Trading Mechanics

Hayre, Chapter 3

Prepayment Modeling and Analysis

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Agency Pass-Through Trade (TBA)

- Trade Confirmation Dates
  - Buyer notifies the investment bank that they want to buy a PT, e.g. $2M of Freddie Mac Gold 30-year 4.5%
  - Investment bank quotes a price, e.g. 101-00
- 48-Hour Day and Good Delivery Requirements
  - Trades close on a specific day of the month according to the Bond Market Association schedule
  - Buyer must be notified by 3pm, 2 days in advance of the close, the exact terms of the pool
  - The pool must satisfy good delivery
    - Must be the same coupon, agency, term, etc.
    - No more than 3 pools per $1M lot
    - Variance in face value must be less than +/- 0.01%

Agency Pass-Through Trade (TBA), cont.

- Settlement Calculations
  - Buyer pays the percent price of current face plus accrued interest (30/360 basis)

$$PAY = B_t \cdot PRICE\left(1 + PTR\frac{DOM - 1}{360}\right)$$

  - For example, settlement on the 16th is

$$PAY = 1,999,960 \cdot 1.01 \cdot \left(1 + 0.045\frac{16 - 1}{360}\right)$$

- Record Date
  - The owner of the pool on the last business day of the month is entitled to the cash flows for that month
  - The actual payment occurs around the 15th of the next month for GNMA and FHLMC and the 25th for FNMA

Agency Pass-Through Trade (TBA), cont.

- Pool Factor Updates and Principal and Interest Calculations
  - Payment is calculated using pool factors at the beginning and end of the previous month, but reflect payment occuring over "month ends"
  - Factors are released in the first couple days of the month
    - Freddie Mac, last business day of the month
    - Fannie Mae, evening of the 4th business day of the month
    - Ginnie Mae, morngin of the 5th business day of the month

  For example, a September 1st pool factor represents borrower payments made from Jul-16 through Aug-15

$$P_t = B_0(F_{t-1} - F_t)$$

$$I_t = B_0 F_{t-1} \frac{PTR}{12}$$

  Where B_0 is the original pool balance.

A New Issue CMO Trade

The investment bank buys 1 or more pass-throughs, structures a CMO, and plans to close/sell the bonds in 45-50 days. It is very similar to the TBA trade.

- Trade date, occurs at any point after the CMO is structured
- No Good Delivery Requirements since pass-throughs have been identified and the structure is specified
- Settlement Date occurs 3 days after the trade date instead of following a schedule
- Settlement Calculations, same as TBA with price plus accrued interest
- Record Date, same as TBA
- Updated Pool and Bond Factors and Investor Cash Flow Calculations, same as TBA with additional cash flow rules for the CMO structure

Mortgage Lending

There are essentially two channels of securities lending: repurchase transactions and dollar rolls

- In repurchases (REPO) one party agrees to sell securities to another in return for cash, and simultaneously agrees to repurchase the same securities at a specific price at a later date
- Dollar rolls (ROLLS) are analogous to REPOS except the party borrowing the security does not have to return the same security only one that is "substantially similar"

Repurchase Agreement (REPO)

- Seller (borrower), the owner of the security
- Buyer (lender), buys and holds the security providing cash to the seller
- Repurchase price and date, price and date that the seller agrees to buy back the security
- Collateral, agency pass-throughs and CMOs
- Haircut
  - Used to setup a margin account that the buyer uses to protect against decline in market value; usually 1-10%
  - Typically marked on a daily basis; changes in the mark can cause a margin call to be settled immediately
- Term, length of the contract; 30 days is common
- Title, the borrower (seller) temporary loses title, however, the borrower receives all principal and interest payments

REPO Example

- Cash Flows
  - At $t = 0$:
    The borrower/seller gets the REPO principal RP

$$RP = B_0 \cdot F \cdot (PRICE + AI) \cdot (1 - H)$$

    where the accrued interst is $AI = PTR(DOM - 1)/360)$ and H is the haircut
    The lender/buyer gets the securities
  - At $t = T$:
    The lender/buyer gets the RP back plus the finance charge of

$$RP \cdot RR \frac{DAYS}{360}$$

    where RR is the REPO interest rate. Note, REPO rate is usually less than LIBOR

Dollar Rolls

- Collateral, only pass-throughs
- In a dollar roll the investor gives up the PI payments, to the temporary holder of the security
- The returned security does not have to be exactly the same, but it must be "substantially similar", i.e. same agency/program and coupon, e.g. 30-Yr Freddie Mac Gold 7.5s
- The transaction can be thought of as two simultaneous buy/sell transactions for the same TBA security for different settlements
- For an Investor long in pass throughs for forward settlement and who wants to avoid taking delivery they roll the the position forward while obtaining attractive financing for the position

Dollar Roll Timeline and Process

- Investor buys the security
- Investor chooses, 48 hours prior to delivery, not to take delivery and "roll it"
- Investor sells the security for the current price plus accrued interest
- Investor gives up principal and interest payments of the security
- Bank foregoes the sale funds for 1 more month
- Investor makes decision based on the quoted drop, difference between current and forward price
  - If prepayment expectation is high on a premium security
  - If prepayment expectation is low on a discount security
  - Also considers the available reinvestment rate
- Roll removes prepayment risk for the investor during the roll period
- Investor buys back a "substantially similar" security for forward price plus accrued interest

Prepayments

- Prepayments are the primary distinquishing feature of MBS
- Understanding and forecasting prepayments is critical to the analysis of MBS
- There is a very important link in the performance of loans and in turn the performance of the pass though or CMO, i.e. individuals make prepayment decisions
- Changes in prepayments can drastically change the value of the security
- Knowledge of historical prepayment drivers is key to forecasting future prepayments
- Prepayment comes from turnover, default, refinancing, and curtailments or partial prepayments

Sources of Prepayment

- Moving or Turnover
  - Some FHA/VA mortgages are assumable
  - Factors that drive this are
    - job changes
    - marriage/divorce/children
- Default or Involuntary Prepayment
  - Technically not a prepayment, however, in agency mortgages the full principal is returned to the investor, i.e. the investor is protected against credit risk
  - Since this component has been small historically it is often absorbed in the error term
    - Increasingly it is being separated and estimated using loan level data
    - Drivers are unemployment, divorce, and lost equity

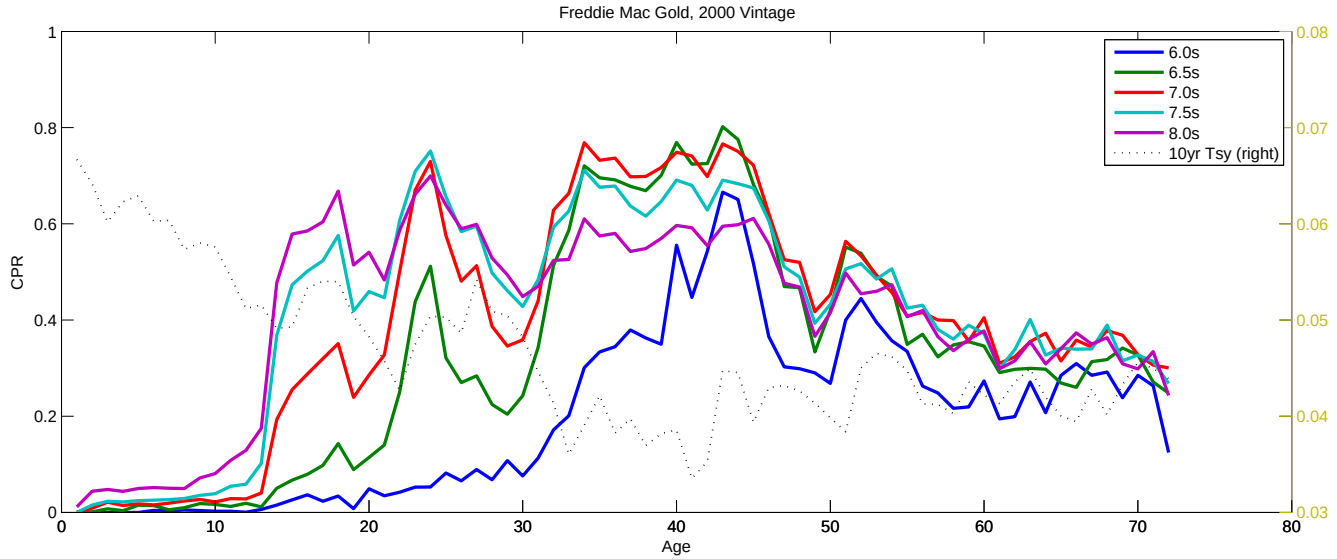
Sources of Prepayment, cont.

- Refinancing
  - Largest and most variable component of Prepayments
  - Rate/Term Refinancing: In low rate environments borrowers opt to refinance to lower their payment
  - Cash-out Refinancing: Borrowers finance more than they owe on the existing loan and receive the balance in cash at closing
  - There is a cost (both time and money) associated with this which causes each borrower to behave differently given the same economic condtion
- Curtailments, Noise and often absorbed in the error term

Prepayment Data

- Early models were based purely on the borrowers' option and overstated prepayments
- Quickly researchers noted that borrowers acted inefficiently and adapted to model their inefficiency
- Very rich data in terms of financial decision making
- Pool level data is easy to obtain as it is a byproduct of trading activity; increasingly loan level data is becoming available
- Range of coupons is narrow, e.g. when rates are at 5
- Age and coupon are the two most important factors
  - recall the PSA curve
  - the coupon is compared to the current available rate
- The strength of the economy is also a predictor of prepayments
- Factor tapes (pool) and remittance data (loan) are the primary source of prepayment data

Analyzing Prepayments



These curves have all of the expected behaviors

- Rate incentives to refinance
- Age/Seasoning ramps
- Burnout
- Time lag response to interest rate lows

Refinance Incentive Calculations

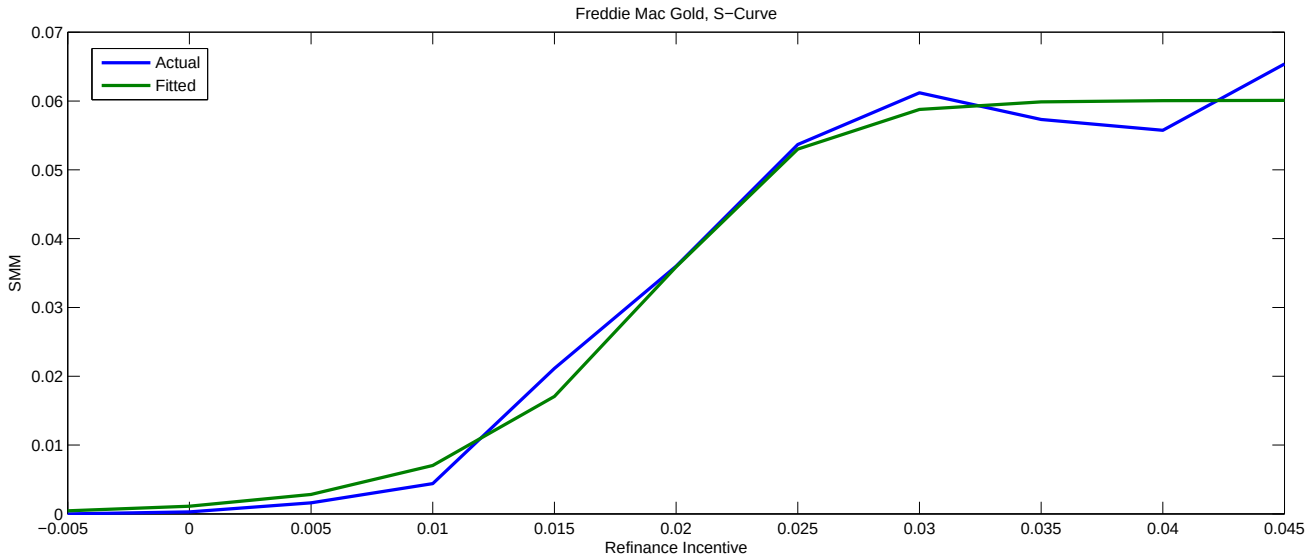
Here RI is the refinance incentive, C is generic for mortgage coupon, and M is the available mortgage rate in the market. Often times the pass through rate is used instead of the mortgage coupon and the 10-year treasury rate is used for the mortgage rate.

- Difference
$$RI = C - M$$
- Ratio
$$RI = C/M$$
- Payment change
$$RI = X_{old} - X_{new}$$
where X_{old} is the borrower's current monthly payment and X_{new} is the borrower's new payment given the market interest rates and terms
- Economic value, this is a calculation of payment savings less the refinancing cost over a certain time period.

It should be noted that the last two calculations are used most often in loan level models not pool level models.

Interest Rate Driver

When rates are low borrowers refinance



The refinance incentive here is using the difference calculation.
The general logistic equation can be used to fit this curve

$$S\hat{M}M = \theta_1 + \frac{\theta_2 - \theta_1}{(1 + \theta_5 e^{-\theta_3(RI - \theta_4)})^{(1/\theta_6)}}$$

It is reasonable to set $\theta_6 = 1$ to eliminate a parameter without too much loss of fit
Others use the arctangent function

$$S\hat{M}M = \theta_1 + \theta_2 \cdot atan(\theta_3 + \theta_4 RI)$$

More Factors

- Age/Seasoning, particularly when borrowers relocate to a new home they are less likely to move or refinance in the near term
- Burnout: As borrowers miss refinance opportunities to refinance they become less likely to take advantage of the same incentive in the future or perhaps a better incentive
  - Using the Pool Factor is common and does not require Monte Carlo (we will use this approach in this class)
  - Using past interest rate history is also common but does require Monte Carlo, typical ways this is done is to capture the cumulative missed savings or number of missed opportunities
  - Active/Passive Decomposition, splits the pool into two segments: loans sensitive to rates and those that are not
- Time lag effect: borrowers react to low interest rates, but the process of originating a new loan takes time (often assumed to be 2 months)

Other Factors

- Seasonality
  - Faster during the summer and slower in the winter
  - More pronounced on discount loans where refinancing is less of a factor

Jan	Feb	Mar	Apr	May	Jun
0.66	0.72	1.01	1.07	1.18	1.22
Jul	Aug	Sep	Oct	Nov	Dec
1.14	1.19	0.99	1.07	0.92	0.83

- Declining home prices
- Weak economic activity
- Unemployment

Prepayment Models

"Investing based on prepayment models is a little like driving while looking through the rear view mirror. It may be hard to stay on the road, but it is better than driving with your eyes closed." Davidson

- Primarily derived from historical experience no matter how simple or complex
- Usually they are estimated statistically
- Difficult to predict behavior of changing products in a changing world
- Strive to create a robust and parsimonious model
  - Robust, good in a variety of conditions
  - Parsimonious, capture the biggest drivers using the fewest parameters
  - More complex models tend to fit the historical data extremely well, but perform poorly in forward projections

Prepayment Model Case Study, Overview

- Gathering and Organizing the Data
  - What is the form of the prepayment data?
  - Need to match up the prepayments with market rates. We'll use 10-year treasury yields.
  - Are there any transformations needed? Common ones are divide by 12 and or 100.
- Calculating Variables
  - Best practice is to model prepayments by modeling the *SMM*.
  - Need to know the WAC, PTR, and WAM of the prepayment data.
  - Choose how to capture the refinance incentive.
  - Other variables/drivers such as age and the pool factor for burnout.
- Plot your data to get a feel for the dynamics
  - Plot the prepayments by age for each coupon/PTR
  - Generate a S-Curve with your refinance incentive variable
- Choosing a model functional form
- Calibrating the parameters in your model, lsqnonlin with upper and lower bounds

Prepayment Model Case Study

Gathering and Organizing the Data

- Ginnie Mae, 1996 Vintage, 30-year (WAM=360)
- PTRs are 6, 6.5, 7, 7.5, and 8%
- This corresponds to WACs of 6.5, 7, 7.5, 8, and 8.5%
- Prepayment data is in percent CPR, so divide by 100 to get to decimal form
- Convert to SMM

$$SMM = 1 - (1 - CPR)^{1/12}$$

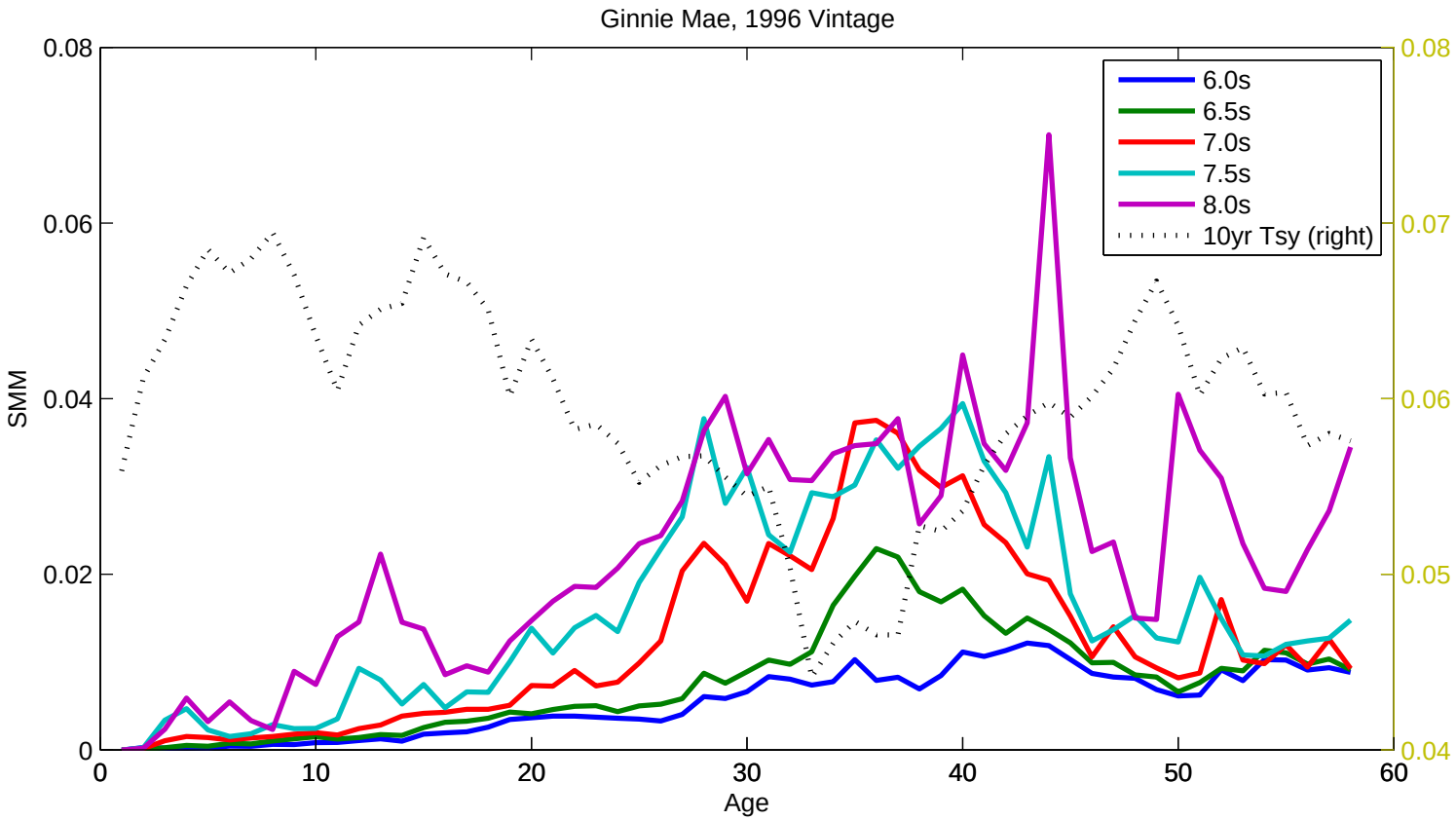
- Treasury yields are in percent form divide those by 100 too

Calculating Variables

- Calculate pool factors to use in the model for burnout. Use the known prepayments and the pass through cash flow calculator.
- Create an age variable
- Calculate the refinance incentive

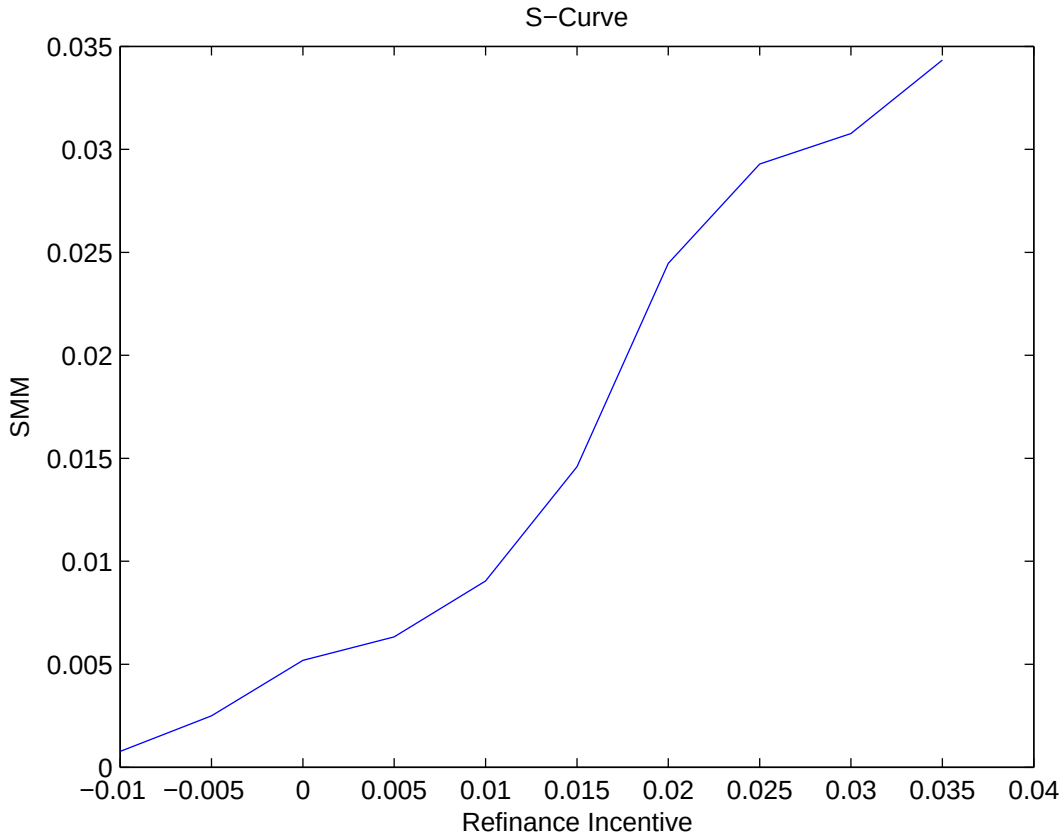
Prepayment Model Case Study

Plot the Prepayments by Age for Each Pass Through Rate



Prepayment Model Case Study

Plot the S-Curve, useful Matlab functions are tabulate and grpstats



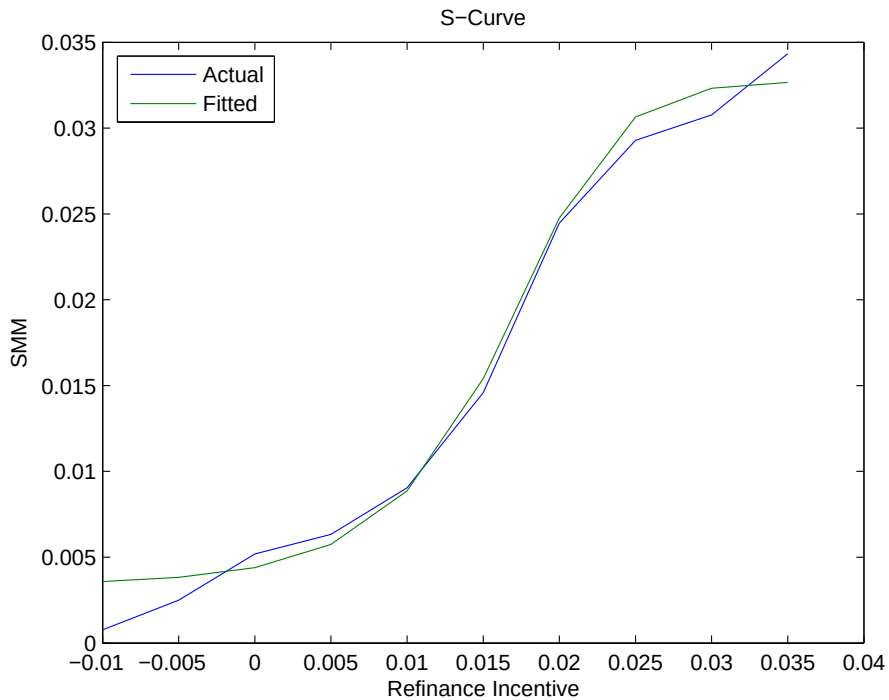
If you look closely you can see that the data has been rounded and tabulated at 50bps intervals.

Prepayment Model Case Study

Choosing a model functional form, I am using the generalized logistic function

I use the lsqnonlin, non-linear least squares, with lower and upper bounds on the parameters

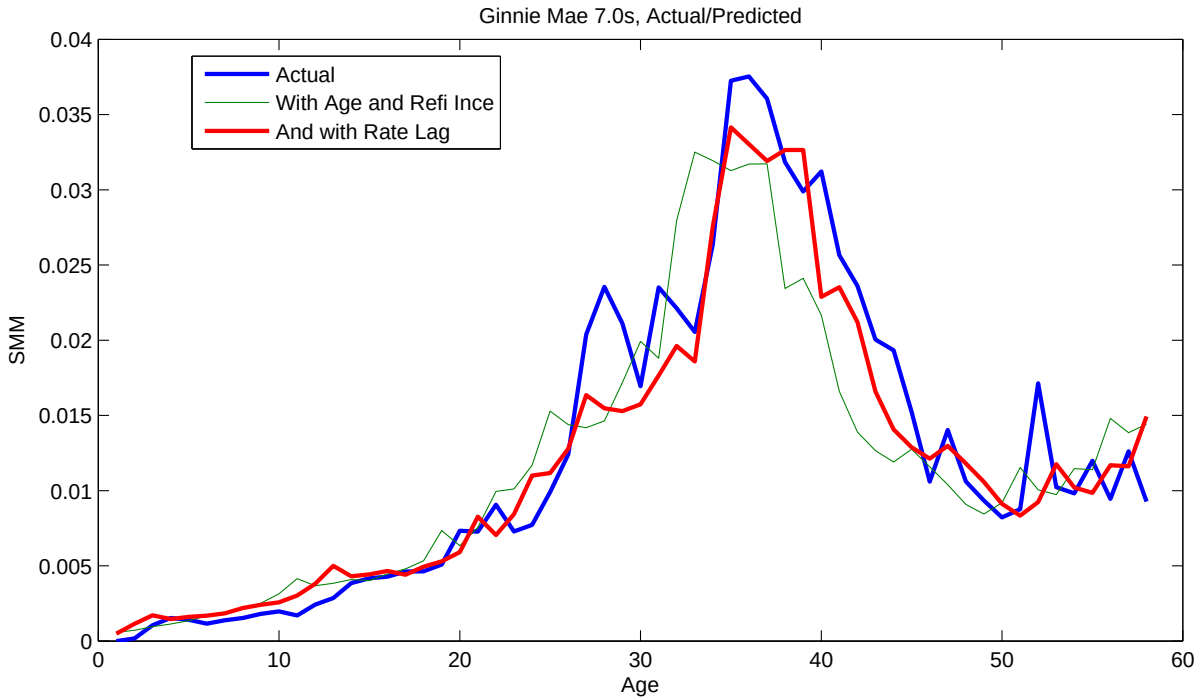
If your calibrated parameters are on a boundary, you should expand the boundary



Prepayment Model Case Study

Adding Age

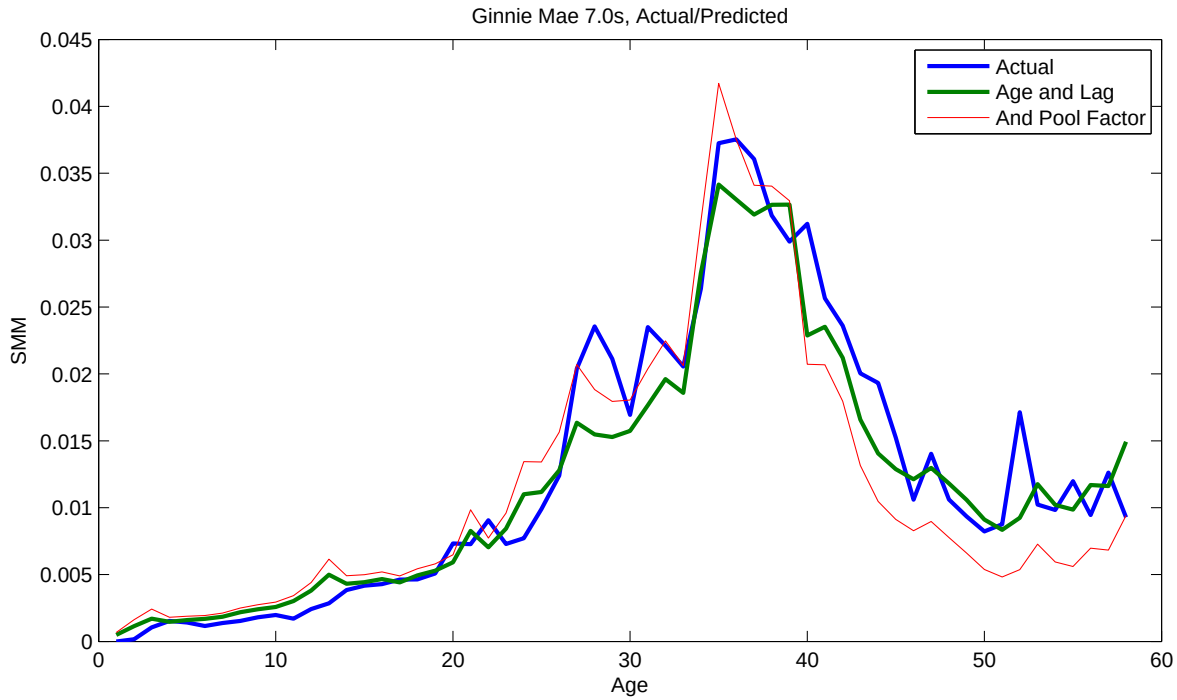
$$\hat{SMM} = \min(AGE/30, 1)\left(\theta_1 + \frac{\theta_2 - \theta_1}{(1 + \theta_5 e^{-\theta_3(RI-\theta_4)})^{(1/\theta_6)}}\right)$$



Prepayment Model Case Study

Adding the Pool Factor

$$\hat{SMM} = PF \cdot \min(AGE/30, 1)\left(\theta_1 + \frac{\theta_2 - \theta_1}{(1 + \theta_5 e^{-\theta_3(RI-\theta_4)})^{(1/\theta_6)}}\right)$$



Prepayment Model Case Study

Code Snippet

```
% model 3, add in the pool factor for burnout
model3=@(theta,x,age,pf) pf.*min(age/30,1)...
    .*(theta(1)+(theta(2)-theta(1))...
    ./(1+theta(5)*exp(-theta(3)*(x-
theta(4)))).^(1/theta(6)));
loss=@(theta) SMM-model3(theta,REFI,AGE,PF);
[model3p resnorm]=lsqnonlin(@(theta)
loss(theta),theta,lb,ub,opts)

% model 3b, switch out refi for lag refi
loss=@(theta) SMM-model3(theta,REFILAG,AGE,PF);
[model3bp resnorm]=lsqnonlin(@(theta)
loss(theta),theta,lb,ub,opts)

i=3;
plot(age,smm(:,i),...
    age,model2(model2bp,refilag(:,i),age),...
    age,model3(model3bp,refilag(:,i),age,pf(:,i)))
title('Ginnie Mae 7.0s, Actual/Predicted')
legend('Actual','Age and Lag','And Pool Factor')
xlabel('Age')
ylabel('SMM')
```

Evaluating Prepayment Models

- Evaluate the fit of a variety of mortgage coupons
- Make plots of predicted versus actual prepayments
  - Over time
  - By age
  - By balance
- Calculate a measure of error
  - Monthly, quarterly, and lifetime variance
- Add market calibration parameters with frequent updates noting trends and/or changes