Model Validation
A RAROC Case Study

Rocky Ieraci
Director
Standard & Poor’s Risk Solutions

February 27th, 2008
Agenda

• Model Validation Framework
• Case Study
• Summary
• Q & A
Model Validation Framework

Governance Framework

Model Development /Revisions

Validation Protocols

Validation of Conceptual and Theoretical Soundness

Confirmation of Model Operation

Outcome Analysis (Backtesting & Benchmarking)

Model Enhancement Opportunities (Based on Validation Activities)

Permission to reprint or distribute any content from this presentation requires the prior written approval of Standard & Poor’s.
Model Validation Framework

Conceptual Soundness

• Review of Conceptual and Theoretical Soundness of model assumptions, inputs, outputs, functions and overall methodology

• “Developmental Evidence” – Focus is on design and construction
  - Can the model be expected to work as intended?
  - Consistency between model and business objectives
  - “Statistical” vs. “Expert Judgment”

• A consistent assessment of two dimensions of model risk:
  - Model error potential (i.e. potential errors in estimation), and
  - Impact of model errors (i.e. what is bottom line impact of errors)
Model Validation Framework

Model Operations

• Confirmation of model operation: on-going monitoring of model and surrounding processes, which may include:
  - Key Performance Indictors
  - Exceptions monitoring (i.e. Overrides)
  - Verification of “replicability”, appropriate use of model, data integrity

Outcome Analysis / Performance Testing

• Review of the model’s historical and relative performance, including:
  - Backtesting – Predicted versus realized outcomes
  - Benchmarking - Uses alternative models, methodology or data to draw inferences about the suitability of the predicted estimates, risk factors, or segmentations prior to observation of actual outcome
  - Importance of tolerance levels and remedial action policy
Case Study
Validation of RAROC Model
Case Study – Overview of Typical RAROC Model

• Many FI’s have adopted some variant of a RAROC model in their loan adjudication and performance measurement processes

• In it’s simplest form,

\[ RAROC = \frac{\text{Risk Adjusted Return}}{\text{Marginal Capital}} \]

• Some uses of RAROC models include:
  - Accept/Reject decisions
  - Loan pricing
  - Structuring (i.e. collateral coverage)
  - Compare profitability across business segments (compensation link?)

• Having the appropriate methodology is critical as it has a direct impact on the bottom line. Both refusing “Good Credits” and accepting “Bad Credits” puts you at a competitive disadvantage.
Case Study – Overview of Typical RAROC Model

A closer look at our example RAROC equation:

$$RAROC = \frac{\text{Total Revenue} - \text{Overhead} - \text{Expected Loss} - \text{Taxes}}{\text{Marginal Credit Capital}} > \text{Hurdle}$$

where,

- **Time Horizon** = One year forward estimate of profitability
- **Total Revenue** = Expected 1st yr Spread Revenue + Upfront Fees
- **Overhead** = Non-Interest Expense (fixed charge applied per segment)
- **Expected Loss** = Obligor PD * Facility LGD * Loan Exposure
- **Taxes** = Jurisdiction specific tax payable on loan income
- **Marginal Credit Capital** = 1st yr credit capital based on one factor VaR model (similar to Basel II)
- **Hurdle** = Cost of capital + risk premium applied to all deals
Case Study – Overview of Typical RAROC Model

Typical RAROC Schematic

- Obligor Risk Rating Process
- PD & PD Migration
- LGD [Loss Given Default]
- EAD [Expos Given Default]
- Loan Amount
- Term

Portfolio Capital Model

- Diversification
- Corporate Policy
- Target Debt Rating [for Portfolio]
- UL [Unexpected Loss]
- EC (Economic Capital)

RAROC

- Total Revenues
- - Overhead
- - Expected Loss
- - Taxes
- Net Income

Non-Interest Expense

LGD EAD PD
Conceptual Soundness Review
Case Study – Conceptual Soundness

Suitability of Inputs

RAROC = \frac{\text{Total Revenue} - \text{Overhead} - \text{Expected Loss} - \text{Taxes}}{\text{Marginal Credit Capital}}

- Concerned with alignment of inputs with expected output
  - **PD** used is “TTC”, but we want one year outlook of profitability?
  - **LGD** used is consistent with average loss expected. How does this align with RAROC measure?
  - **EAD** based on expected utilization. For revolving loans how is expected utilization estimated? Not an alignment issue, but one of consistency.
Suitability of Inputs, con’t

- **Marginal Credit Capital** – Horizon is one year
  - Best estimate of how much capital FI needs to hold to maintain target rating over following year?
    - Rating Philosophy will, in part, dictate what the credit capital figure represents.

---

![Diagram with labels](image-url)

- **Bottom of the Cycle Capital**
  - Max capital requirement over a cycle.
  - It is a-cyclical

- **PIT Capital**
  - Capital requirement over the next year.
  - It is Cyclical.

- **TTC Capital**
  - Avg capital requirement over a cycle.
  - It is a-cyclical.
Case Study – Conceptual Soundness

Suitability of Inputs, con’t

• Risk Rating Philosophy – Point in Time or Through the Cycle?
  
  - Expansion:
    
    $$RAROC = \frac{\text{Expected Spread + } \text{Expected Fee Rev} - \text{Expected Loss}}{\text{Marginal Capital}} \geq \text{Hurdle Rate}$$
  
  - Downturn:
    
    $$RAROC = \frac{\text{Expected Spread + } \text{Expected Fee Rev} - \text{Expected Loss}}{\text{Marginal Capital}} \geq \text{Hurdle Rate}$$

• Consider PD of cycle sensitive group of credits
  
  - TTC PD < PIT PD in downturn → Actual EL likely > than estimated
  
  - Will Marginal Capital compensate?
Case Study – Conceptual Soundness

Suitability of Inputs, con’t

• Anything missing on Revenue front?
  - Return on invested capital
  - Relationship revenues – controversial and difficult to get right
    • Can be a subjective factor in final loan decision
    • Can be an estimate that is built into profitability equation
    • Important to track outcome of estimates to avoid ‘gaming’

• What does this all mean for our RAROC model?
  - Interpretation issue – expect one year forward assessment of risk based profitability, but we get ????
Other Issues

- What are the impact of the term assumptions?

- If we only use the first year’s expected profit and marginal capital, we introduce a bias against long term deals. Some ways to counter this:
  - RAROC calculated relative to term of deal.
  - Use average forward marginal capital
  - Accept bias and mitigate as much as possible (Term Premium)
Case Study – Conceptual Soundness

Other Issues, con’t

• How is Total Capital allocated down to deal level?
  - Assumptions: Contribution to UL, Tail, Expected shortfall
  - What about Exposure and Industry concentration?
  - How does this impact our RAROC and resulting loan decision?

• Operational Risk
  - As we move towards SME world, it can become a significant component of total losses

• Regulatory Capital

• Differentiated Hurdle Rates

• Price Taker vs. Price Setter?
Model  Operation & Performance Testing
Case Study – Confirmation of Model Operations

• In this context, confirmation of model operation would primarily entail setting up a report that tracks KPIs, for example:
  - Ratio of rejected vs. accepted deals
  - Average RAROC by segment for new deals, including trends
  - # of below hurdle deals accepted – ‘exceptions monitoring’
  - Initial RAROC estimate vs. current using actual balances

• Replicability Test – Take sample of deals and apply RAROC model, do we get same result?

• Particularly with legacy systems, data integrity test should be performed periodically. Are we using the “right” inputs when calculating RAROC?
Case Study – Outcome Analysis: Backtesting

- Backtesting of input along three dimensions:
  1) Discriminatory Power
     - Rank Order Tests
     - GINI Coefficient
     - KS and other statistical measures
  2) Accuracy of Estimates
     - Statistical accuracy tests;
     - Importance of Confidence boundaries;
     - Correlation of Risk Factors - adjustments required
  3) Confirmation of Philosophy
     - Point in Time vs. Through the Cycle - Are predicted outcomes following intended behavior?
     - Rating Migration patterns – Mobility Metric
Case Study – Outcome Analysis: Backtesting

• Inputs fine, but do combination of these inputs produce accurate forward looking picture of risk based profitability?

• Static portfolio analysis – Total expected vs. realized economic profit

**Expected Economic Profit, (Sum of individual deals)**

\[
\text{Expected Revenue} - \text{Expected Expenses} \geq \text{Hurdle Rate} \times \text{Marginal Capital}
\]

**Realized Economic Profit, (Portfolio)**

\[
\text{Realized Revenue} - \text{Realized Expenses} \geq \text{Hurdle Rate} \times \text{Capital Usage}
\]
Case Study – Outcome Analysis: Benchmarking

• Benchmarking of RAROC methodology (also CS Validation)
  - Selection of representative peer sample or ‘best practice’ banks
  - Sources of benchmark information may include:
    • Publicly available information
    • Collective expert knowledge within organization
    • Survey research (i.e. questionnaire on risk based pricing)

• Benchmarking RAROC results
  - Consortium studies: FIs run a sample of representative deals through their pricing model and results shared anonymously

• Benchmark alternative risk based pricing models
  - Analysis conducted at portfolio/segment level
  - Alternative model provides more realistic estimate of profitability?
Summary

• Importance of Model Validation function

• Continuous improvement process

• Many models do not seem overly complex but underlying concepts can be very technical and complex

• “Hidden” assumptions and their impact on results often overlooked

• These “simple” models can impact the bottom line significantly
Q & A
Contact Information

Rocky Ieraci, Director
Standard & Poor’s Risk Solutions
Tel: (416) 507-3208
E-mail: rocky_ieraci@standardandpoors.com
Web site: www.risksolutions.standardandpoors.com
Analytic services and products provided by Standard & Poor’s are the result of separate activities designed to preserve the independence and objectivity of each analytic process. Standard & Poor’s has established policies and procedures to maintain the confidentiality of non-public information received during each analytic process.