STRATEGIC ANALYTICS

Economic Capital for Retail Loan Portfolios

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Strategic Analytics Today

$1+ trillion in assets being analyzed in > 25 countries

Clients include leading retail lenders worldwide including:

- Capital One
- Discover
- HBOS
- HSBC
- Lloyds TSB
- SunTrust
- US Bank
- Wells Fargo

Used to analyze all retail and consumer lending products:

- Mortgage
- Home equity lines and loans
- Auto loans
- Cards
- Personal lines and loans
- Student loans
- Small business loans

Domain Expertise

Industry Risk Performance Studies

Scenario-based Forecasting

Portfolio Stress Testing

Economic Capital Modeling

Product and Services Overview

Service & Software Packages

SA's services and software are bundled to suit to clients' modeling requirements.

Retail and Mortgage Risk Services

- Scenario-based Forecasting
- Portfolio Stress Testing
- Forecast Volatility Analysis
- Topaz / Eclipse Industry Risk Studies
- LookAhead Forecaster Software

Retail and Mortgage Finance Services

- P&L Forecasting
- Economic Capital Modeling
- Diversification Benefits Modeling
- Portfolio Optimization

End-User Software Applications

SA provides end-user software applications to satisfy the most advance requirements.

LookAhead™

Scenario-based Forecasting Software

- LookAhead Power Station
- LookAhead Expert
- LookAhead Forecaster

TrueCapital™

Economic Capital Modeling Software

PossiblePaths™

Monte Carlo Scenario Generation

Overview

- Dynamics of Retail Portfolios
- Through-the-Cycle Economic Capital
  - with Static Pools
- Risk Aggregation
  - Bottom-up
  - Top-down

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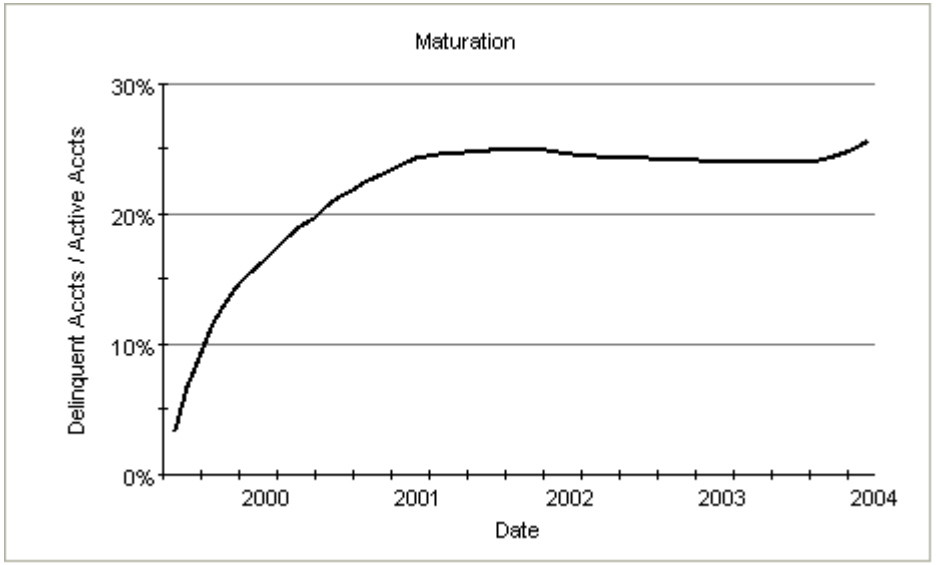
The Dynamics of Retail Portfolios

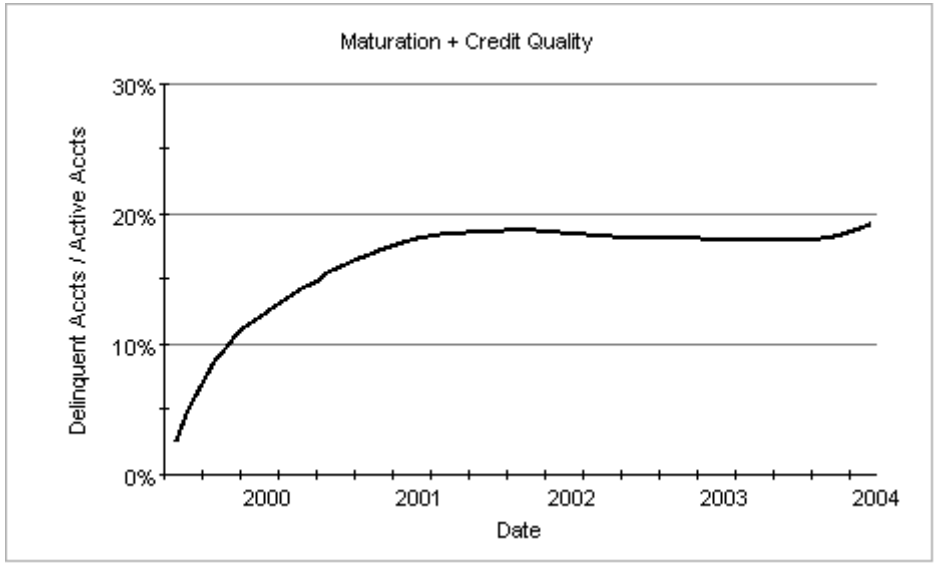
Components of Portfolio Performance

- Vintage Lifecycle



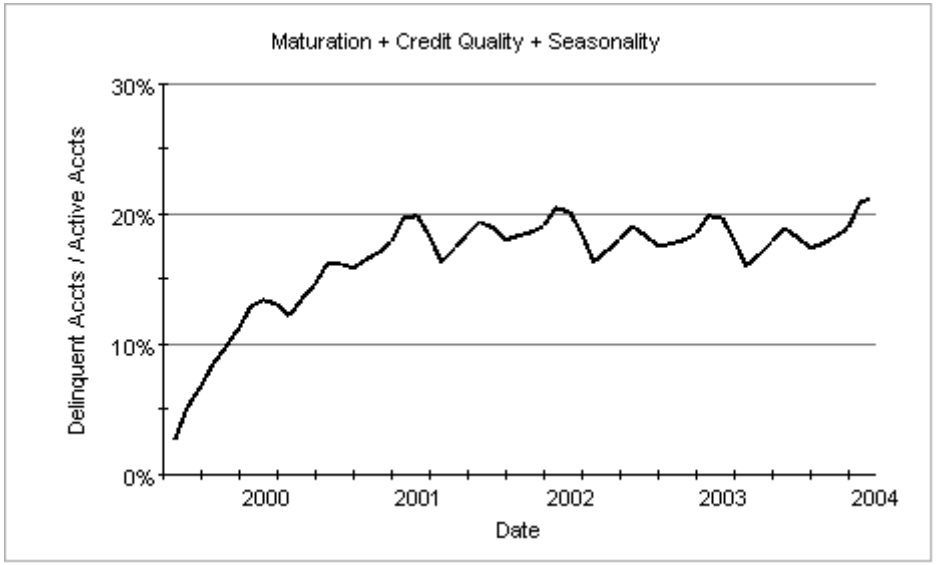
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality



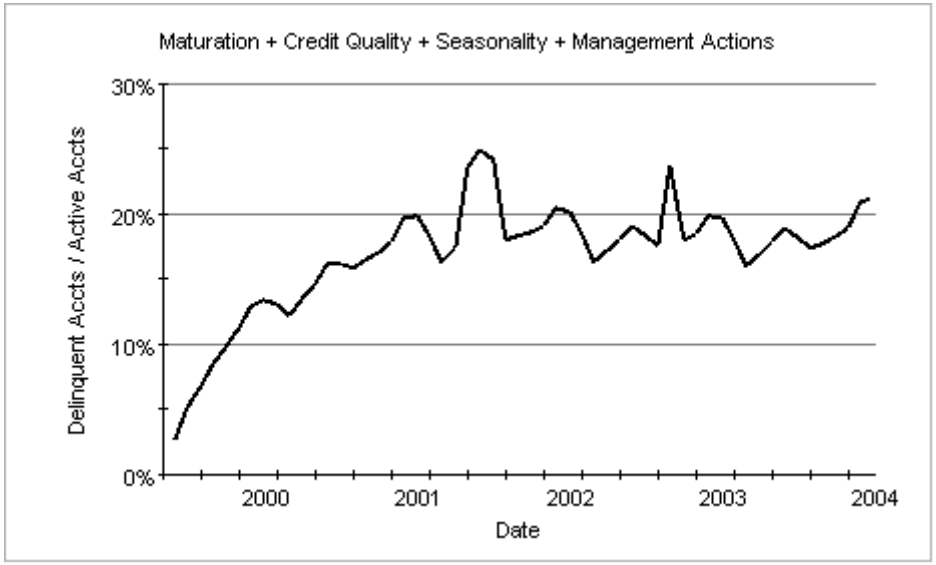
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality
- Seasonality



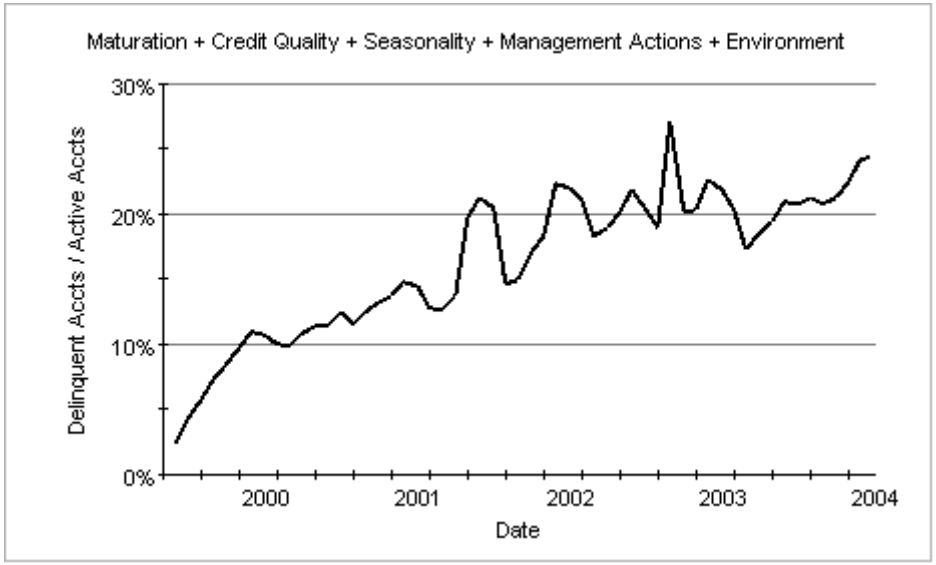
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality
- Seasonality
- Management Actions



Components of Portfolio Performance

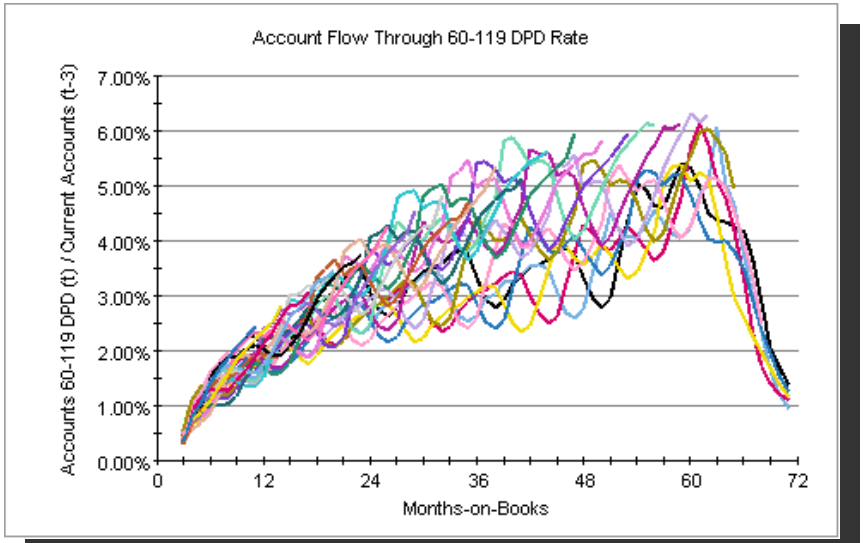
- Vintage Lifecycle
- Credit Quality
- Seasonality
- Management Actions
- Macroeconomic & Competitive Environment

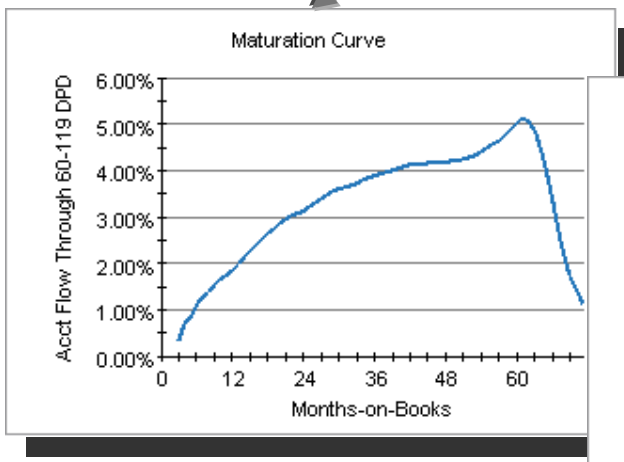


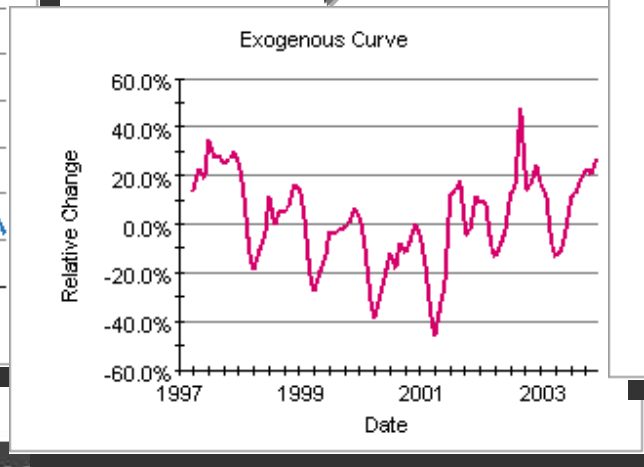
Dual-time Dynamics (DtD)

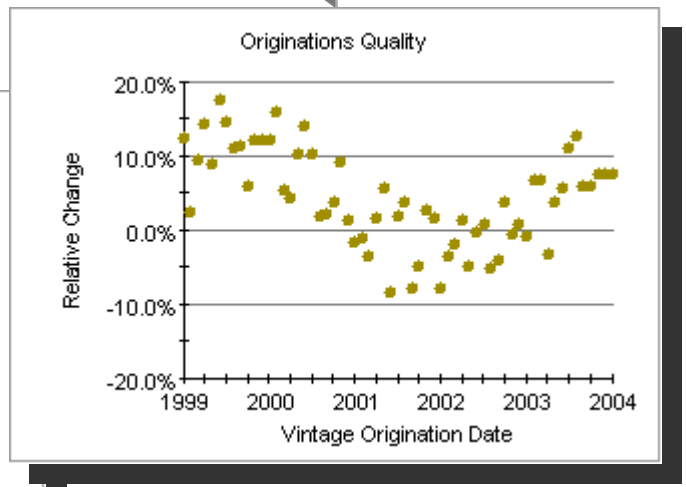
- Vintage-level data is decomposed into functions of months-on-books (maturation), calendar date (exogenous), and vintage (quality).

$$r(a,v,t) = e^{f_m(a)} e^{f_g(t)} e^{f_Q(v)}$$









Point-in-Time Static Pool Modeling

- Segment using any information available at time of origination.
- Include vintage segmentation.
- Employ a model that can explicitly include lifecycle, credit quality, and environmental impacts. Distribution shifts in behavior scores are fully explained by these effects.

Model	Analysis Level	Lifecycle	Credit Quality	Environment
Survival[1]	Account, Terminal Events	Nonparametric	Application Scores, etc.	Macroeconomic Factors
Panel Data	Account, Any Events	Nonparametric	Application Scores, etc.	Macroeconomic Factors
Age Period Cohort	Vintage, Any Rate	Nonparametric	Nonparametric[2]	Nonparametric[3]
Dual-time Dynamics	Vintage, Any Rate	Nonparametric	Nonparametric[2]	Nonparametric[3]

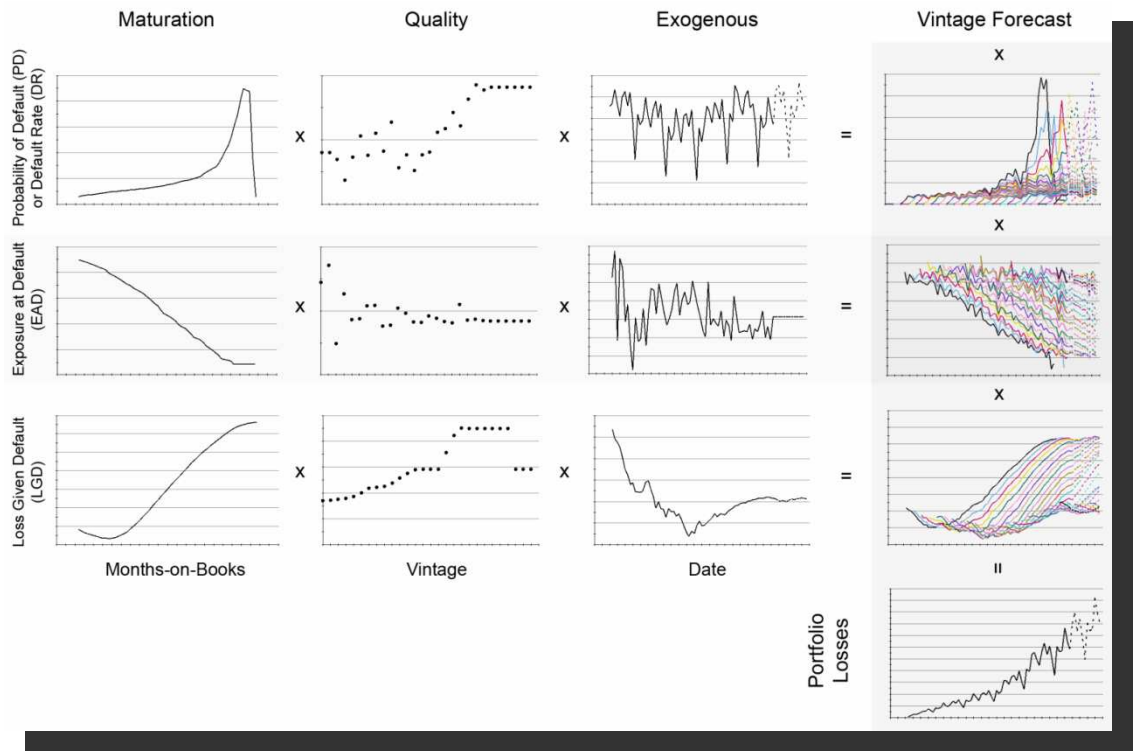
[1] Leveraging recent developments in Survival and Proportional Hazards Models.

[2] A nonparametric approach avoids problems with adverse selection, such as was seen in the US Mortgage Crisis.

[3] A nonparametric approach avoids explaining all portfolio trends with macroeconomic data, which is a common occurrence in portfolio modeling. Macroeconomic factors are brought in after removing management actions.

Creating the Portfolio Forecast

- Probability of Default (PD) or Default Rate (DR), Exposure at Default (EAD), and Loss Given Default (LGD) could all be analyzed via decomposition.
- For the rest of this analysis, we will focus on PD / DR and follow the Basel II approach with respect to EAD and LGD.



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Through-the-Cycle Economic Capital

Through-the-Cycle Capital

- We assume that this means Through-the-(Economic)-Cycle. Lifecycle effects can be explicitly captured via multi-year lifetime-capital calculations.
- Although PIT calculations can be done many years into the future, many institutions want to know what static level of capital is required for “any” economic environment.
- Even with TTC calculations, capital needs will change because of new originations.
  - TTC calculations could not have prevented the US Mortgage Crisis, because of the enormous volume and adverse selection in new originations.
- Standard Behavior Scores cannot be used in TTC calculations. They are, by definition, dynamic relative to the environment, unless they are Proportional Hazards Behavior Scores or DtD Scores.

Implications for Retail Portfolios

- Most economic capital models:
  - Have no recognition of lifecycle effects, so the US Mortgage example is particularly bad.
  - Have no recognition of adverse selection as seen in all US products in 2005-2008.
  - Are vulnerable to “small” changes in existing products.
- The Vasicek model fits poorly to retail loan data.
  - The Vasicek model does not work for Retail, because no portfolio is “well diversified”, i.e. steady-state with respect to volume, mix, and quality of originations.
- However, using any of the Static Pool models mentioned earlier, we can obtain retail-specific economic capital.

Retail-specific Economic Capital

1. Segment the portfolio by vintage and other distributionally-stable attributes – no behavior scores.

2. Decompose history, e.g. Survival models or Dual-time Dynamics.

$$p(a,v,t) = h_0(a)e^{Q(v)}e^{Y(t)}$$

where $h_0(a)$ is the maturation function of age, $Q(v)$ is the quality function by vintage or account, and $Y(t)$ is the environmental function.

3. (Optional) Create a macroeconomic factor model for the exogenous curve and extrapolate it backward as far as those macroeconomic factors are available to create an environmental impacts index.

$$\tilde{Y}(t) = f(\vec{p}, \vec{E}(t))$$

4. Fit a distribution (Normal, NIG, etc.) to annual changes T in the environmental impacts index. For a given solvency s, the environmental impact is

$$\tilde{Y}(T) = D^{-1}(s)$$

Retail-specific Economic Capital

5. Probability of default for one-year solvency level s becomes

$$PD(a,v,s) = h_0(a)e^{f_Q(v)}e^{D^{-1}(s)}$$

if D is a Normal distribution, then we can write

$$D^{-1}(s) = \sigma N^{-1}(s)$$

where sigma is a portfolio volatility factor.

6. Sum over the next 12 months in the lifecycle (or whatever time scale is needed).

$$PD(v) = e^{f_Q(v)}e^{D^{-1}(s)}\sum_{t=1}^{12} e^{f_m(t-v)}$$

- This gives the PD for today's portfolio under an economic environment of severity $D^{-1}(s)$.

Implementation Details

- Regulators can publish volatility factors σ, just as the publish R values today, but σ may be measured directly on any portfolio.
- Vendors sell lifecycles by products, in case the institution has limited historical data or expertise.
- With sufficient segmentation, $Q(v)$ will go to 1, except for adverse selection. An institution can compute Q for their loans, or hold more conservative capital.
- Nonlinear decomposition models are available in all stats packages and extensively studied.

Implications for Retail Capital

- Capital calculations would not exhibit procyclicality.
- Capital would adapt to the credit risk of recent originations.
- Capital could be computed years into the future in order to adjust for Through-the-Lifecycle effects.
- No more surprises like US Mortgage.

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Economic Capital Aggregation

Bottom-up Capital Aggregation

- Usually operate on the lowest level of the data.
- Correlate performance time series to a common set of factors driving all loans.
- Aggregate risks via Monte Carlo simulation of those factors.
- Most implementations require the same model structure for all products.
- Greatest difficulty is in capturing all cross-correlations between the many macroeconomic factors.

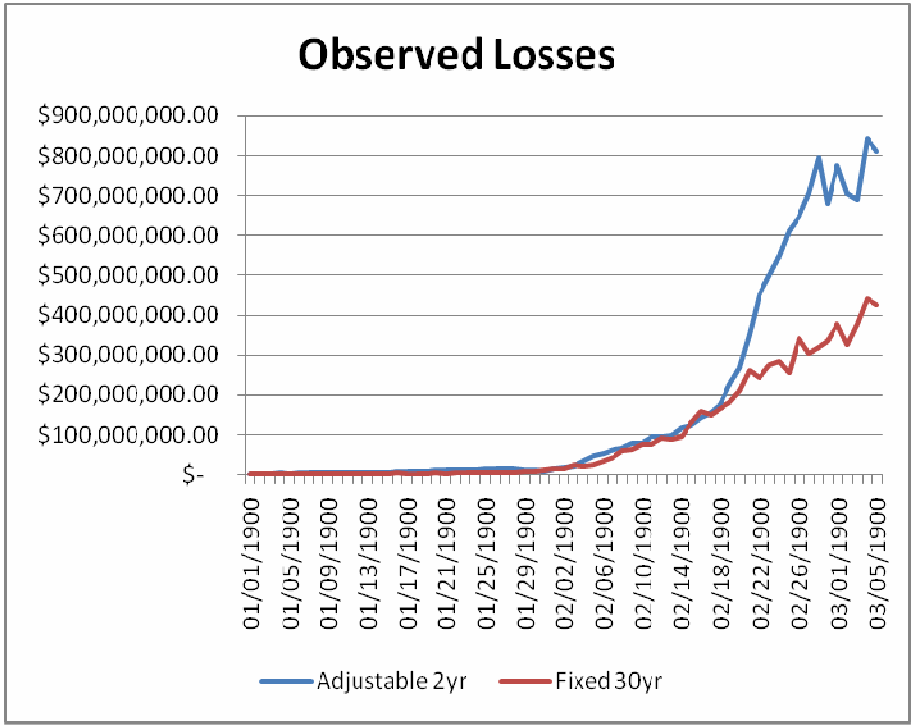
Top-Down Capital Aggregation

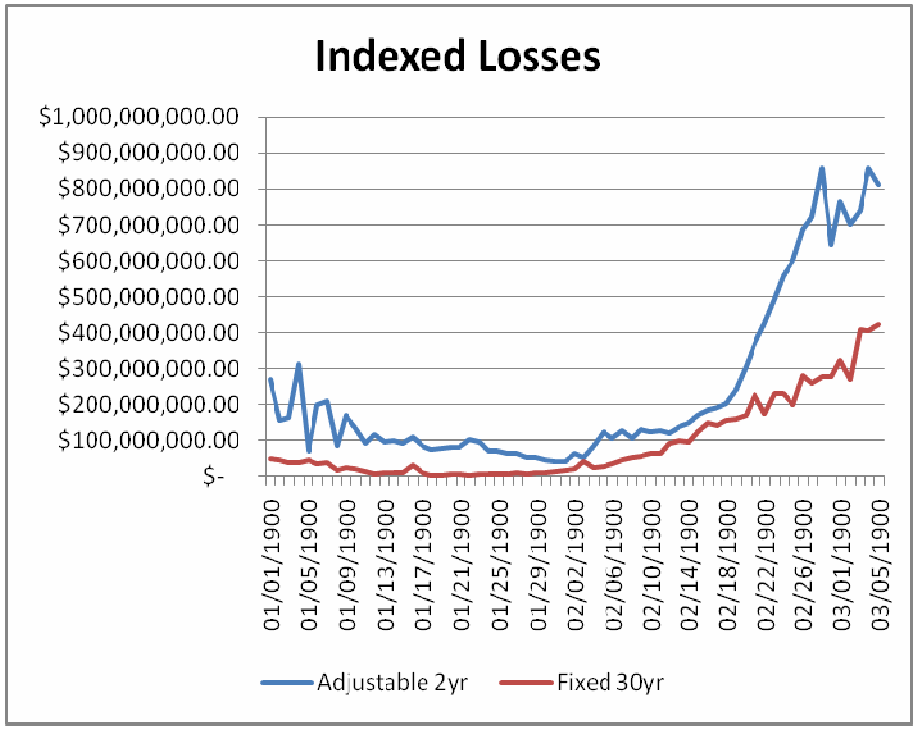
- Marginal distributions are created for each product using the model appropriate to their type.
- Marginals are combined via an appropriate copula.
- Combined results are dependent upon the length of historical information.
- For retail portfolios, synthetic loss indices should be created to simulate the performance of a steady-state portfolio through the observed macroeconomic environment.

Loss Aggregation Example

1. Create marginal distributions using whichever method is most appropriate for your product
2. Compute synthetic index time series for each segment
3. Use marginal CDFs to generate Q-Q plots and data
4. Choose appropriate Copula and fit it
5. Use copula structure to produce an aggregated loss distribution from your marginals

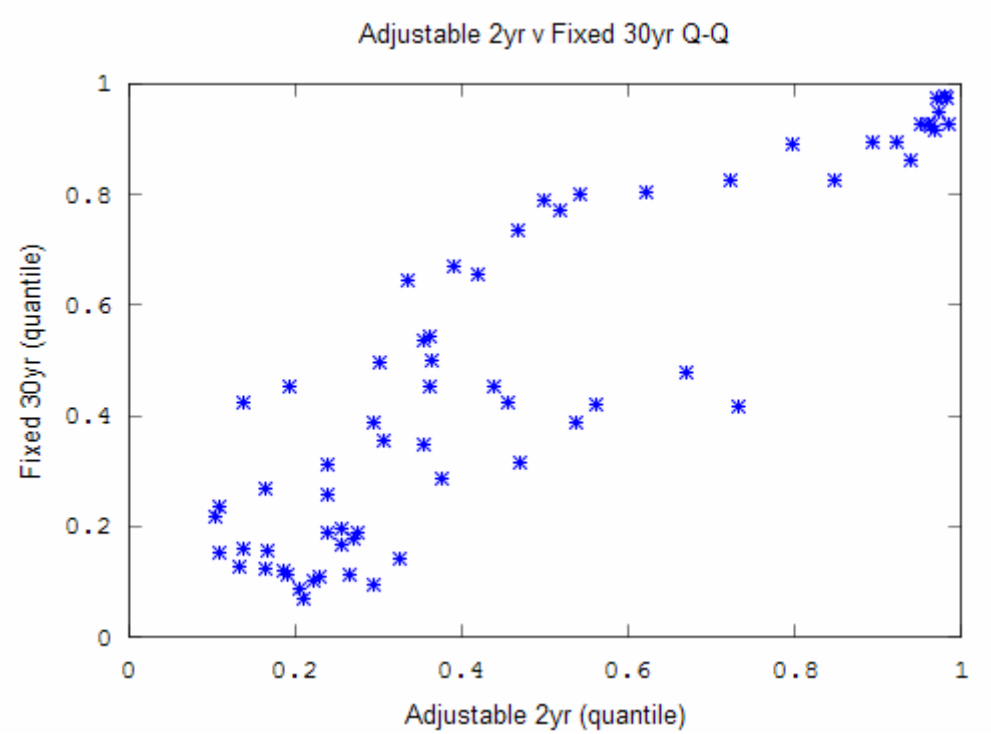
30yr Fixed and 2yr ARM Losses





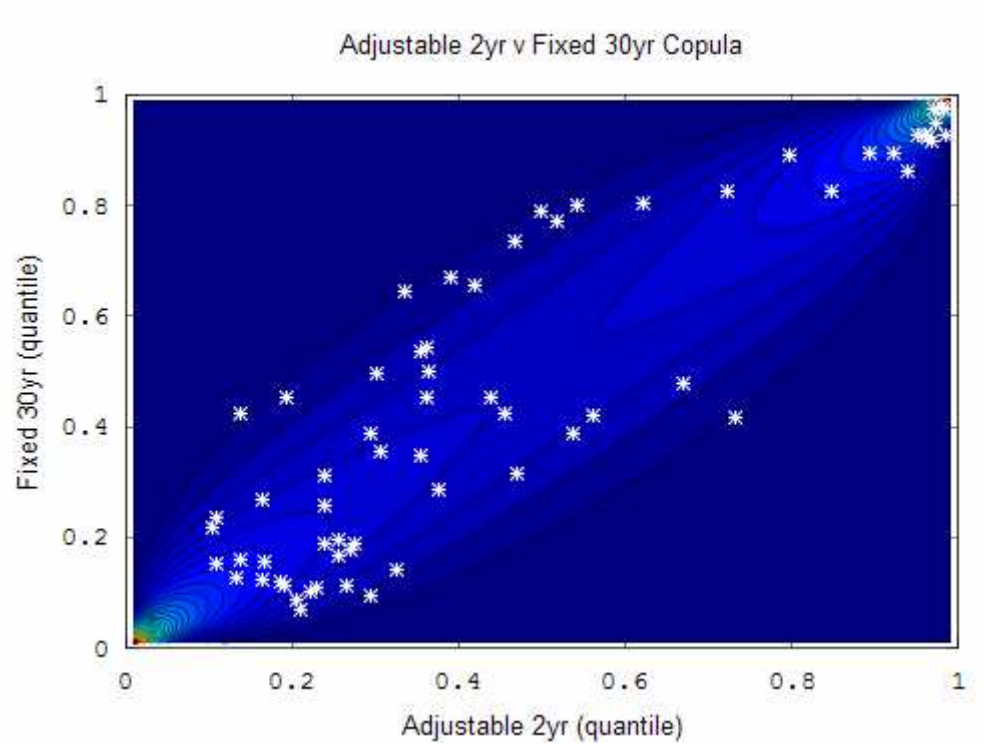
- Generate index loss curves that simulate the current portfolio in terms of booking and quality throughout the historical environment
- Index should represent the characteristics of your portfolio (segment mix, age, etc.) replayed through time

Copula fitting



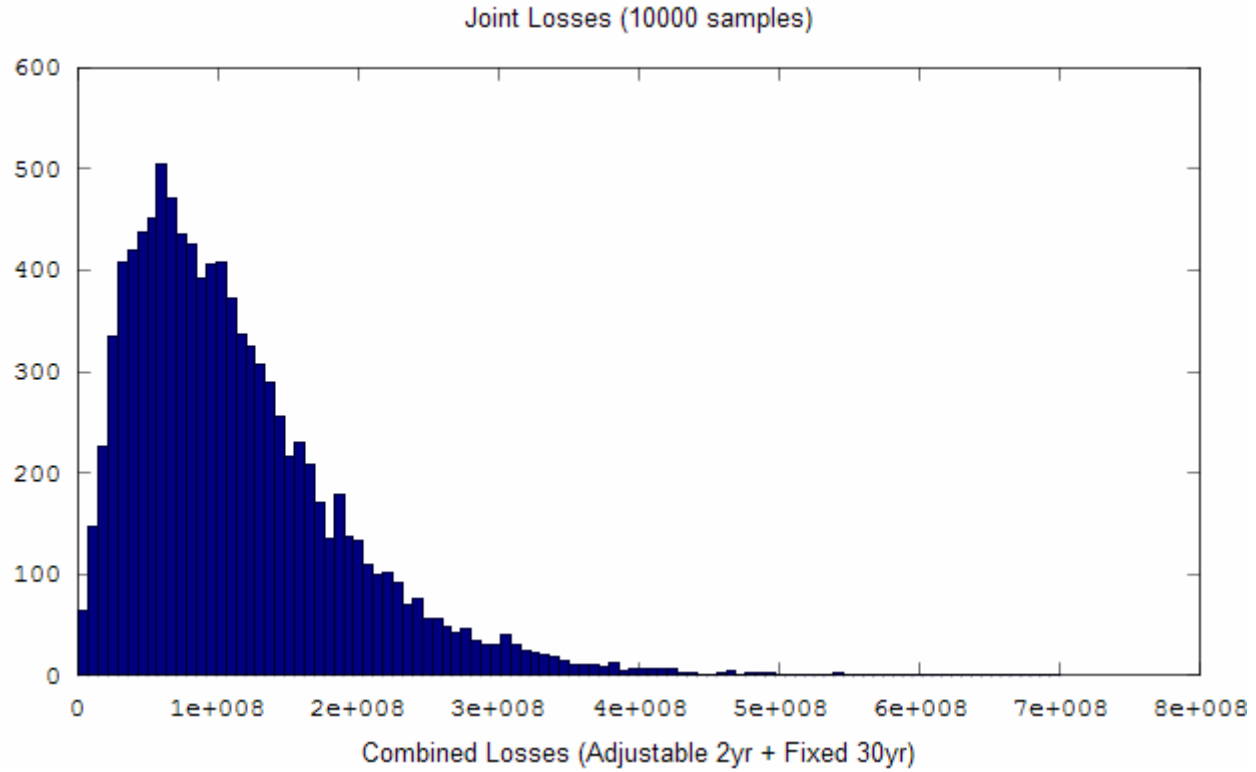
- Translate points on the synthetic indices into quantile pairs
- With only two segments we can use any number of copula, otherwise we could nest Archimedean copula or use Student-t / Gaussian copula

Copula Fitting



- We use Maximum-Likelihood to fit a Gaussian Copula to synthetic temporal data
- Many goodness-of-fit measures have been proposed to choose between different parameters and copula

Combined Loss Distribution



- Now we sample from the copula and translate this using our product specific marginal distributions into aggregate losses

Conclusion

- Standard models exist that fit retail data well and can be employed for both Point-in-Time and Through-the-Cycle economic capital calculations.
- Behavior scores can only be used in Point-in-Time models.
- Standard implementations of bottom-up approaches usually require models that are inappropriate for retail portfolios, but other more-accurate approaches already exist.