Account Level Retail Modeling

Approaches and Challenges

Shirish Chinchalkar

October 2013

Agenda

1. The complexity of loan level modeling
2. Our approach for modeling mortgages and auto loans
3. Analyzing portfolios of different asset classes
4. Conclusion

The retail portfolio – Some challenges

➢ Mortgages, HELOCs, and HELoans

- ✓ Complexity of modeling different types of mortgage products

➢ Auto Loans

- ✓ Used and new car loans, modeling residual value

➢ Credit Cards

- ✓ FICO, credit limits, new originations tightly controlled

Objectives

- ➢ Develop a consistent framework for modeling each asset class. Model borrower behavior using observable factors
- ➢ Capture correlation between different asset classes
- ➢ Stress testing and Risk Management
- ➢ Regulatory reporting

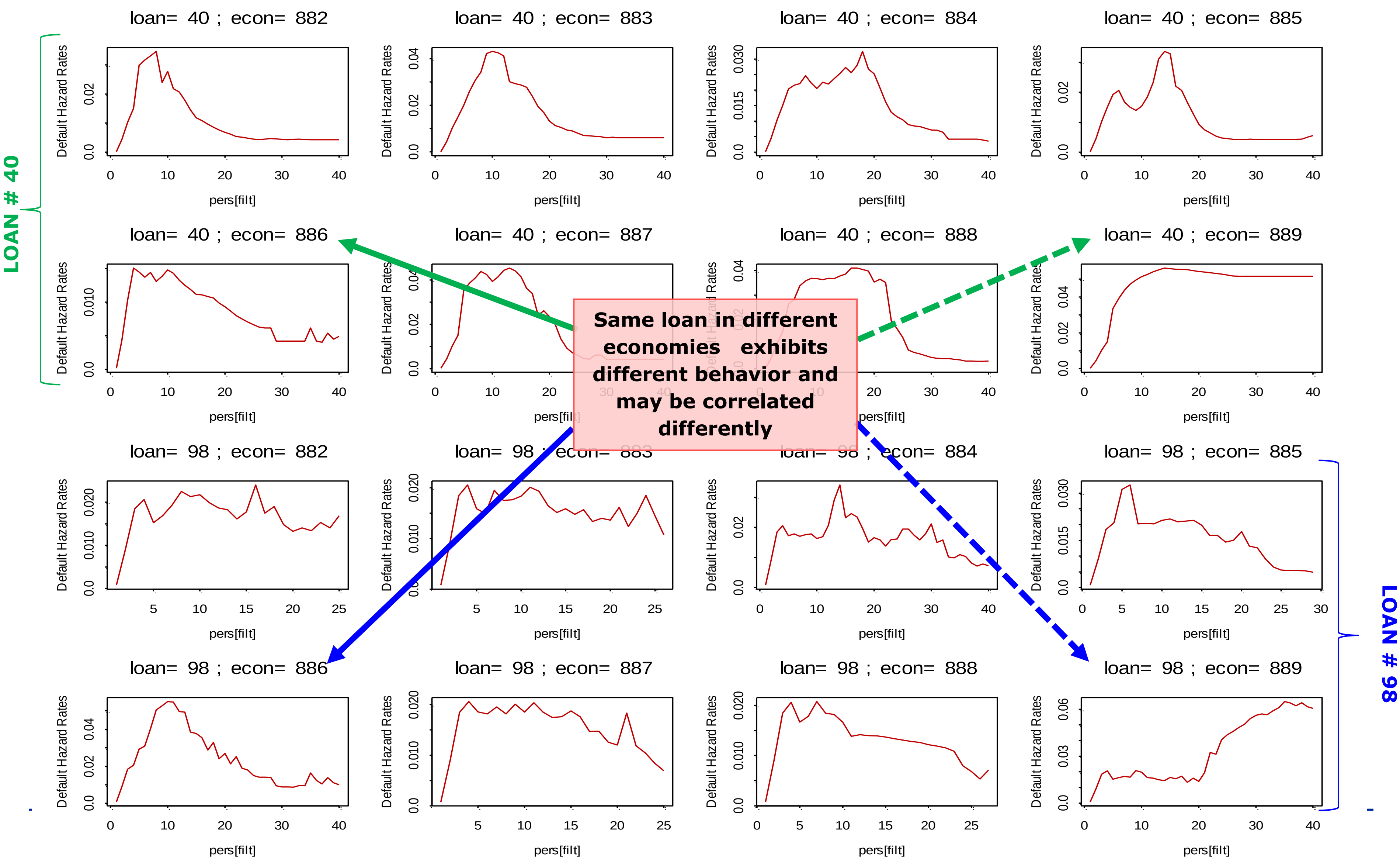
Why are mortgages complicated to model?

- Many (many) scenarios are required to capture the behavior of mortgages in different states of the world
- Loan-level behaviors are not homogenous
- Non-monotonic behavior with respect to several factors
- Interaction terms needed to explain borrower behavior
- Single period analysis cannot generally be used for path-dependent instruments like mortgages

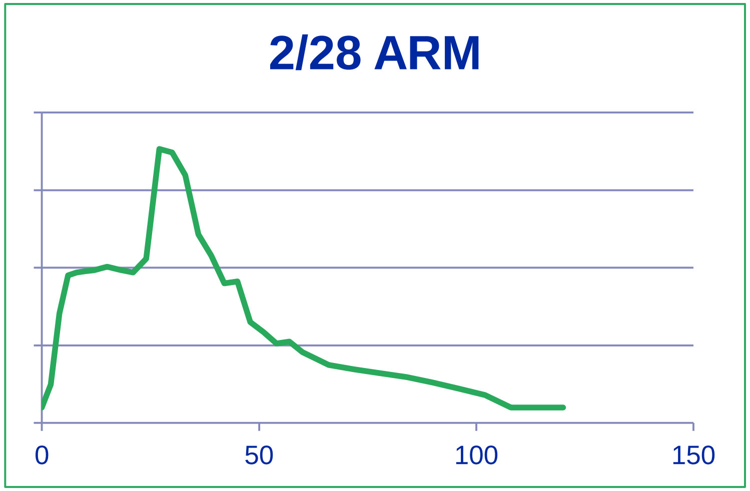
Modeling it this way allows us to:

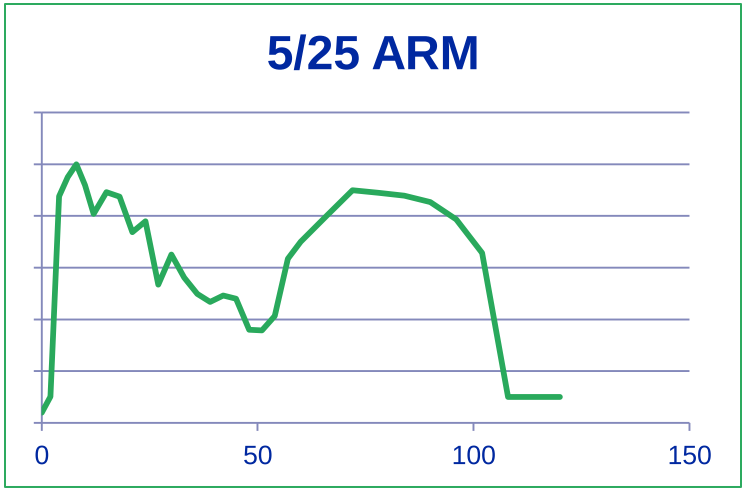
- Generate full collateral loss distribution and losses for *MA, Fed CCAR, and user-defined scenarios*
- Use actual or simulated *macro-factors directly* (scenario analysis, historical validation)
- Model seasoned pools and new issuance in one framework (*using pool-level & loan-level data*)
- Obtain loan level cash flows and price individual loans
- *Explicitly* model primary and pool-level mortgage insurance
- Perform tranching, VaR, and capital allocation using *tail risk contribution* of loans
- Generate *full loss distributions* for individual tranches of an RMBS

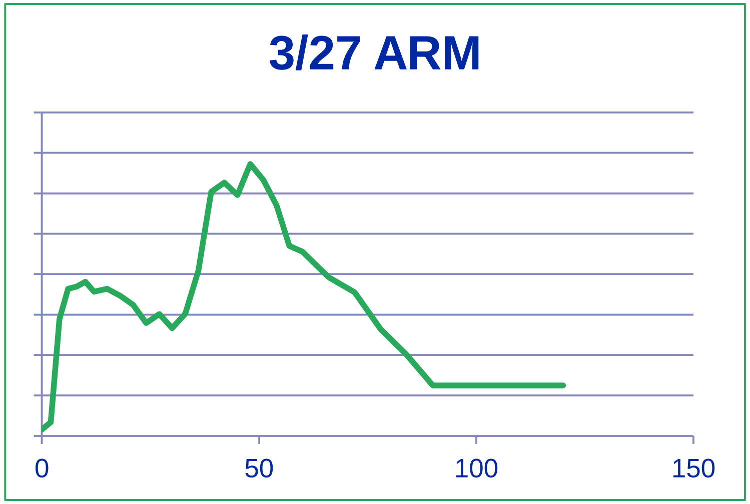
Loan level modeling in different economies

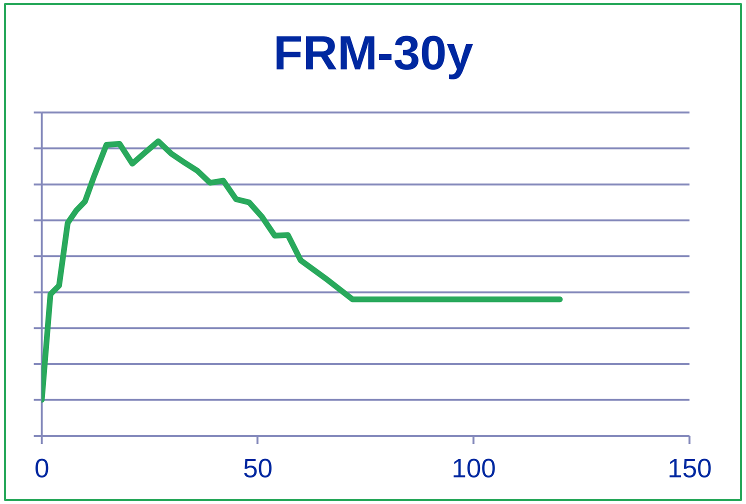


Different baselines for different types of loans

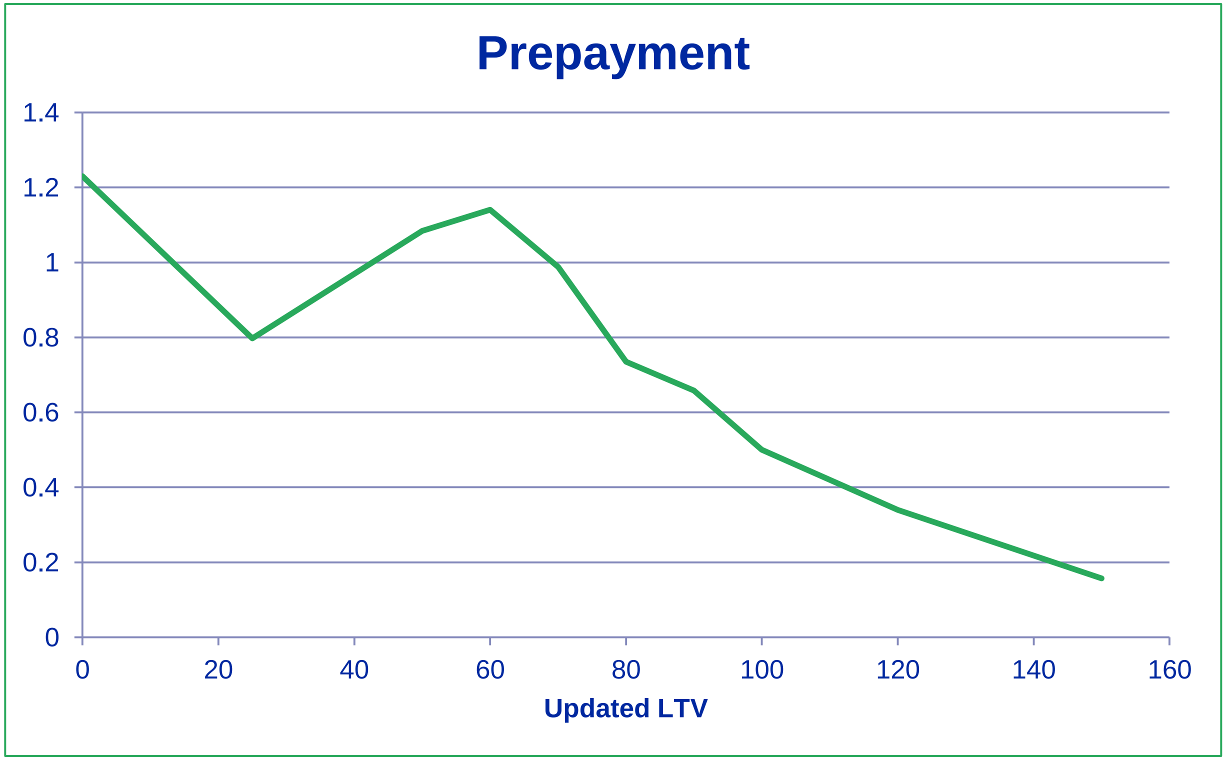






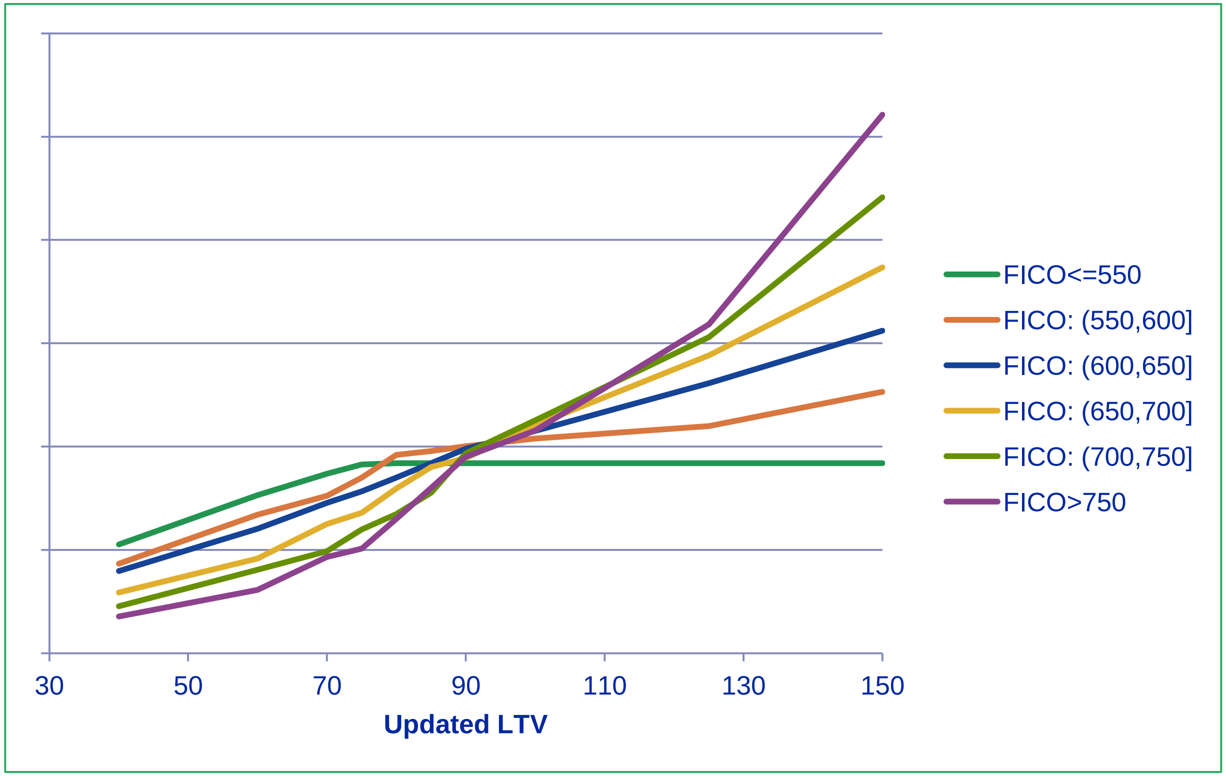


Non-monotonic relation with different factors



Prepayment incentive is different for borrowers in different updated LTV buckets

Interaction terms needed to explain borrower behavior



Default sensitivity is different for borrowers in different FICO buckets

Using Aggregate Pool Statistics I

Consider two pools drawn from this population: one **homogeneous** and one **barbelled**

(but both with approximately the same mean CLTV and FICO)

		Combined LTV			
		Low <70	**Medium [70,80)**	**High [80,85)**	**Very High >=85**
FICO SCORE	**Low < 710**	2.4	4.9	5.5	9.7
	Medium [710,750)	1.0	3.2	3.5	7.0
	High [750,775)	0.5	1.5	1.7	4.0
	Very High >= 775	0.1	0.7	0.9	1.8

	FICO	CLTV	Def. rate
Homogeneous	746	75.0	**2.5**
Barbell	737	77.5	**4.9**

Aggregate pool statistics may mask risk behavior.

Using Aggregate Pool Statistics II

Draw one portfolio uniformly and one barbelled

Repeat 10,000 times

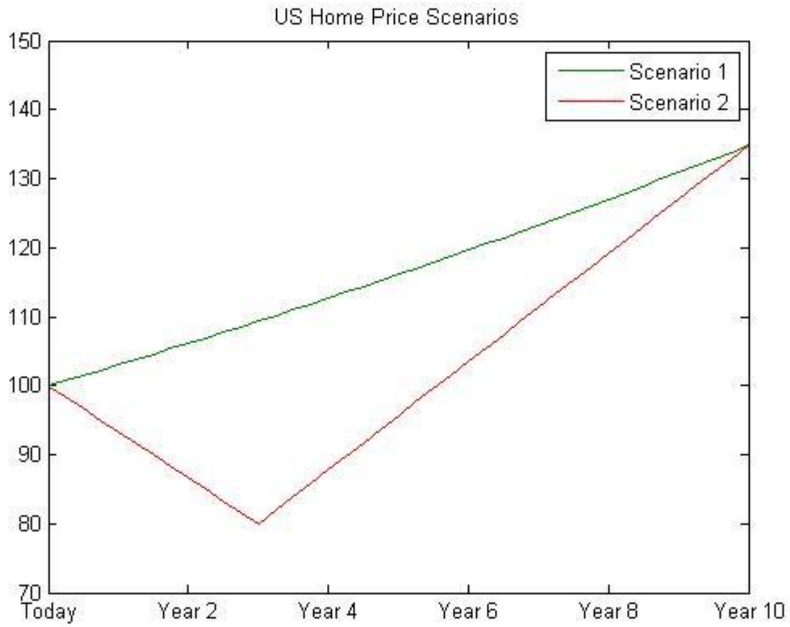
ONE POOL	Mean FICO	Mean CLTV	3-yr default rate
Portfolio A - uniform sample	742	76	3.0
Portfolio B - barbell sample	738	75	4.9

- Over 99 % of barbell portfolios had a default rate higher than the maximum default rate of the uniform portfolios

Aggregate pool statistics may mask risk behavior (again).

Multi-period Simulation and path dependence

- **Home prices start at 100 and end, 10 years later, at 134.**
  - **Scenario 1: home price appreciation of 3% per year for 10 years**
  - **Scenario 2: home price depreciation of 20% over 3 years followed by a gain over the next 7 years**



Pool	EL (Scenario 1)	EL (Scenario 2)
1	9.0	15.8
2	6.6	10.3
3	6.0	9.0
4	7.0	11.5
5	1.6	2.1

Multi-period simulation is valuable due to strong path dependency.

Why are Mortgages Complicated to Model?

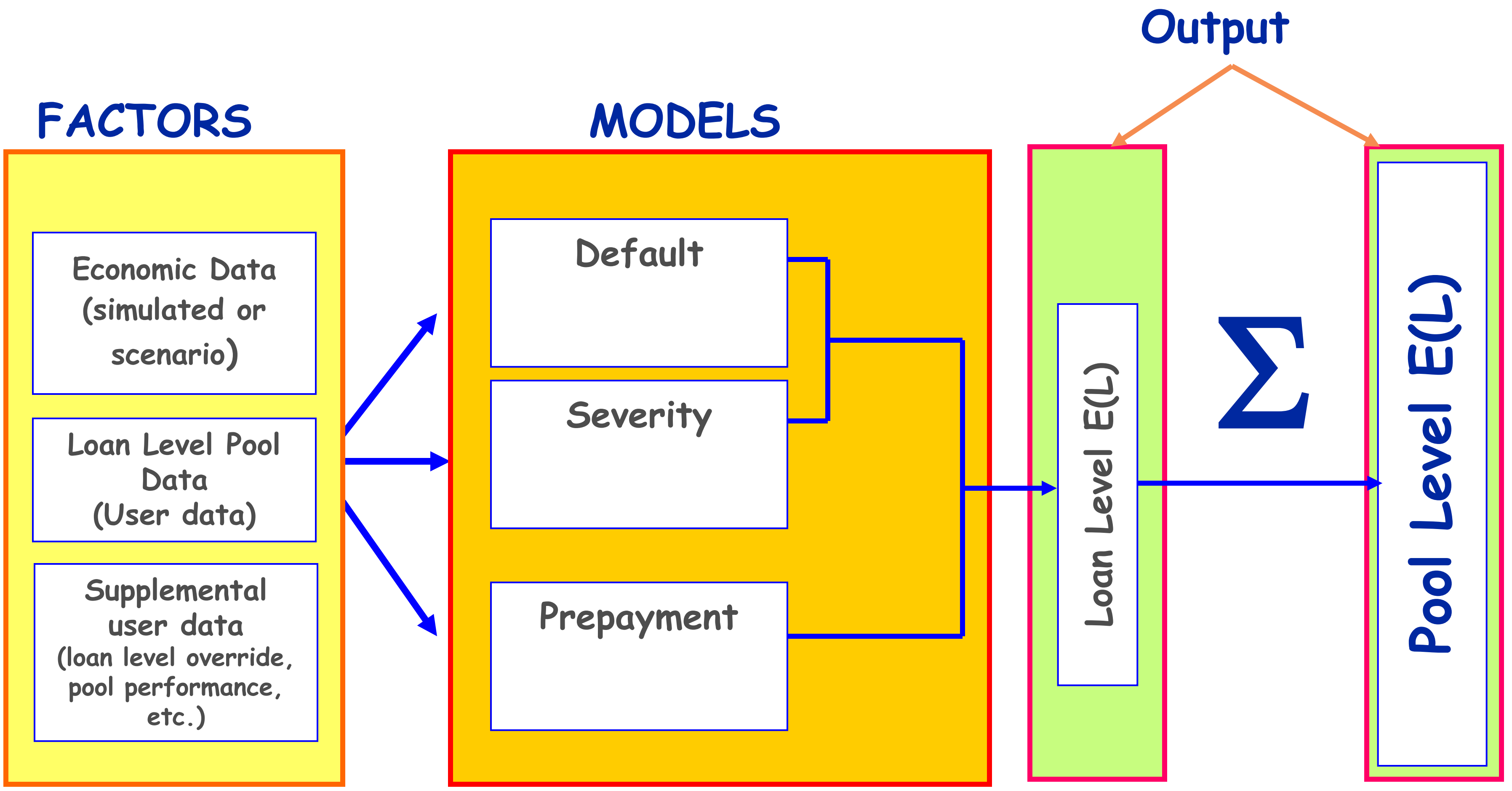
- If loan-level data is available, it may be preferred because
  - ✓ A single loan can behave very differently in different economic scenarios.
  - ✓ Different loan types behave very differently in the same economic scenario.
- Drivers of mortgage performance, including prepayment and default, are strongly *path dependent*.
- Mortgages have many embedded options, including
  - ✓ the option to prepay (call)
  - ✓ the option to walk away from the loan (put).
- The terms of these options do not generally average out analytically.

Mortgages are one of the most difficult asset classes to model.

Overview I

- Our model is an analytic tool for assessing the credit risk of a **portfolio of residential mortgages** (RMBS & whole loans), auto loans, and asset backed securities
- The model comprises **loan-level econometric models** for default, prepayment, and severity.
- These models are integrated through **common dependence on local macro-economic factors**, which are simulated at national and local (MSA) levels
- This integration produces **correlation in loan behaviors across the portfolio**.
- Because we use a multi-step Monte Carlo approach, the model can be **combined with an external cash flow waterfall tool** and used for **simulation of RMBS transactions**.
- The models also use **pool-level performance** to update the output in real-time.

Mortgage Modeling: Overview II



Mortgage Modeling Framework – Economic Factors

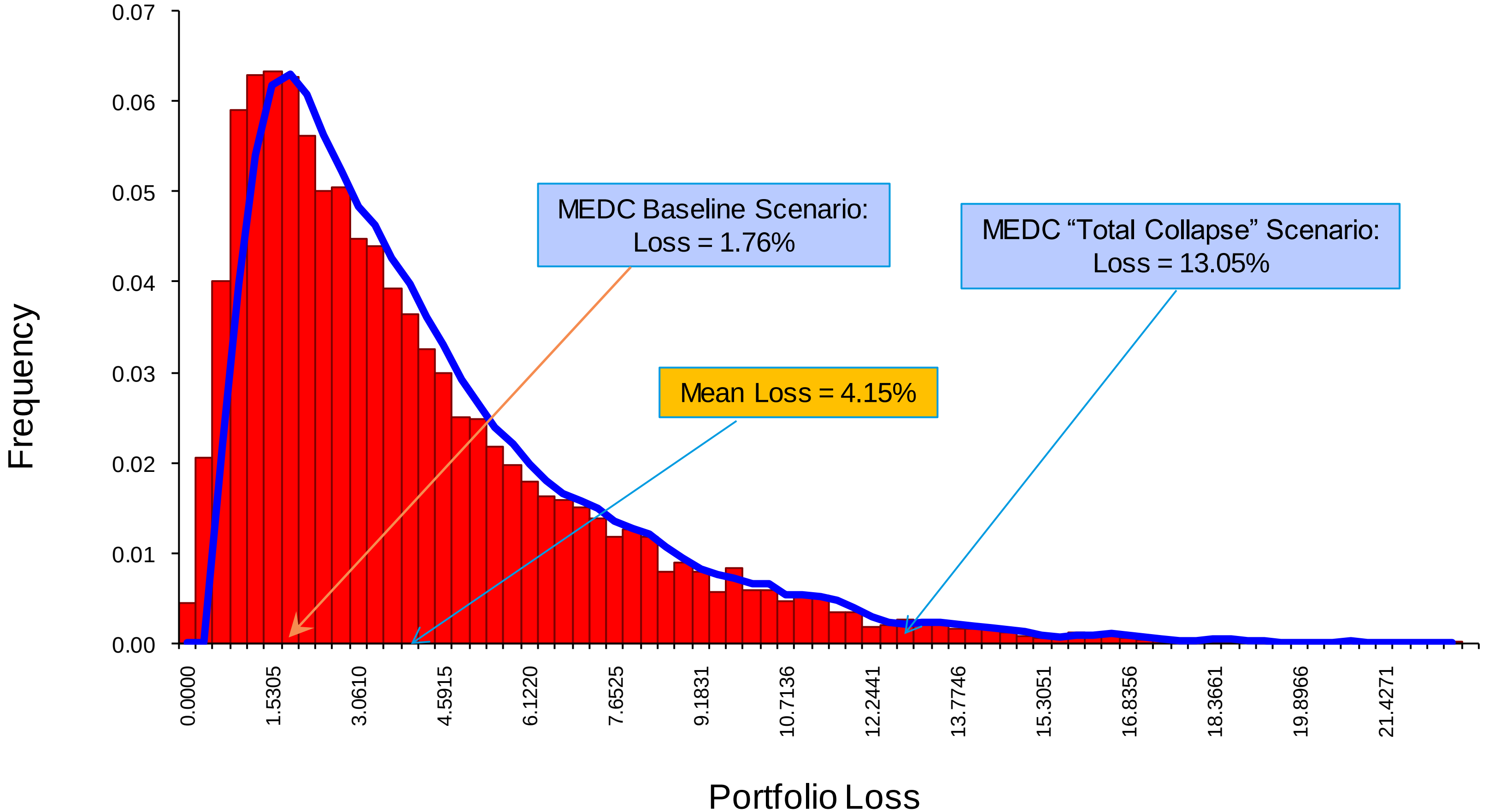
- The key economic processes that are simulated in the model are:
  - ✓ **Interest rates** (10-year CMT & 6-month LIBOR)
  - ✓ **Home Price Change** (national, state, and MSA level)
  - ✓ **Unemployment rates** (national, state, and MSA level)
  - ✓ **Loan market rates** (Freddie Mac (FHLMC) mortgage rate or subprime market rate)

Explanation of modeling process - Auto Regressive processes are used to model changes in the unemployment rate and the log of the home price index at the national level. Subsequently the unemployment rate and home price index at the state and MSA level are modeled using the results at the national level, plus their own lags. These macro factors are correlated through common dependence on interest rates and, in the case of the local economic factors, on the national levels of unemployment and home prices, respectively.

Modeling Auto Loans

- The key economic processes that are simulated in the model are:
  - ✓**Interest rates, used car rate, Oil prices, used car index**
  - ✓**Home Price Change** (national, state, and MSA level)
  - ✓**Unemployment rates** (national, state, and MSA level)
- The key drivers of residual value of a car are:
  - ✓Used car index, age of car, make of car
- Loan and borrower factors that affect prepayment and default:
  - ✓Make of car, used or new, age of car at purchase
  - ✓Interest rate, loan amount, LTV
  - ✓Type of lender (bank, captive, or others)
  - ✓FICO

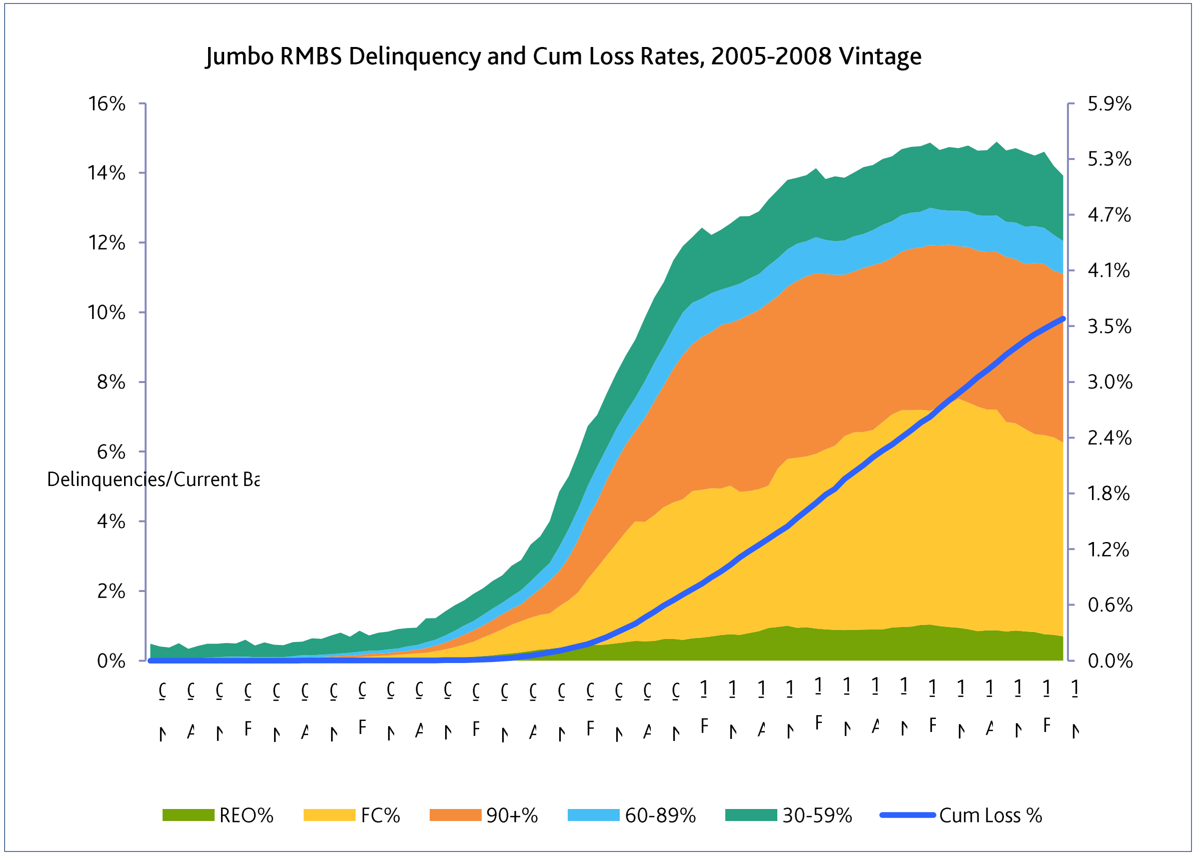
A Mortgage Portfolio Loss Distribution

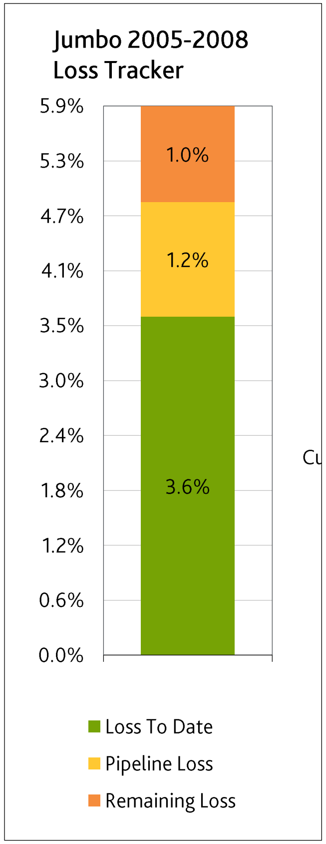


In addition to generating the full loss distribution, it is possible to estimate losses under *MA or user-defined scenarios*.

US Jumbo RMBS Performance

Source: Moody's Investors Service





Delinquent loan pipeline makes up a key part of future losses.

Modeling Seasoned Mortgage Pools: Delinquent loans

- We categorize delinquent loans into: 30, 60, and 90+ Days Past Due.
- Default and prepayment hazard rates differ substantially between delinquent loans and current loans.
- Each delinquency status has different default and prepayment behavior.
- Explicitly modeling delinquent loans permits much finer analysis than “roll-rate” approaches for portfolio monitoring.

Delinquent loans behave very differently than current loans.

Modeling Seasoned Loans: Incorporating Pool-specific Realized Performance To-date

- Realized performance can, on occasion, be very different than predicted due to unobservable differences in underwriting, servicing, borrower characteristics, etc.
- It is important to incorporate individual components of the realized performance, namely default, prepayments, and severity, separately.
- In the majority of cases, the predicted and observed behaviors generally agree closely. In some cases, however (e.g., table below), the pool-performance can be valuable.

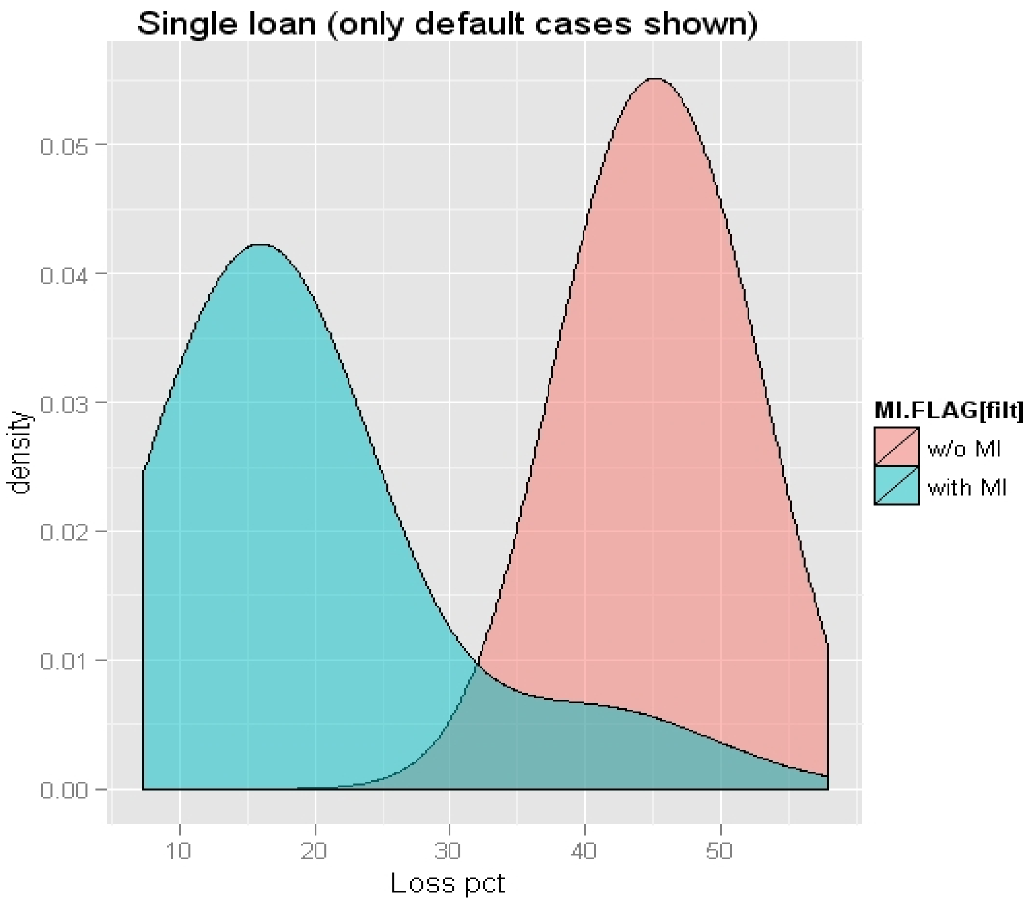
Portfolio	Without mid-course update	With mid-course update	Comments
1	15.2	13.7	Good originator
2	19.6	23.7	Severity higher than expected
3	22.9	17.3	Conservative originator
4	29.7	14.4	Retail. Good underwriting

Pool-level idiosyncratic behavior can be useful in future projection.

How Does Primary MI Work?

- Policy has a <u>coverage level</u> between 0% and 100%
- When loan defaults, gross loss equals sum of
  - Unpaid balance at time of default
  - Unpaid interest
  - Other costs less certain deductions
- Reimbursement is lesser of
  - Gross loss × coverage level
  - Loss net of proceeds of sale of property (if property is sold before claim is paid.
- <u>Example:</u> Borrower defaults, gross loss = $200K. Coverage level = 30%
  - If house is sold for $110K, net loss is $90K, insurer pays $60K (= 30% x $200K)
  - If house is sold for $150K, net loss is $50K, insurer pays $50K
- Claim can be <u>rescinded</u> due to fraud, bad servicing, etc.

Single-loan Loss Histogram with and w/o Primary MI

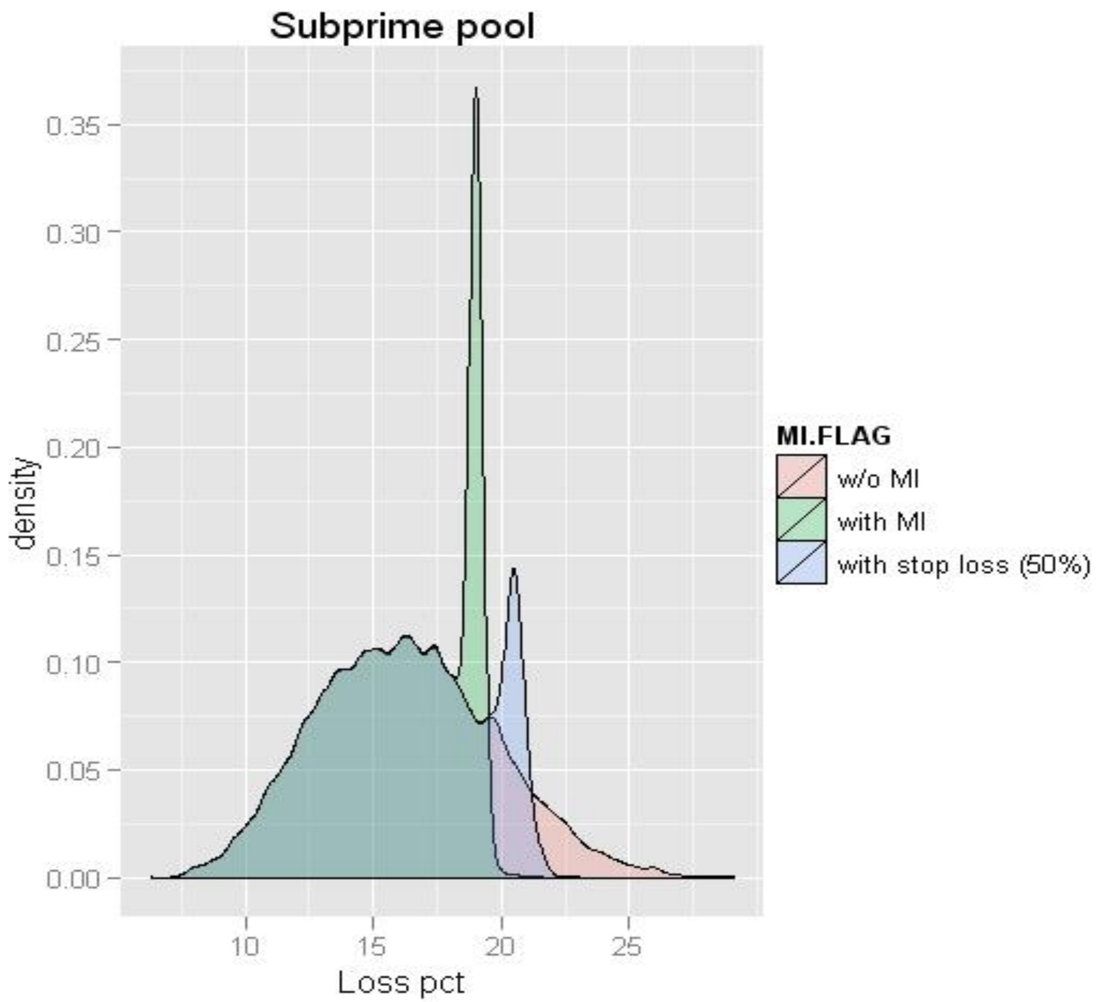


Effect of primary Mortgage Insurance is not always intuitive.

How Does Pool MI Work?

- Policy applies to total unpaid balance of all loans in pool
- Covers losses not covered by Primary MI
- Main terms parameters are:
  - Pool deductible
  - Pool stop-loss
  - Loan-level stop-loss (% of initial principal balance of loan)
- Certain loans in the pool may not be covered based on LTV or absence of primary MI
- Rescission:
  - Claim automatically denied if rescinded by primary MI
  - Can also be rescinded for same reasons as primary MI (even if primary MI is still in force)

Pool Loss Histogram with different levels of pool MI

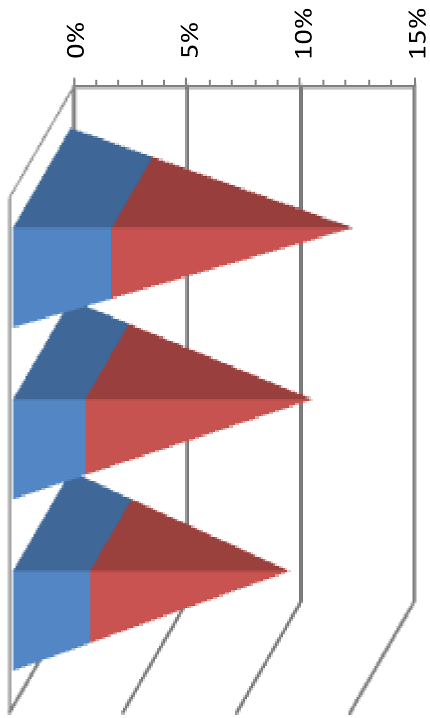


Effect of pool-level mortgage insurance is even less intuitive.

Tail Risk Contribution to VaR

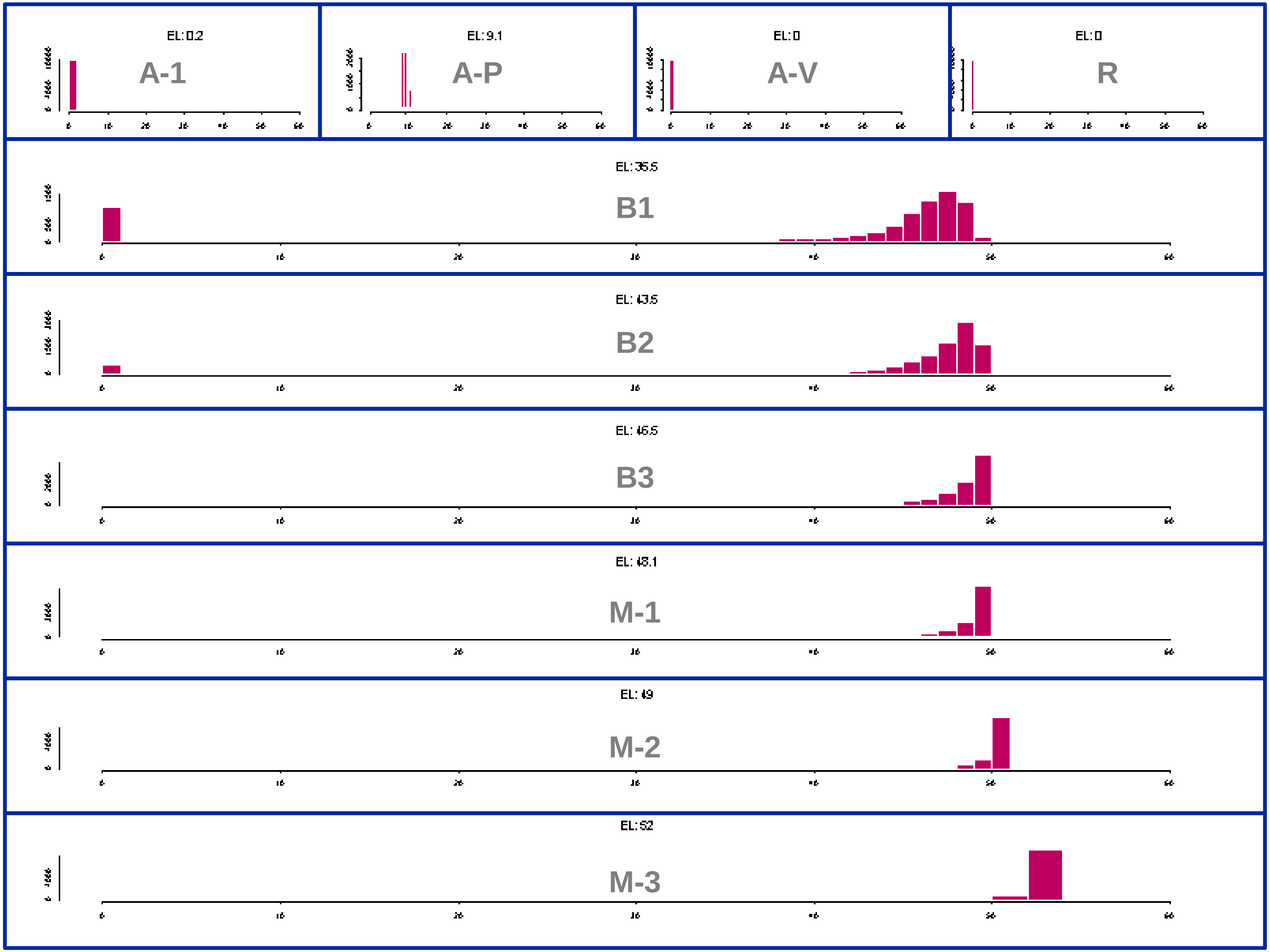
- **TRC is the contribution a loan makes to the tail risk of a portfolio.**

	EL	99.5% VaR Level
Original portfolio	4.0%	12.6%
With 100 highest EL loans removed	2.9%	10.2%
With 100 highest contributors to VaR removed	3.1%	9.7%



Tail risk of a loan is often different than its stand-alone risk.

A-1	A-P	A-V	A
B1			
B2			
B3			
M-1			
M-2			
M-3			


EL: 0.2
A-1
EL: 9.1
A-P
EL: 0
A-V
EL: 0
R
EL: 35.5
B1
EL: 43.5
B2
EL: 46.5
B3
EL: 48.1
M-1
EL: 49
M-2
EL: 52
M-3

Custom Scenarios

- Custom scenarios are an integral part of stress testing
- User can provide a view for one or more macro-economic variables such as interest rates, GDP, HPI, and Unemployment rate
- Models can “fill-out” all the missing variables at the national, state, or MSA level and through time in a consistent manner
- Can “anchor” a simulation around a custom scenario. We can then obtain a full loss distribution, Value at Risk, Tail Risk Contribution, and loan level detail.

Modeling This Way Allows Us To…

Analyze portfolios of different asset classes in a correlated fashion using an intuitive and consistent set of macro-economic variables

- Generate losses for **MA, Fed CCAR, and user defined scenarios**.
- Conduct **scenario analysis** using observable macro-economic factors.
- Conduct **validations** using realized economies to-date.
- Use the **same framework** to evaluate **seasoned** portfolios and **new originations.**
- Calculate **VaR** and PD-based and EL-based **tranche attachment points**.
- Calculate the **tail risk contribution** for each loan and thus help in managing the tail risk of a portfolio of mortgage loans.
- Provide collateral loss distribution and the cash flows that **can be combined with a waterfall engine** to produce tranche-level loss distributions.

Conclusion

- Modeling **at the loan level** significantly improves detail in estimating losses.
- Modeling ***each loan behavior*** **(**default, prepayment, and severity) **separately** provides substantial flexibility in calibration and specification.
- **Prepayment can have a dominant effect** in determining the distribution of losses during periods of home price appreciation and/or falling interest rates.
- The state of the **local and national economy significantly impacts** the performance of pools.
- Default, prepayment, and severity appear to be **correlated through their joint dependence** on common economic factors.
- The **multi-step approach to simulation offers advantages** when assets have **path dependent behavior**, as in the case of mortgages.