

Canary in the Coal Mine

- What nonlinear dynamics based risk evaluation tells us about the US Mortgage Crisis
- Why it is now being adopted by RMBS investors
- Implications for Australia

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Overview

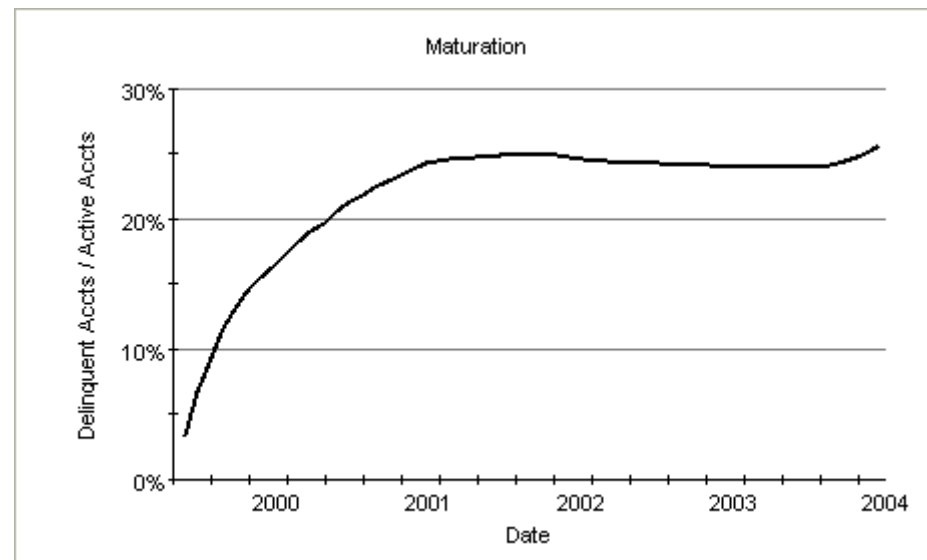
- A Technology Introduction
- A History Lesson
- A Forecasting Example



A Technology Introduction – The Dynamics of Retail Portfolios

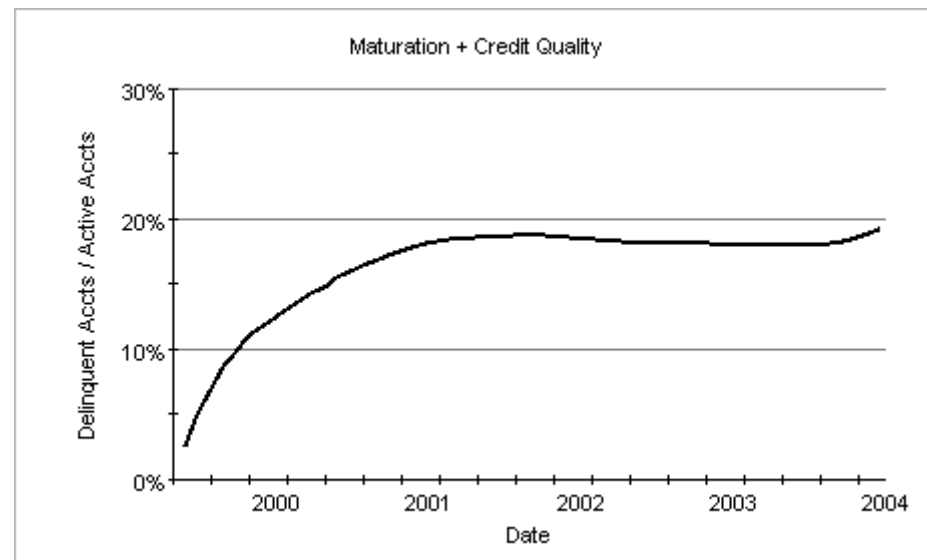
Components of Portfolio Performance

- Vintage Lifecycle



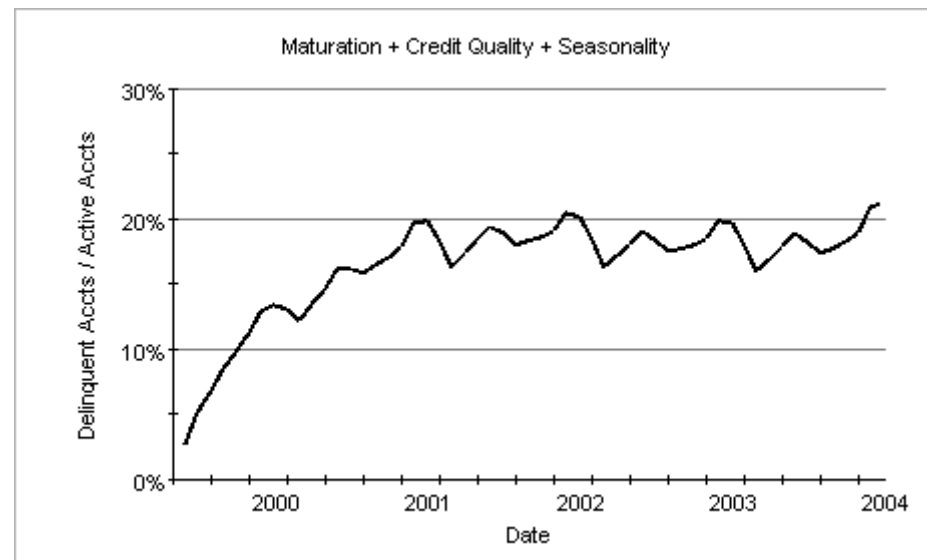
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality



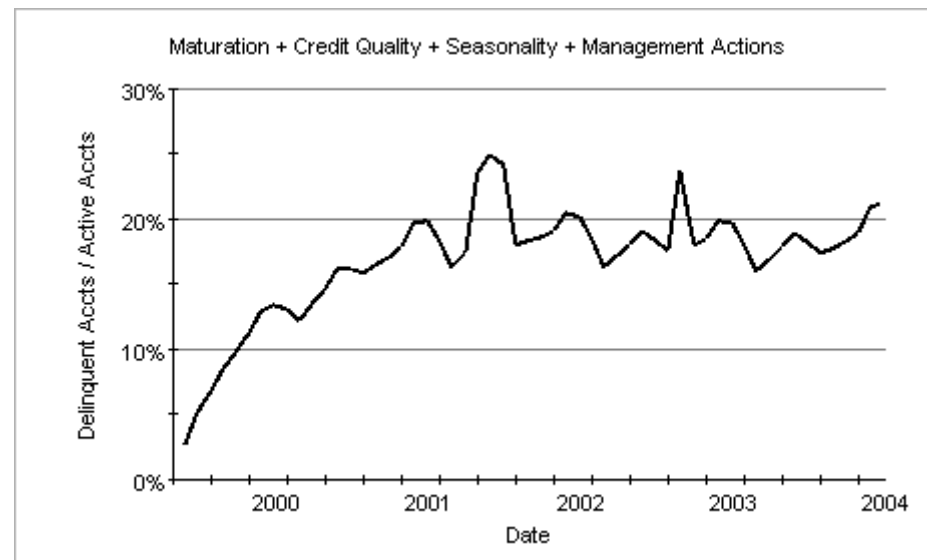
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality
- Seasonality



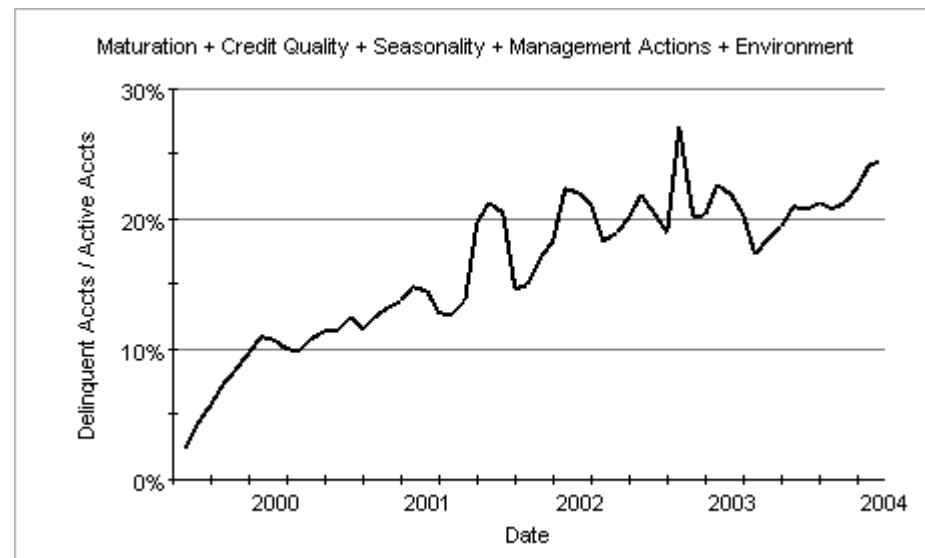
Components of Portfolio Performance

- Vintage Lifecycle
- Credit Quality
- Seasonality
- Management Actions



Components of Portfolio Performance

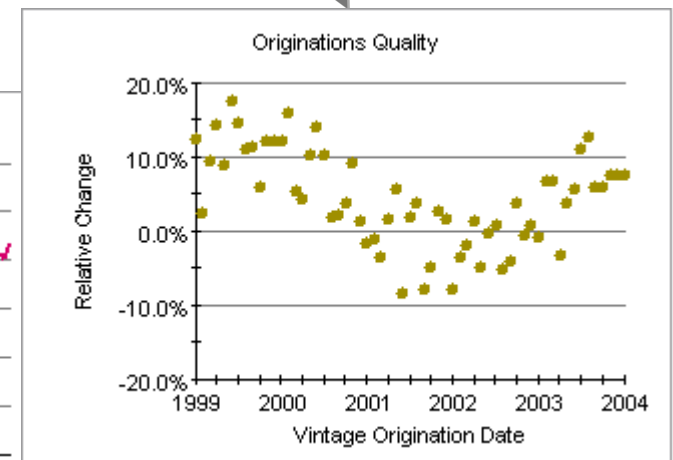
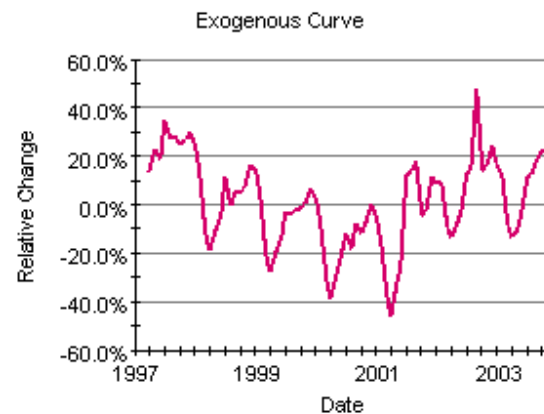
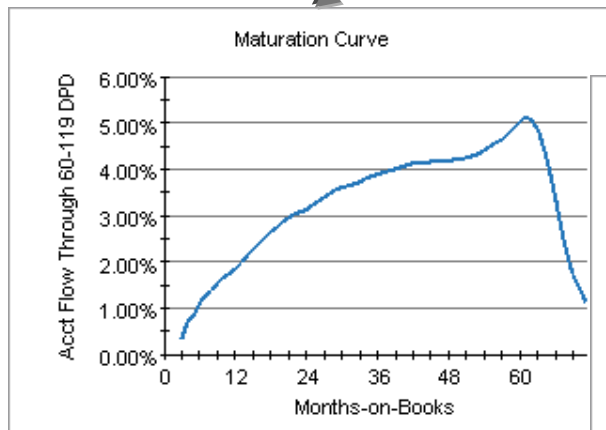
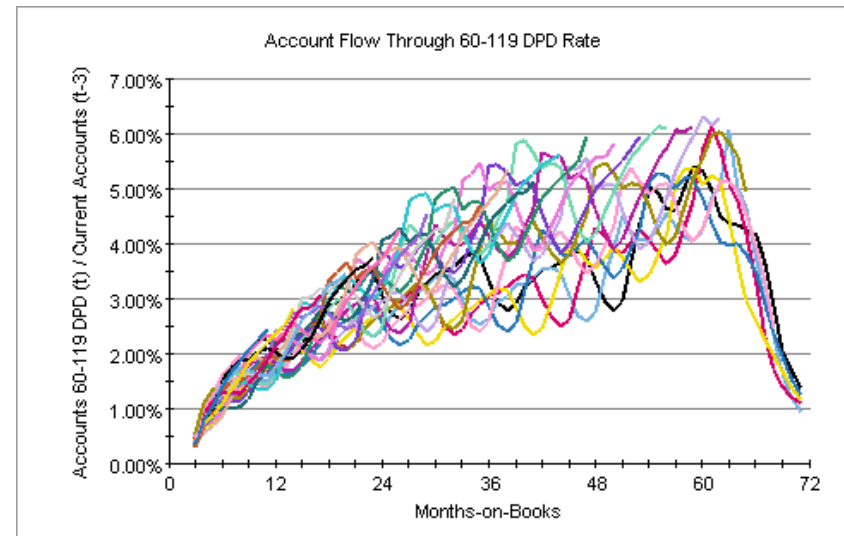
- Vintage Lifecycle
- Credit Quality
- Seasonality
- Management Actions
- Macroeconomic & Competitive Environment



Nonlinear Decomposition

- 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

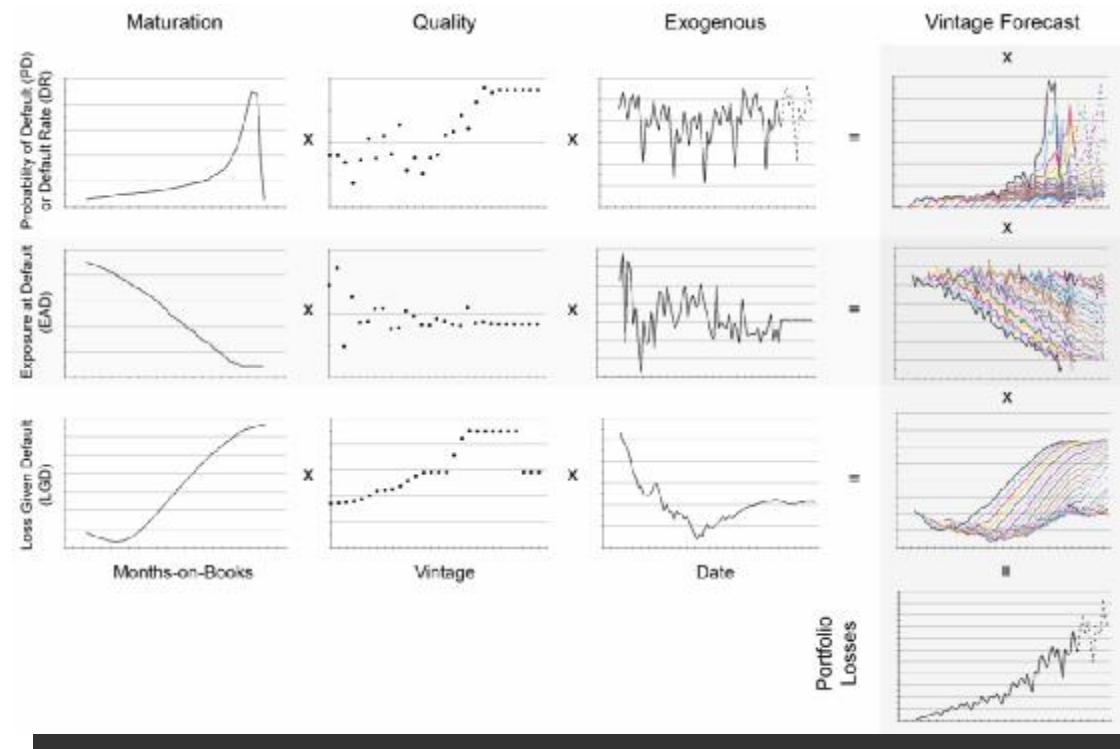
¹ Leveraging recent developments in Survival and Proportional Hazards Models.

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.





**A History Lesson –
2007—20?? Mortgage Crisis**

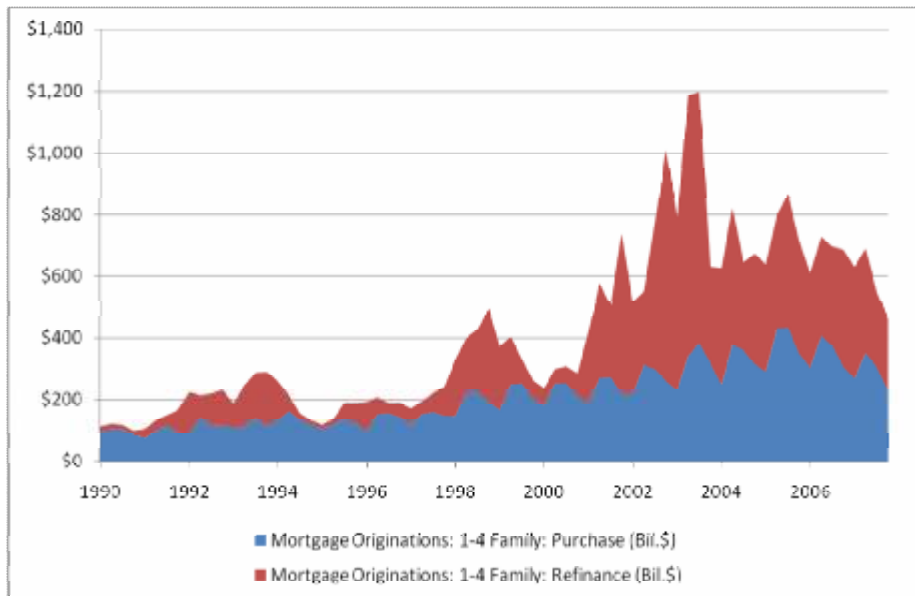
Basel II QIS 4.0

- Quantitative Impact Study 4 was conducted from 2004Q4 to 2005Q1 to assess capital requirements under the new Basel II guidelines.
- The results showed a 61% decrease in capital needs for mortgage and a 74% decrease for home equity.

Preliminary Change in Minimum Capital Requirements: Basel I to Basel II		
Portfolio	Average Percent Change in Portfolio MRC	Median Percent Change in Portfolio MRC
Wholesale Credit	(24.6%)	(24.5%)
Corporate, Bank, Sovereign	(21.9%)	(29.7%)
Small Business	(26.6%)	(27.1%)
High Volatility Commercial Real Estate	(33.4%)	(23.2%)
Income Producing Real Estate	(41.4%)	(52.5%)
Retail Credit	(25.6%)	(49.8%)
Home Equity (HELOC)	(74.3%)	(78.6%)
Residential Mortgage	(61.4%)	(72.7%)
Credit Card (QRE)	66.0%	62.8%
Other Consumer	(6.5%)	(35.2%)
Retail Business Exposures	(5.8%)	(29.2%)
Equity	6.6%	(24.4%)
Other Assets	(11.7%)	(3.2%)
Securitization	(17.9%)	(39.7%)
Operational Risk		
Trading Book	0.0%	0.0%
Portfolio Total	(12.5%)	(23.8%)
Change in Effective MRC	(15.5%)	(26.3%)

US Mortgage Boom and Bust Cycle

Mortgage Originations

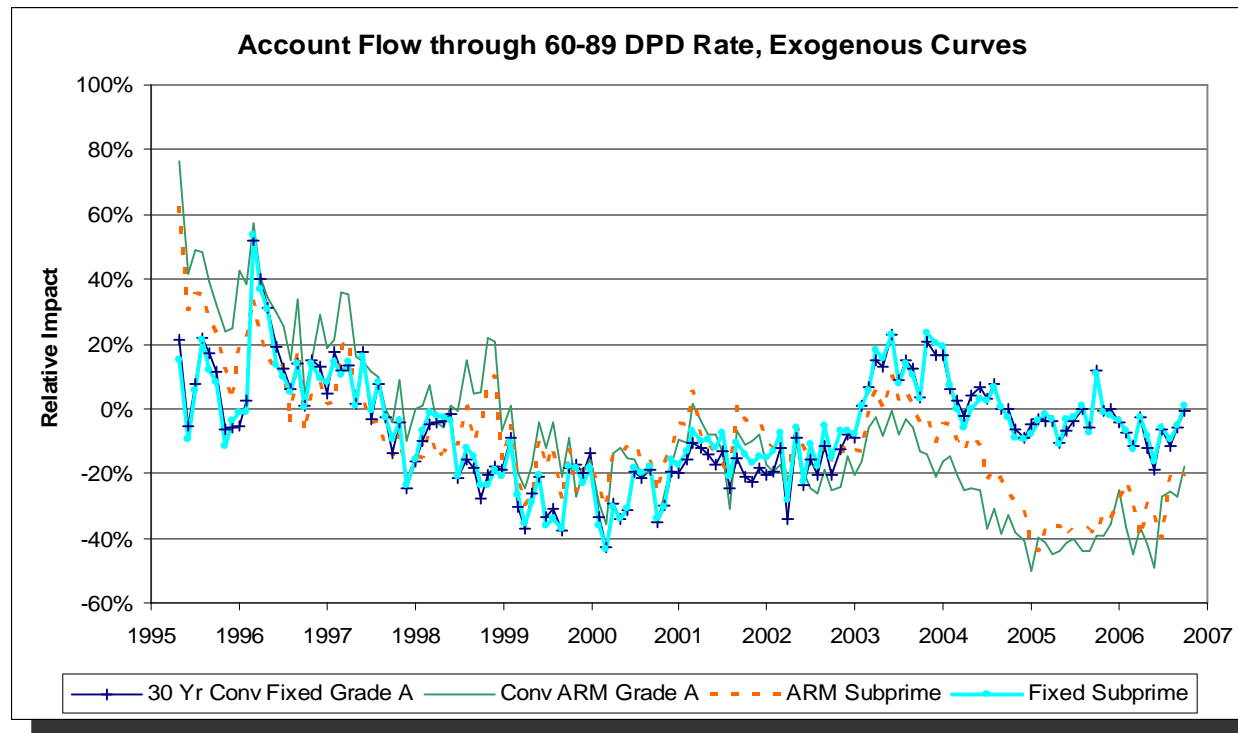


60 Day Delinquencies



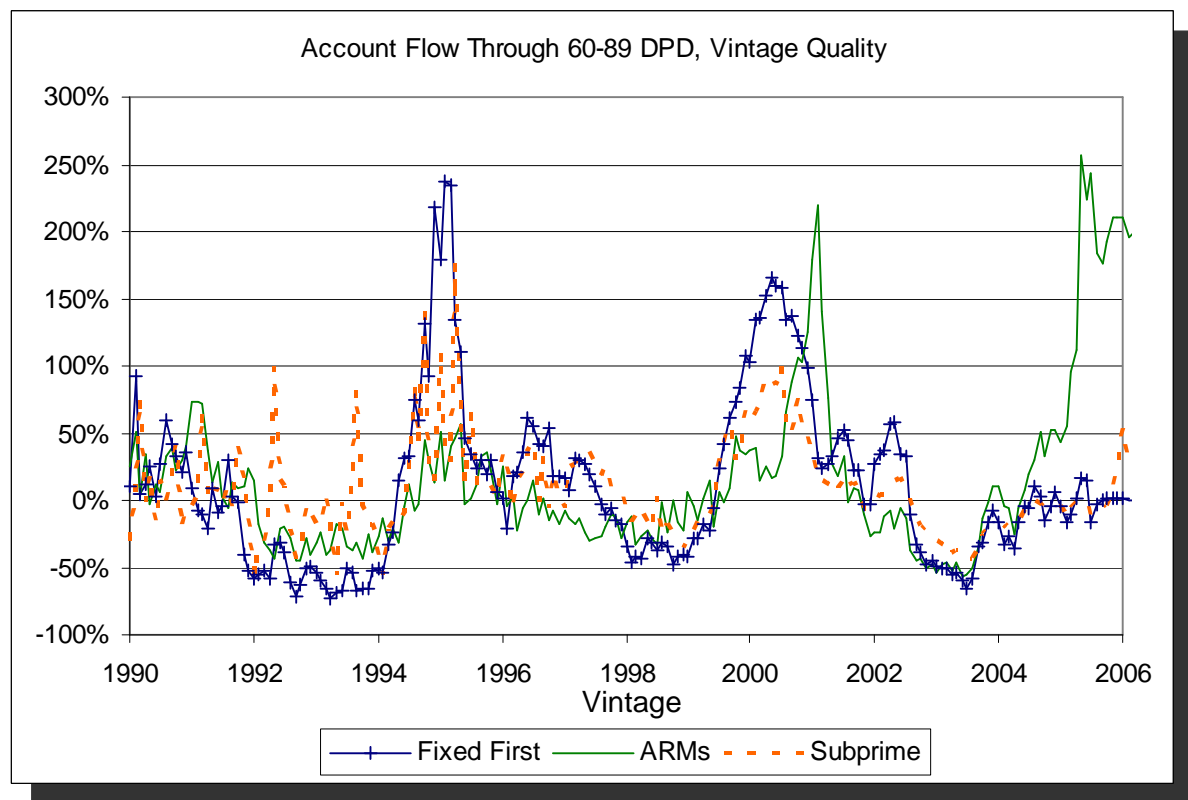
- Whenever interest rates drop, a refi and new home boom ensues – usually lasting 12 to 24 months
- After a boom, delinquency and foreclosure rates climb

US Mortgage Meltdown 2007



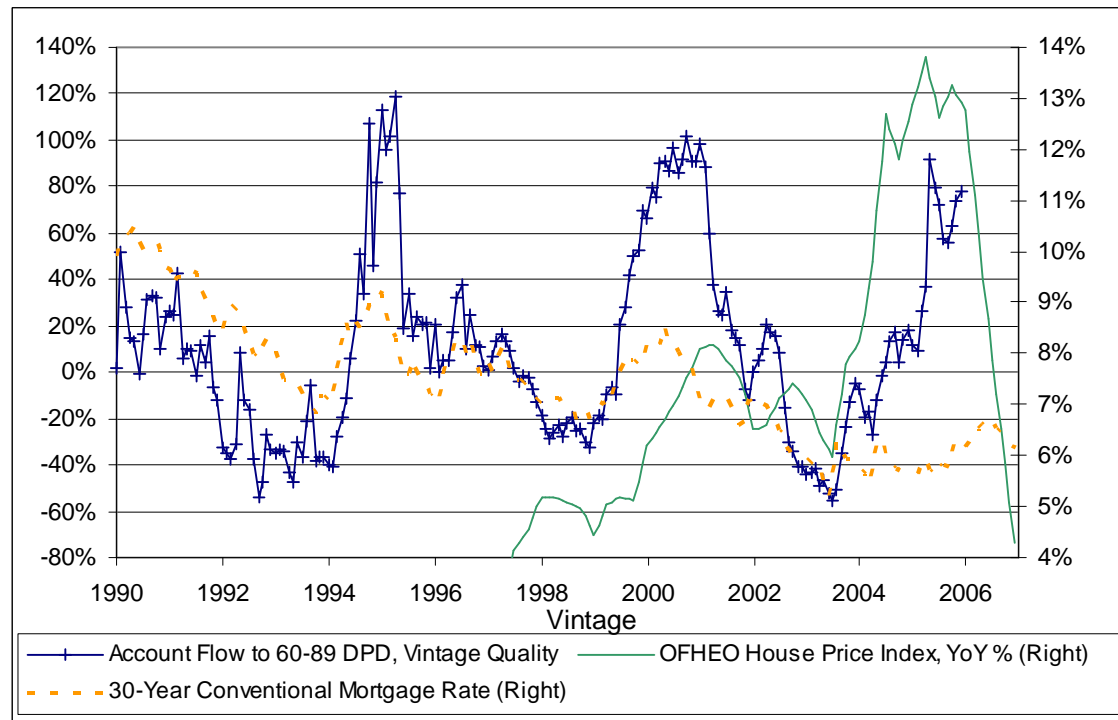
- The US Mortgage environment began to deteriorate in 2000 along with other consumer loan types.
- In 2001, a surge in home prices stopped the deterioration.
- By 2004, the overall economy was growing strongly, so US mortgage largely missed the last recession.

US Mortgage Meltdown 2007



- The quality of originated mortgages shows three clear periods of deterioration since 1990.
- The 2000 deterioration is well known in the industry, but not well understood.
- The 2005-2007 problems are in the news now.

US Mortgage Meltdown 2007



- Today's problems are not just due to fraud, Option ARMs, securitization, or subprime.
- Falling interest rates provide incentive for purchasing and refinancing.
- Rising home prices in 2001 and 2004-2005 provided the justification for booking riskier loans.
- The economy does not control quality. It provides the motivation driving banks to change their targets and policies, which then affects quality in-the-door.

Mortgage Crisis Phases

Phase 1 (2005): Originations quality deteriorates, but not seen by scores.

Phase 2 (2007): House prices start to decline, so default severity rises rapidly.

Phase 3 (2008): Liquidity crisis because securitization market collapses.

Phase 4 (2008 Q4): General recession begins, increasing defaults.

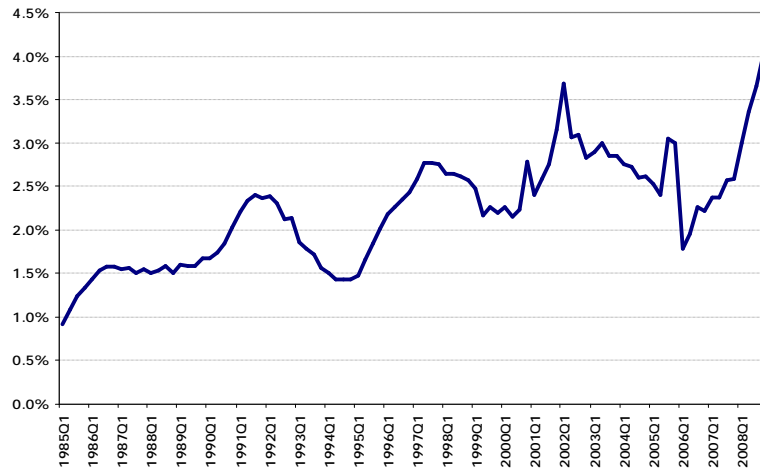
- All US retail products experienced all 4 phases of this crisis. Subprime and Alt-A mortgages were simply the worst.

A Forecasting Example - US RMBS

Common Approaches to Forecasting are Inadequate

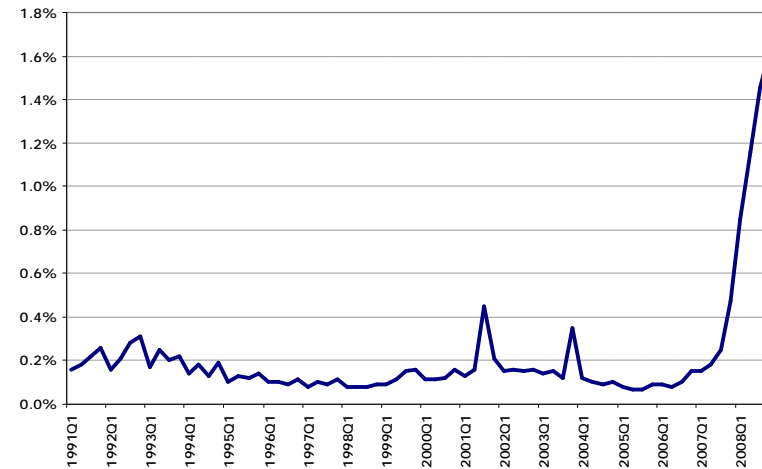
- Most Roll Rate models and score-odds calibrations do not employ “forward-looking” techniques and are rarely helpful beyond 6 months.
- They cannot explain impacts from economy or anticipate turning points.

Consumer Loan Charge-off Rate - Commercial Banks,
Seasonally Adjusted



source: Federal Reserve Board

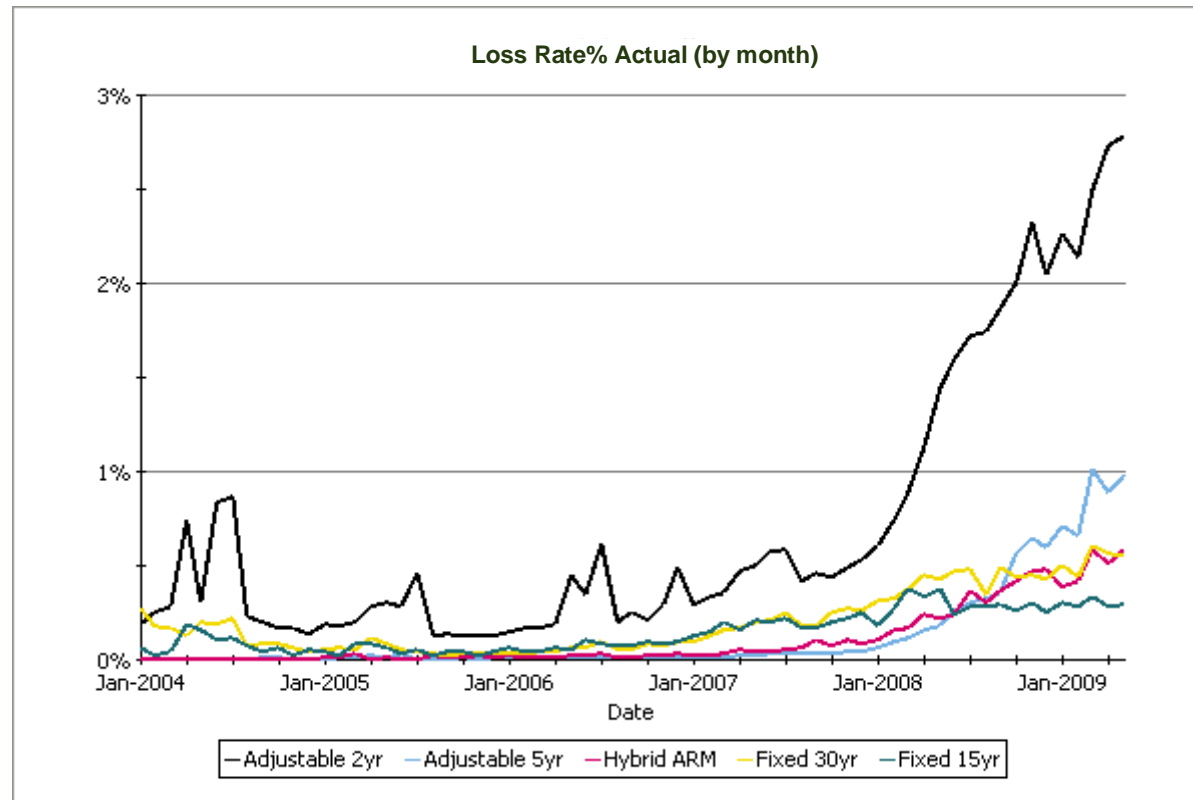
Single-family Home Residential Mortgage Charge-off Rates,
Commercial Banks



source: Federal Reserve Board

- **Models that assumed fixed macroeconomic relationships, or that scores fully explained quality, failed badly in the US Mortgage Crisis.**

Losses have risen across all Mortgage Products



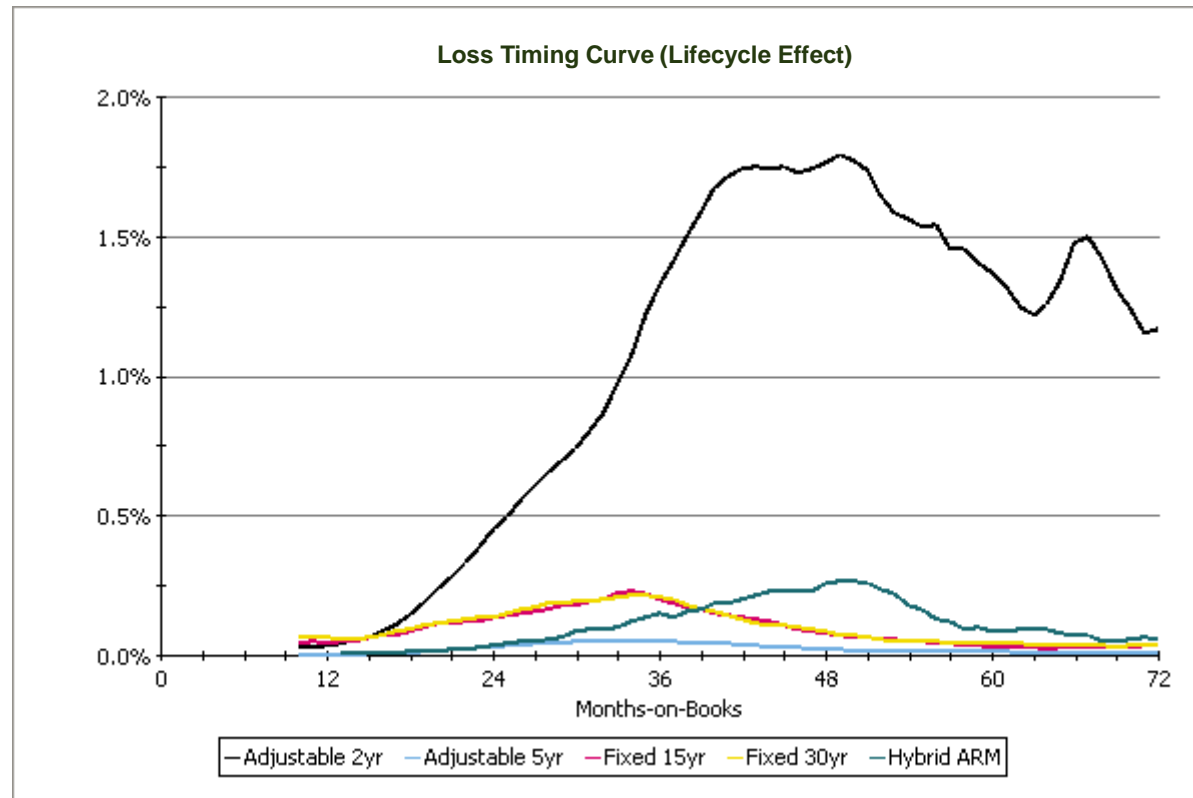
- **Not surprisingly, Charge-off Rates for all products have risen quite significantly over the last 2 years.**
- **Charge-off Rates for 2yr ARMs have risen even more dramatically over the last 18 months.**

Segment the Deals for Analysis

- Each deal is split into the 207,360 segments described below.
- Segmentation aids the creation of product-specific lifecycle and environmental curves.

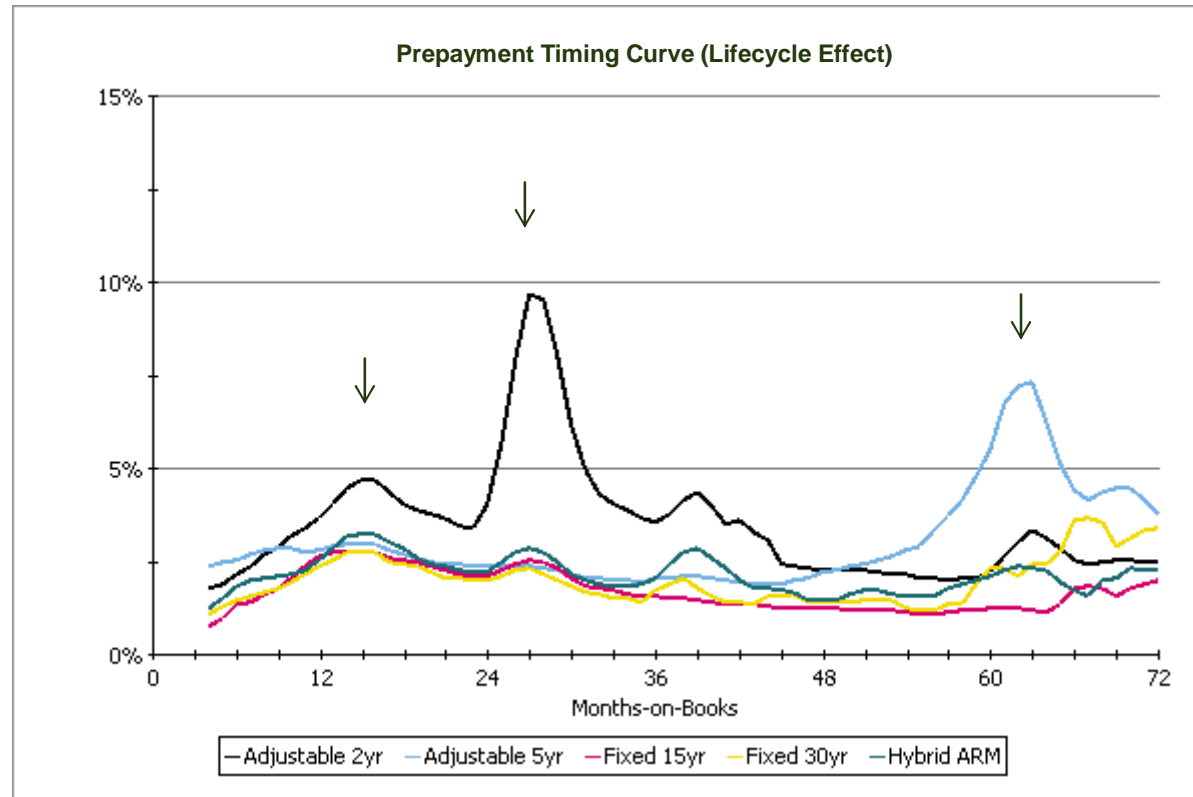
Product	Score	LTV	DocType	Occupancy	AssetType	Region	Jumbo
Fixed <= 15yr	Fico below 660	LTV < 80	Full Documentation Loan	Primary	Single Family Home	The top 30 CSAs should be listed by CSA, everything else by state	Jumbo loan
Fixed > 15 yr and <= 20yr	660 <= FICO < 720	80 <= LTV < 90	Low Doc, No Doc,..	Other	Condo		Not Jumbo
Fixed > 20 yr	720 >= FICO	LTV >= 90			Other		
Adjustable <= 2yr							
Adjustable >2 yr and <= 3yr							
Adjustable >3 yr and <= 5yr							
Adjustable >5 yr							
Negative Amortizing							
Option ARM							
Other ARM							
Interest Only							
Baloon							

Lifecycle of loan losses is one driving factor



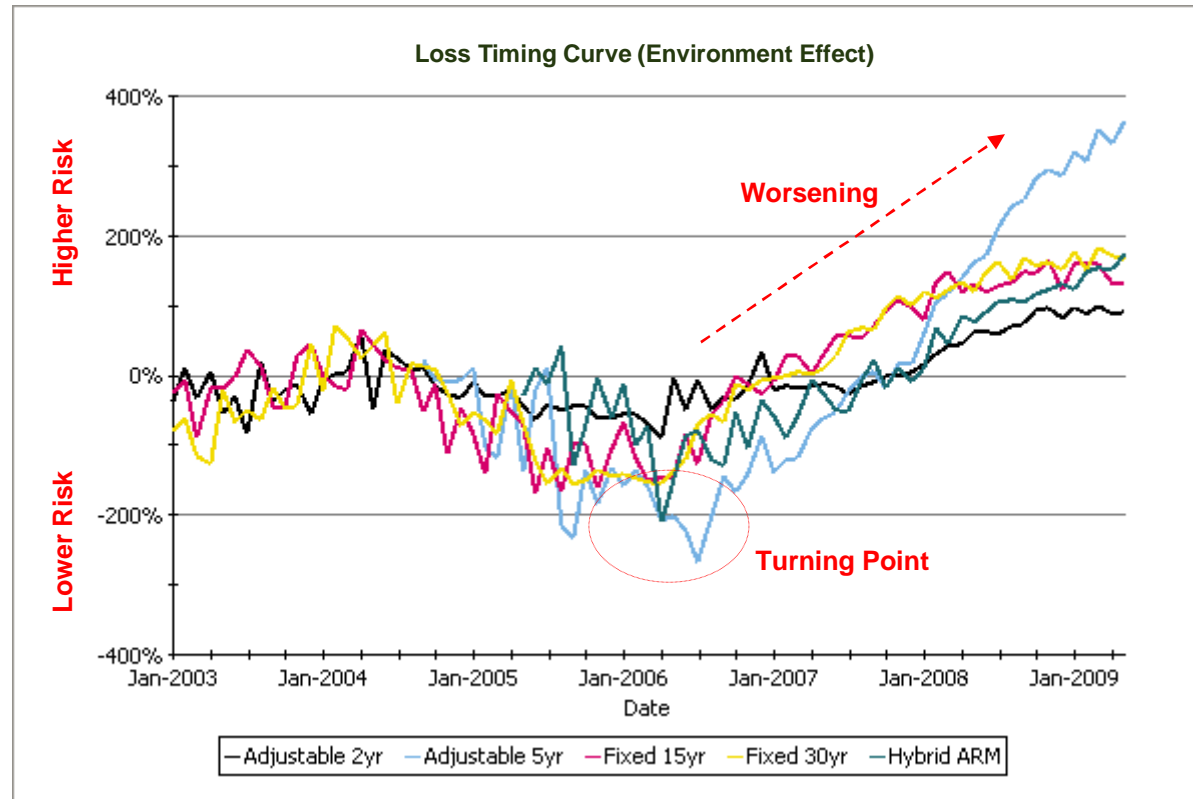
- These curves illustrate the lifecycle properties particular to the delinquency and loss rates.
- We typically see stacking of these curves by risk and product dynamics.

Prepayments also show strong lifecycle effects



- These curves illustrate the lifecycle properties particular to the prepayment rate (generally due to refinancing).
- A general increase in prepayment activity after annual terms or rate resets can be clearly observed.

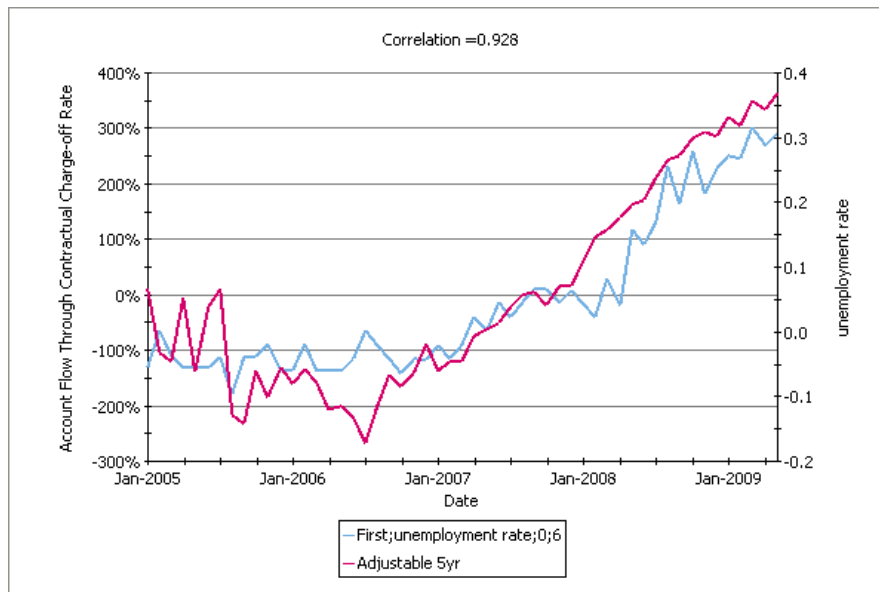
Deteriorating Environment is another strong factor



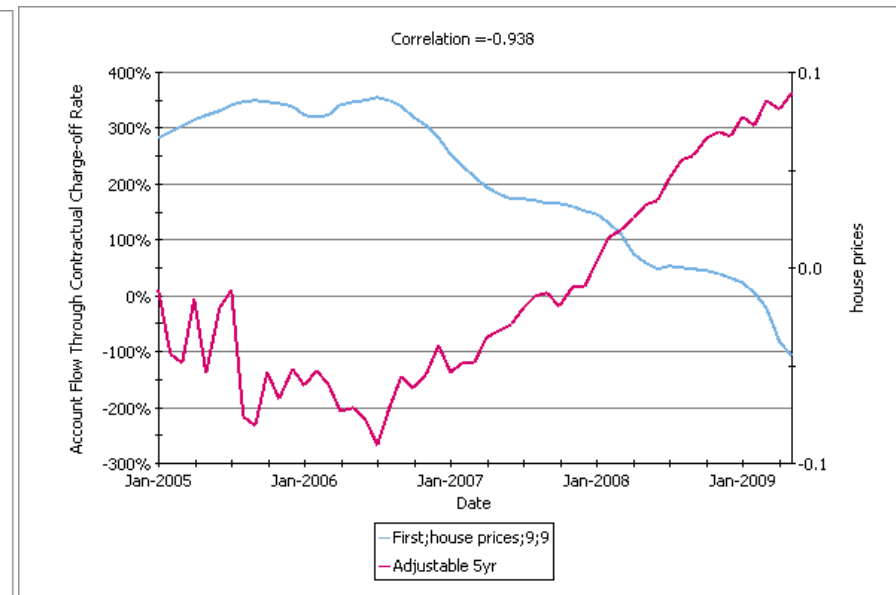
- The exogenous component of the loss curve is largely driven by macroeconomic factors.
- After turning in mid-2006, the environment has steadily deteriorated over the last 24 months. The pace of deterioration has been the worst for Hybrid ARMs.

Exploring Macroeconomic Drivers

Unemployment Rate

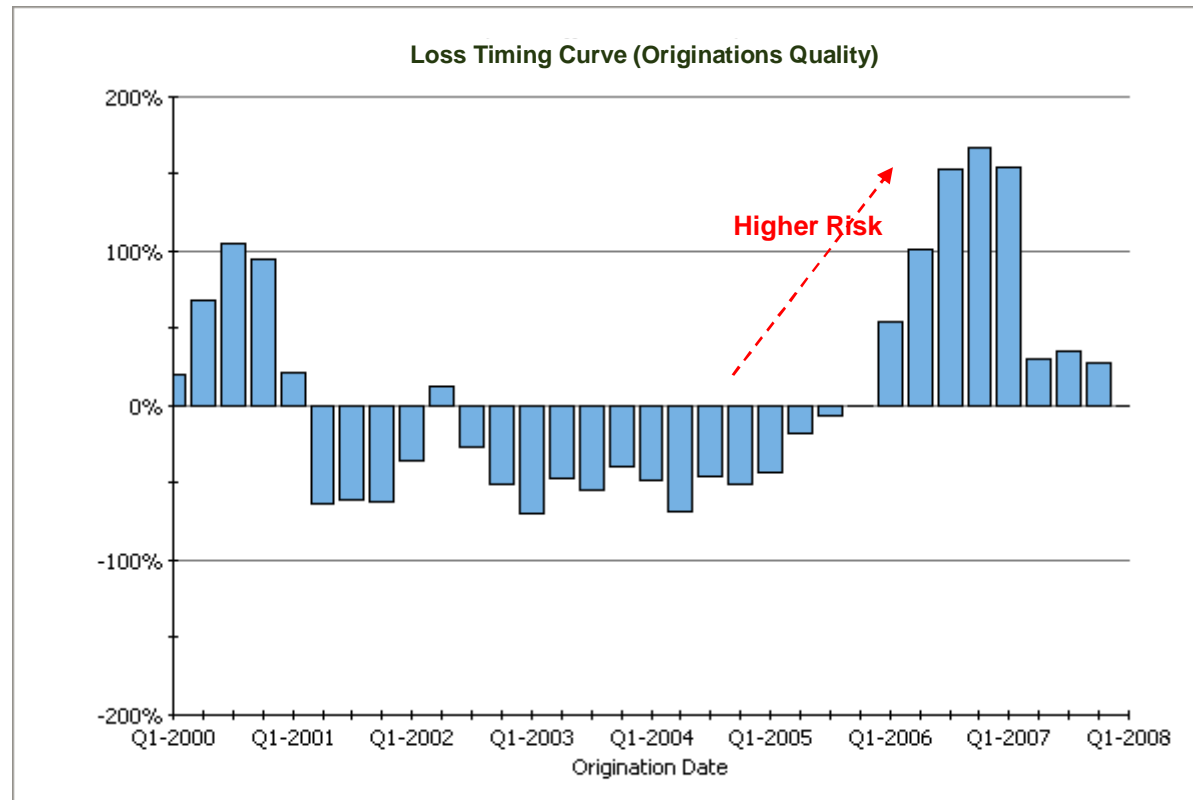


House Prices



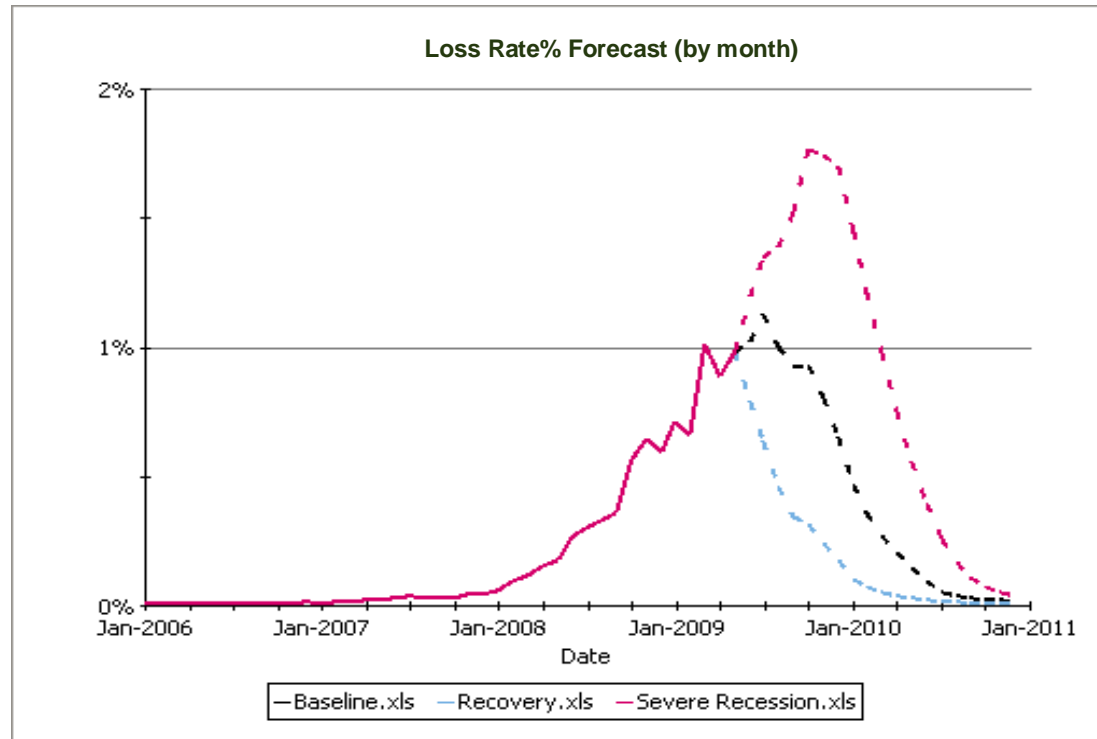
- The Exogenous curve shows strong relationships to Unemployment (positive correlation) and House Prices (negative correlation)

Worsening Originations Quality is the third major factor



- Looking across various types of ARMs, we confirm that V2006 and V2007 have significantly worse underwriting than the historical portfolio.
- Compared to loans originated in 2005, V2006 is 140% worse and V2007 is 80% worse. This deteriorating quality was generally not captured by bureau scores.

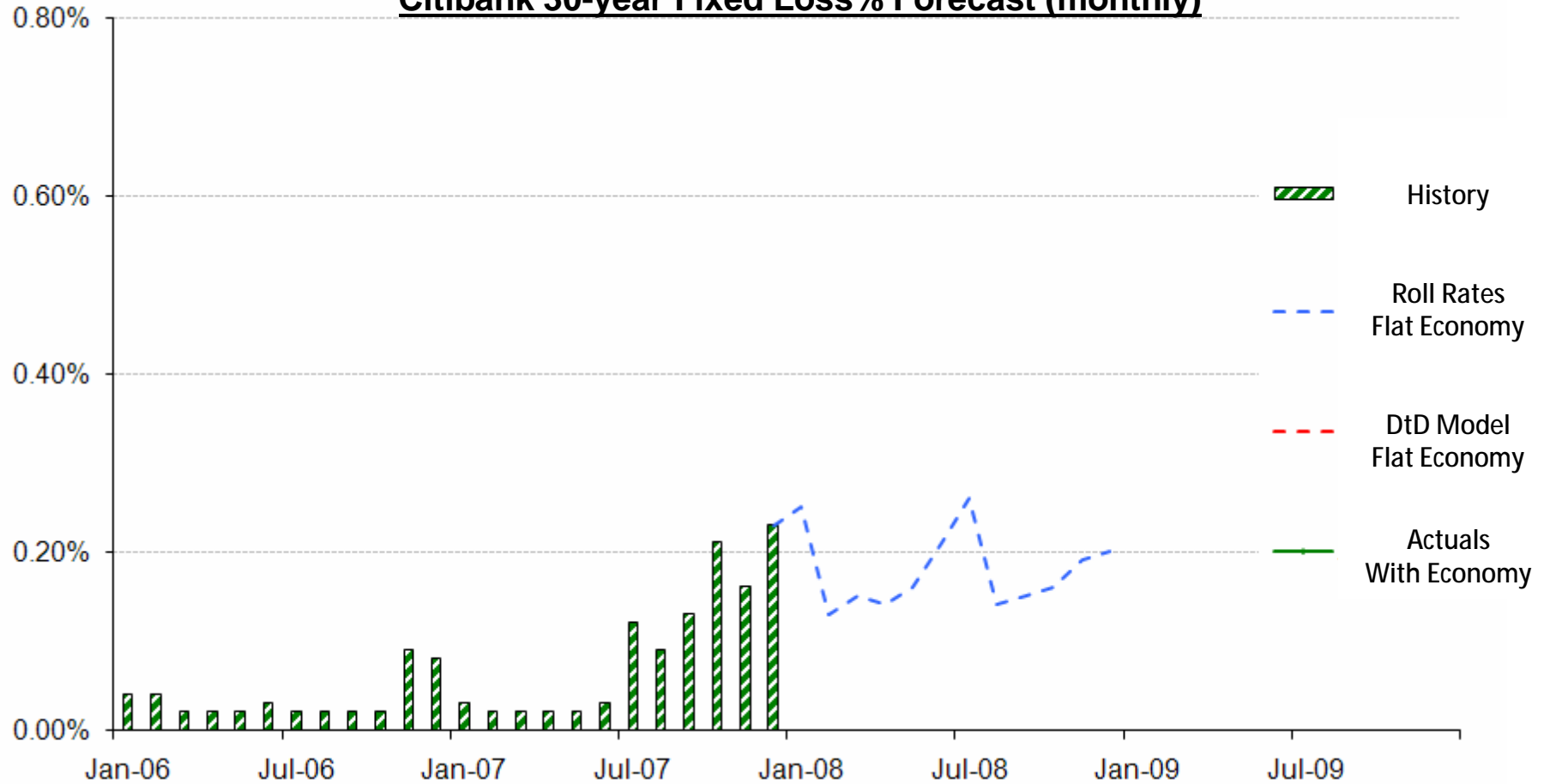
Economic Stress Test Results



- **Portfolio losses were stressed with different outlooks for House Prices and Unemployment. They were combined via a multivariate weighting model to create the final Economic Response Model**
- **Baseline scenario sees a leveling-off of losses in 2009 and a gradual reduction in 2010. Recovery scenario sees an immediate reduction of losses starting in 2009. While the Severe Recession scenario sees a sharp rise in losses throughout 2009 with eventual curing occurring second half of 2010.**

Portfolio Forecasts Comparing Models

Citibank 30-year Fixed Loss% Forecast (monthly)



Roll Rates	DtD Model	Actuals	DtD Model "Lift"
\$102mm	\$217mm	\$246mm	\$115mm (113%)

Note: Backtest was performed on Citibank Mortgage Securities totaling 50K Loans with \$9B in Receivables.

Conclusions

Conclusions

- Origins of the US Mortgage Crisis run deeper than lax underwriting and poor securities pricing.
- Scenario-based forecasting and allowance for adverse selection are required for proper pricing.
- Models already exist that can capture the dynamics of mortgage portfolios and properly forecast the securitized pools.
- DtD as implemented in LookAhead began showing dire forecasts for US Mortgage in February 2006 – this was predictable.

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