paul Brahm, FCAS, MAAA
+1.952.832.2506
4 October 2007

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

Don Mango, FCAS, MAAA
Morristown, NJ USA