EaR Single Family Forecasting Model New Loan Acquisitions Model (SFM-NAM)

Model Version & ID

**Whitepaper**

Primary Model Owner: Hamilton Fout

Author(s): Hamilton Fout, Jing Han, Yigang Zhang

Modeling and Analytics Department: Economic and Strategic Research (ESR)

Approving Officer: Enter Text

Application/EUC Version & ID: Enter Text

Disclaimers

Confidential Commercial Information – Confidential Treatment and FOIA Exemption Requested.

Unless otherwise specified in this document, do not use this information as an input to or in support of other reporting processes, production aplication, pr EUC (End-User Computing), regardless of financial reporting designation. Contact the provider of the information listed in this document if you need to use the information for such purposes.

Version Log

|  |  |  |  |
| --- | --- | --- | --- |
| Version No. | Date | Changes | Author(s) |
| 1 | August 25, 2017 | First draft | Hamilton Fout, Jing Han, Yigang Zhang |
|  | November 30, 2017 | Added results from vetting and scaling | Hamilton Fout, Jing Han, Yigang Zhang |

Table of Contents

[Executive Summary 5](#_Toc499808539)

[Introduction 6](#_Toc499808540)

[Model Uses / Purpose 7](#_Toc499808541)

[Model Outputs 8](#_Toc499808542)

[Theoretical Background 8](#_Toc499808543)

[Final Model Structure 9](#_Toc499808544)

[Model Testing / Validation 21](#_Toc499808545)

[Model Limitations 21](#_Toc499808546)

[Conclusion 27](#_Toc499808547)

[References 28](#_Toc499808548)

[Appendices 28](#_Toc499808549)

Executive Summary

The Single Family Forecasting Model's New Loan Acquisition Model (SFM-NAM) forecasts the monthly acquisition of new loans by loan purpose (i.e. refi and purchase) in Fannie Mae’s single family mortgage portfolio across various scenarios (CORP, DFAST and MST). The model relies on prepay predictions from the Single Family Forecasting Model’s Transition Model (SFM-Tran), purchase origination volumes from the Economic and Strategic Research (ESR) team (see Purchase Origination Model whitepaper[[1]](#footnote-1)) and management assumptions on market share and liquidation share. The SFM provides a full forecast view on Fannie Mae’s single family portfolio and is consumed by various business units, including Finance, Single Family Credit and Business, etc.

The SFM-NAM is essentially an enhancement of the loan level component (LLC) of the refi originations model (see Refi Originations Model whitepaper[[2]](#footnote-2)) currenty used in forecasting refi volumes for CORP, DFAST and MST. This whitepaper will briefly cover the Purchase Originations Model given the absence of change from the Purchase Origination Model whitepaperand will focus on the use of the SFM to forecast refi volumes as well as differences in the updated model (including model implementation) relative to what has currently been done to date. This SFM-NAM is planned for deployment in DFAST 2018.

Introduction

The SFM-NAM provides forecasted volumes of Fannie purchase and refi acquisition volumes for purposes of the Corporate Forecast, DFAST and MST. This whitepaper will focus on the forecasting of refi volumes but will begin with a brief overview of purchase originations and acquisitions. By convention, we will refer to market volumes as purchase originations and Fannie volumes as acquisitions. When clarification is necessary, we will use the terms “market” or “Fannie” to describe volumes.

PMM Originations and Acquisitions Forecast

The PMM origination forecast predicts the volume of purchase money mortgage (PMM) originations at the market level. It relies on Macro Advisor’s United States Model (MAUS) to forecast housing market activity (in particular, existing house sales and new home sales), and relies on the Fannie house price forecast to predict transaction values and management assumptions on cash share and loan-to-value ratios (LTVs). Information from other sources is used to benchmark and calibrate the forecast; for example, historical PMM originations are benchmarked annually to HMDA (Home Mortgage Disclosure Act) data.

The PMM origination forecast breaks down purchase mortgages into three segments: 1) existing house sales (EHS) ; 2) new house sales (NHS) ; and 3) manufacturing house sales (MHS). For each part, the forecasted origination volume can be written in the following equation:

The forecast of housing units come from MAUS, which is a large scale macro-econometric model of the US economy. ESR calibrates seasonal adjustments and adds them back into the MAUS forecast to generate non-seasonally adjusted forecasts, as the forecast of volumes is in terms of non-seasonally adjusted volumes. In addition, ESR has a separate equation to convert the forecast of housing starts to housing completions in generating the forecast of new home sales.

The forecast of average price is based on extrapolating the most recent NAR transaction price record using the Fannie non-seasonally adjusted US home price forecast. The cash shares and average LTV ratios are based on ESR assumptions. Fannie purchase acqusitions are calculated as the product of market-level purchase originations times Fannie’s share of the purchase market based on ESR management assumption (see the Acquisition Flow Forecast whitepaper for more information[[3]](#footnote-3)).

Refi Originations and Acquisitions Forecast

Similar to the PMM origination forecast, the refi origination forecast predicts the overall market-level transaction volume in the refinance market. Two component models are used in the refi origination forecast: 1) the Mortgage Application Component (MAC); and 2) the Loan-level Liquidation component (LLC). The final forecast uses the MAC for the first two periods and the LLC for the remainng periods of simulation.

### Mortgage Application Component

The Mortgage Application Component (MAC) uses the refi application index (Refi Apps) from Mortgage Bankers Association (MBA) from the most recent two periods (monthly) to forecast the near term refinance origination:

### Loan Level Component

The loan-level component (LLC) consumes the Single Family Model’s Transition Model (SFM-Tran) forecast of refinance liquidations (see below for more details) and a refi recapture rate based on scenario values and management assumptions to generate a forecast of market refi originations and, given a market share assumption, Fannie’s refi acquisitions. The forecast procedure can be summarized in the following equation:

The refi liquidation forecast ( is provided by the SFM prepayment model. To be exact, the refi liquidation is the sum of liquidation UPB of all loans forecasted as rate-term or cashout refinance liquidation. The recapture rate measures the ratio between Fannie refi acquisition and refi liquidation, and the calculation is given by:

The Fannie refi acquisitions and liquidation market shares are based on ESR management assumption, with the latter set at Fannie’s share of MDO in the simulation (see below for more details). The balance increase is calculated using existing functionality in the SFM as described below.

As we describe below, if the model prediction is at odds with management view for refi originations, a number of dials can be used to adjust model output. For instance, the prepayment speed in the SFM (current to prepay transition) can be dialed to speed up or slow down prepays and thus raise or lower refi origination and acquisition volumes, all else equal. As a particular example, ref liquidations can be scaled in the LLC to matchthe first two periods of volumes based on the MAC.

Model Uses / Purpose

The Single Family Forecast New Loan Acquisition Model (SFM-NAM) is a component of the Single Family Forecasting Model (SFM). Specifically, SFM-NAM brings in new acquisition to form the whole book of Fannie Mae Single Family portfolio at any future time so that the Single Family Forecasting Model’s transition predictions can be applied to the whole book (run-off and prospective) rather than just the runoff book as in other applications (e.g. GAGO using CCFA).

Business Uses

The usages of the SFM-NAM include, but are not limited to, business planning, corporate expense forecasting, revenue forecasts, and portfolio size management. The primary use of the model is in volumes forecasting for the Corporate Forecast, DFAST and MST financial forecasts, as well as ESR’s monthly macro and housing forecast.

Model Dependencies

The model has a number of upstream dependencies: National home price history and forecast, interest rate history and forecast, state-level median household income history and forecast, a projection of monthly Fannie Mae market share based on management assumption, a number of user inputs specifying values for dials in the model (see below for more details) and the purchase origination/acquisitions volumes from ESR.

Model Scope / Applicability

The scope of the originations model covers all loans excluding seconds and reverse mortgages. The acquisition models include the flow channel acquisitions and thus exclude reverses, government loans and seconds.

Model Outputs

* PMM Originations as an input from ESR
* Purchase Acquisitions as an input from ESR
* Refi Originations, calculated from the dynamic refi recapture rate based on the scenario and management assumption and refi liquidations (obtained from the SFM transition model forecast).
* Refi Acquisitions, calculated as the product of Refi Originations and market share assumption

Theoretical Background

Single-family mortgage originations are the sum of purchase and refinance originations. SFM-NAM divides the forecasting of these into two separate modules by loan purpose. Purchase origination are broken down into three components: existing home sales, new home sales and manufacturing home sales. The inputs for calculating the above three components include: forecasts of starts and existing home sales provided by MAUS, forecasts of average house prices based on NAR historical data and Fannie’s home price forecast, cash share based on ESR assumptions, and average LTV ratio based on ESR assumptions. Refinance origination are based on two components: the Mortgage Application Component (MAC) and the Loan-level Liquidation Component (LLC). The MAC uses a linear regression on the most recent two periods (monthly) of refi applications (Refi Apps) from Mortgage Bankers Association (MBA). The LLC uses a formula to derive refi originations and acquisitions from refi liquidations provided by the SFM and assumptions underlying the refi recapture rate.

Final Model Structure

PMM Originations and Acquisitions

Purchase originations and acqusitions are provided outside of the SFM by ESR. Please see above for a brief overview of the Purchase Originations Model or the Purchase Originations Model whitepaper for a more detailed look at the model.

Refi Originations and Acquisitions

Refi originations are based on two components: the Mortgage Application Component (MAC) and the Loan-level Liquidation Component (LLC). The MAC forecasts the first two months of refi originations based on incoming data from MBA. The LLC uses the SFM’s predictions of refi liquidations (e.g. rate-sensitive liquidations) combined with a recapture assumption to generate refi originations and acquisitions for all forecast periods after the second period. The LLC also contains a number of management assumptions and dials that are detailed below.

### Mortgage Application Component (MAC)

The MAC model uses the refi application index (Refi Apps) from MBA from the most recent two periods (months) to forecast the near term refinance origination:

The parameter values are estimated with data from October 2008 to October 2016 and the estimates are shown in the following table:

|  |  |  |
| --- | --- | --- |
| **Explanatory Variable** | **Parameter Value** | **P-value** |
| *Intercept* | 0 | N/A |
| *Refi Apps\_(t-1)* | 0.01395 | <0.0001 |
| *Refi Apps\_(t-2)* | 0.01556 | <0.0001 |
| *R square* | 97.65 | N/A |
| *No. of obs.* | 95 | N/A |

### Loan-level Component LLC

In order to calculate the official refi originations and acquisitions for CORP, DFAST and MST we rely on the Loan Level Component (LLC) based on the refi liquidation component of total voluntary prepays from the SFM. The LLC converts Fannie’s rate-sensitive prepay liquidations into subsequent refi acquisitions. This process relies on (A) Fannie’s SFM to forecast rate-sensitive prepay liquidations, (B) a process to forecast liquidations of prospective loan acquisitions based on the profile of recent vintages, (C) a set of management assumptions related to the scaling of SFM rate-sensitive liquidations based on recent model performance tracking results, and (D) a set of management assumptions related to the recapture rate of forecasted rate-sensitive prepay liquidations. In short, this component predicts acquisition/origination volumes based on the recapture of rate-sensitive liquidations and relies on assumptions on refi market share, liquidation share and the rate of balance increases as well as adjustments of SFM liquidations based on recent model performance tracking and alignment with the Economic Forecast working group and the Chief Economist’s views on the housing and mortgage market.

The Loan-level Liquidation Component of Refi Origination is expressed as follows:

…(1)

…(2)

where Refi liquidation in equation (1) is obtained from the SFM transition prepayment model and the refi recapture rate is decomposed into the threee terms: the refi acquisition market share, the refi liquidation market Share, and balance increases of recaptured refis.

### Management Assumptions and Dials Used in LLC Implementation

*Fannie Market Share*

The Fannie market share assumptions are based on incoming securitization, acquisition and securitization data, as well as quarterly mortgage debt outstanding (MDO) and annual HMDA (and other data) used to size the share of the market that goes to Fannie and other secondary market participants (Freddie, Ginnie, Held-on-Book and PLS). The following example from the Q2 2015 forecast illustrates how ESR produces market share assumptions. This represents the final implemented strategy following discussion with the ESR forecasting group and approved by the ESR VP:

**Long-Term Assumptions/Forecast Recommendation for 2015 Q2 Forecast:**

* **FNMA PMM/Refi:** retains 60 percent of the GSE market
* **FNMA Refi:** FNMA will lose refi market share in the near-term as GNMA streamlined refis increase the size of the refi market not captured by FNMA.
* **FNMA PMM:** We maintain FNMA PMM market share assumptions from the previous forecast and continue to monitor the unfolding effects of the 95-97 product and the GNMA MIP cut.
* **GNMA PMM:** 
  + GNMA’s 2014 Actuarial Report assumes that FHA shares will stay elevated in 2015 at 16% and decline to 15% in 2016 and beyond.
  + GNMA’s PMM shares of FHA/VA/PIH/RD maintain the recently observed relationship – FHA is historically 60% of GNMA PMM Volumes. This share has declined over last 12 months. MIP decline will potentially push relative share of FHA back to 60%.
  + GNMA PMM share is 26.7% in the remaining months of 2015 and will decline to 25% after 2015
* **GNMA Refi:** 
  + The surge in FHA refi apps in the last two months will be a re-sorting of FHA loans to FHA loans affecting near-term refi market shares but not out-year shares.
  + Using industry estimates of the effect of the MIP change on near-term volumes and changes in the relative size of conventional apps, GNMA’s refi share will increase and return to its 2013- 2014 average of 14.5% over a year.
  + Historically, government refi apps have made up 12% of the dollar volume of refi apps. In the last month, this share was at 17%. We assume that this holds up through 2015Q2 and transitions back to 12% by the start of 2016. This implies a 41.7% increase in GNMA refi share to 20.5% through 2015Q2 and then a transition back to 14.5% by the end of 2016Q2.

The final market share assumptions used in the flow forecast for March 2015 were as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***March 2015 Flow Forecast*** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| **Market Share** |  |  |  |  |  |  |
| *Fannie Mae* | 31% | 34% | 32% | 32% | 31% | 31% |
| *Freddie Mac* | 22% | 23% | 21% | 21% | 21% | 20% |
| *Ginnie Mae* | 25% | 25% | 22% | 22% | 22% | 22% |
| *Held on Book* | 20% | 17% | 23% | 23% | 24% | 25% |
| *PLS* | 2% | 1% | 1% | 2% | 2% | 2% |

In the next couple of months ESR slightly adjusted its Freddie/Fannie/Ginnie shares based on the following observation:

* We continue to track the unfolding effects of the MIP reduction by Ginnie earlier this year, which contributed to a $10B securitization volume increase between March and April for Ginnie (~$5B increase in purchases). As a result we have adjusted up our forecast for Ginnie's purchase market share over the next two years, resulting in a downgrade of our forecast for Fannie and Freddie purchase volumes over the period. (Source: May 2015 Flow Forecast Notes)

ESR updated its Q2 forecast assumptions with the following additional analysis:

* Based on the extended effect of the MIP reduction on refi volumes for GNMA (traditonally government refi apps volume make up 10% of the market volume but have grown as high as 20% in certain months of 2015 and are more recently closer to 15%) we have extended the period of increased Ginnie share through Q3 2015 with the same gradual decline as before but now delayed one quarter.
* We currently assume FNMA will take 60% of GSE business in both PMM and Refi business in our volumes forecast.
* As the tables below illustrate, in recent periods FHLMC has taken more than 40% of the market share in PMM securitization As recently as 2013, we were close in PMM to 60/40 with Freddie.
* **Proposal:**
  + Keep the refi traditional share at 60/40
  + Assume that the short-term PMM traditional share is set as the weighted average of the previous 6 months of observables (~53%)
  + Assume that we transition over the next 12 months back to the long-term anchor of 60/40 (May 2016 FNMA PMM traditional share= 60%).

The tables below represented ESR share estimates in June 2015:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***June 2015 Flow Forecast*** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| **Market Share** |  |  |  |  |  |  |
| *Fannie Mae* | 31% | 31% | 30% | 31% | 31% | 30% |
| *Freddie Mac* | 22% | 23% | 20% | 21% | 21% | 20% |
| *Ginnie Mae* | 25% | 26% | 25% | 23% | 22% | 22% |
| *Held on Book* | 20% | 19% | 23% | 23% | 24% | 25% |
| *PLS* | 2% | 1% | 1% | 2% | 2% | 2% |

In July 2015, ESR further revamped its shares based on an updated calculation of our Fannie/Freddie shares with the following commentary (Source July 2015 Flow Forecast Notes):

* As we prepare for the next corporate forecast in Sept 2015, we continue to track Fannie’s share of GSE acquisitions and the continued effect on market shares from Ginnie’s MIP cut earlier this year.
  + Fannie’s share of GSE securitization activity remained below 60% for June 2015 (~56%). Given the volatility of the series, we view this share as consistent with our forecast assumption for this month that Fannie’s current share of GSE acquisitions is ~58% and will return to 60% over the next 11 months.
  + Ginnie’s market share  continued to remain elevated in June (~42% of agency PMM securitizations in both May and June), while Ginnie’s refi share declined from 28% to 26% of agency refi securitizations from May to June. Government share of refi volumes are also down according to the most recent MBA applications data, indicating that Ginnie’s recent increased refi share may finally be declining as streamlined refinance opportunities begin to decline.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***July 2015 Flow Forecast*** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| **Market Share** |  |  |  |  |  |  |
| *Fannie Mae* | 31% | 30% | 30% | 31% | 31% | 30% |
| *Freddie Mac* | 22% | 22% | 20% | 21% | 21% | 20% |
| *Ginnie Mae* | 25% | 26% | 26% | 24% | 22% | 22% |
| *Held on Book* | 20% | 21% | 23% | 23% | 24% | 25% |
| *PLS* | 2% | 1% | 1% | 2% | 2% | 2% |

As illustrated above, ESR reviews the assumptions quarterly to coincide with the corporate forecast cycle/stress-testing cycle with potentially materially updates to the market share assumptionss at these points. ESR also monitor the data and makes adjustments as necessary for the forecasts in the intervening months.

Currently ESR combines the market share and originations forecast assumptions as follows:

Where

and

The notation represents the period ahead forecast from the perspective of time .

Here represents the market share assumption for participant in the th period of the forecast formed in period for the originations with loan purpose .

The restriction

implies the following consistent identity:

Please note that this produces an originations estimate for each market participant (Fannie Mae, Freddie Mac, Ginnie Mae, Private Label Securitization and Held on Book as indexed by ). The item that is actually forecasted is the acquisition and securitization volume of the participants, with the exception of the Held on Book originations which is an originations forecast.

ESR also uses observations of DU applications, ARDB month-to-date delivery volumes and Freddie/Ginnie month-to-date securitization volumes to overwrite near-term predictions (current and future month). This helps address the potential disconnect between originations (what is being forecasted in the macro/housing process) and acquisitions/securitizations (what is being forecasted in the flow forecast process). ESR is currently investigating whether to impose additional timing assumptions in later periods of the forecast based on recent historical observations of origination to acquisition/securitization delays by participant and loan purpose to further address this potential timing disconnect.

As an example, here is an illustration using the June 2015 flow forecasting process of how ESR overwrote near term actuals for FNMA refi and PMM acquisitions:



In the July 2015 flow forecast ESR also used month-to-date securitization volumes for Ginnie to raise the near-term actuals for Ginnie and lowered the remaining periods by an off-setting amount to keep the annual Ginnie Mae volume unchanged. In ESR could also make adjustments to our Freddie volumes forecast using their month-to-date securitizations volumes as well.

A dry run is planned for 2017 Q4 which will allow for the forecasting team to understand how (or if) we will be able to use incoming data to adjust the model forecast.

*Fannie Liquidation Share*



Given the refi acquisition market share assumption from ESR assumption, the refi liquidation market share assumption can be approximated by the MDO share as follows:

,

where suffix represents different scenarios, is the share of total originations that are refis, which is set by management assumption, and suffix represents time (month).

is an acronym for weighted average life and example values for WAL under different scenarios (as obtained from CCFA) and used for DFAST 2017 (as an example) as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **WAL** | **Corp** | **DFAST Base** | **DFAST Adverse** | **DFAST Severely Adverse** |
| **Loan Life Year** | 6.2 | 7.0 | 7.3 | 6.9 |
| **Loan Life Quarter** | 25.0 | 27.9 | 29.0 | 27.4 |
| **Loan Life Month** | 74.9 | 83.8 | 87.1 | 82.2 |

The intuition here is that the existing MDO share carries forward for surviving loans while those recaptured loans take the Fannie market share for incoming originations. As we finalize details of the model implementation, it is possible that the refi originations market volume in the above equation will be replaced with the previous value of the LLC and be built iteratively. It is also possible that the *WAL* which is a lifetime measure that may be difficult (or impossible) for SFM to calculate may be replaced by some other average liqudation measure that helps gauge how much of MDO/the Fannie book is churning in any given period.

Given the book date values for MDO share, the PMM market share, the refi market share, PMM market volume, a measure of the refi Market volume and the iteration structure, the MDO share can be forecasted as an estimate for the refi liquidation share.

*Balance Increase*

The final term in the recapture rate, balance increase (from the point of refi liquidations to refi acquistion), is obtained from the SFM (and existed in the LFM as well), specifically from the Cashout Refi Ratio (CRR) model and the historical average of the cashout refis to prepay UPB and the historical average of the rate-term to prepay UPB. The CRR model uses a logistic regression to predict the cashout refi over prepay ratio from the home price index and the interest rate projection. The predicted cashout refi ratio is then used to calculate the balance increase as follows:

The following excerpt comes from the LFM New Acquistion Model (LFM-NAM) and provides some details on the CRR:

**From the LFM Model Doc (In Blue):**

The share of refi loans that are cashout refis is driven by two key economic factors:

**Rate incentive:** When rates decrease, more borrowers will refinance to take advantage of the better rates, and cashout refis will represent a smaller share of total refis. Conversely, when rates increase, more refis will be the result of cashouts.

**MTM LTV:** Cashout refis also require a certain amount of equity (usually 20-25%). When, on average, loans have high MTM LTV, we expect cashout refis to represent a smaller share of total refis, and when loans have low MTM LTV, more refis will be cashout refis.

Calculating average MTM LTV for the entire book for each month of the forecast is not computationally feasible. Instead, we use the difference between HPI and the “expected” HPI from the linear HPI trend of the course of the estimation period. When HPI is significantly higher than the trend, we expect loans to have low MTM LTV because home prices are growing rapidly. Conversely, when HPI is lower than the trend would say, MTM LTV will high. This is observed in the data:

*Cashout Ratio Model*

The cashout refi ratio model is a two-stage model: first stage estimates average rate incentive at the national level, and second stage estimates cashout ratio using first stage output as input variable. Rate incentive is defined as current note rate minus market rate.

The rate incentive model is a linear regression using FRM30 growth in the previous five years, where dependent variable is average rate incentive.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **t-Value** | **Prob>|t|** | **Interpretation** |
| Intercept | 4.46657 | 19.54 | <.0001 |  |
| frm30\_1yrgr | -0.5154 | -1.9 | 0.0595 | 1 year ago FRM30 Growth |
| frm30\_2yrgr | -1.02856 | -3.23 | 0.0015 | 2 year ago FRM30 Growth |
| frm30\_3yrgr | -1.9858 | -5.86 | <.0001 | 3 year ago FRM30 Growth |
| frm30\_45\_avg | -0.9594 | -3.13 | 0.0021 | Avg of 4 and 5 year ago FRM30 Growth |

The cashout ratio model is also a logistic regression, using rate incentive and HPI trend gap. The model, then, uses the primary observable economic drivers (rate incentive and MTM LTV), ensuring that it changes logically under different economic scenarios. Second stage model dependent variable is ln(Cashout Share/(1-Cashout Share)), to guarantee the predicted value never goes beyond the 0-1 boundary.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **t-Value** | **Prob>|t|** | **Interpretation** |
| Intercept | -0.2305 | -8.8 | <.0001 |  |
| rate\_incentive | -0.35356 | -9.24 | <.0001 | modeled rate incentive |
| hpi\_trend\_gap | 2.73678 | 28.75 | <.0001 | Difference between HPI and long-term HPI linear trend |

*Refi Loan Size*

The size and LTV of refi acquisition loans is expected to be connected to concurrent prepayments. Historically we compare the UPB and LTV of refi acquisitions to those of prepayments less than 10 years old and with amortization terms of 30 years or more, and see the following ratios:

**Cashout Refi / Prepay LTV:** 0.9727089

**Rate/Term Refi / Prepay LTV:** 1.0467178

**Cashout Refi / Prepay UPB:** 1.0133184

**Rate/Term Refi / Prepay UPB:** 1.0834942

Given the prepay population average UPB and LTV, we use these ratios to produce target UPB and LTV for the acquisition cashout and rate/term refi populations, and adjust the acquisition loans accordingly.

*Model Dials*

Dials will be used from time-to-time to adjust model output to align with management view. Dials will be set generally so that they respond to scenario-specific variable values, model performance tracking results and other drivers. Modeling solutions are preferable to the use of dials. If model performance begins to deteriorate or deviate from management view, we will revisit dial setting but we do not plan to do this as part of the normal course of business. We will, however, investigate the model performance at regular intervals (e.g. DFAST and Q4 Corporate Forecast). Figure A1 illustrates the general architecture of the model along with the location of the various dials (NOTE: Dials 1,2 and 4 in the figure represent Dials 1, 2 and 3, respectively below. The Dial labeled 3 in the chart for purchase volumes will not be necessary in the initial rollout).

In general, the SFM NAM contains the following three dials:

1. **Total voluntary prepay dial**

Apply dials to total voluntary prepayment (TVP) based on model performance tracking or to align with management view

1. **Turnover/refi share overrides**

Given the (potentially adjusted TVP volumes above), refi liquidations are calculated as the share of TVP that will become refi and turnover using the baseline modeling mechanism (i.e. just as in CCFA decomposition is based on whether loan is out of the money by more than 75 bps). This share can be overwritten as follows:

The share can be calculated as follows:

Using historical data on liquidation share (Fannie MDO share), refi market share and balance increase:

Alternatively, the turnover share can be calculated using the historic model mechanism prediction. Once an estimate of is available, it can be modeled based on home prices and interest rates as follows:

The turnover (or refi) volume can also be further adjusted it is outside of the pre-defined ranges (1) relative to PMM acquisition and (2) relative to Refi Liquidation; Refi liquidation will adjust accordingly to offset the turnover adjustment

The ceiling and floor can be calculated using historical observations of to calculate turnover liquidations (above) and compare with purchase acquisitions the following period.

1. **Refi recapture dial**

The model also contains a final dial to adjust the refi recapture rate mechanically to capture management view[[4]](#footnote-4)

*Major Differences Between LLC Used Prior to DFAST 2018 and SFM-NAM to be Deployed in DFAST 2018*

The following list describes the major differences between the ESR forecasting approach and the LFM-based credit forecast used prior to DFAST 2018 and the proposed SFM-NAM to be used in DFAST 2018:

* **Purchase acquisitions** will come directly from ESR for MST, DFAST and CF runs (The SF credit forecast uses a time-series purchase acquisition equation to approximate the ESR volumes)
* **Cash flow model** will switch from CCFA (UPB-based) to SFM (count-based)
* **Refi forecast** will be based only on SFM (LLC) and recapture methodology, with the REC used for benchmarking purposes and to (potentially) generate liquidation share
* **Book is built in simulation** versus post-processing, since SFM will handle both the run-off and prospective book
* **Recapture rate** takes inputs from the model (liquidation share/balance increase/ALR) as well as the user (market share, initial MDO, WAL)
  + **Balance increase** will be provided by model based on assumption of rate term refi balance increase (1%) and data-driven cashout balance increase, with model sorting refi volumes into rate term versus cashout (existing LFM construct)
  + **Liquidation share** will be approximated by MDO share and requires a measure of prepay speed (WAL/ALR), initial book and MDO values, Fannie market shares and market benchmark predictions of purchase and acquisition volumes (REC for refis)
* **Dials will be imposed in simulation** potentially for liquidation speed (transition to prepay), refi (rate-sensitive) share of liquidations and refi recapture rate
* **Future enhancements:** Capability to generate inputs on-the-run for non-production runs (purchase aqsns, market share)

Model Testing / Validation

Forthcoming/In progress

Model Limitations

Several limitations are noted for the SFM-NAM, including a dependency on management assumption for the transition model turnover and refi liquidation distinction, approximation of refi liquidation market share with Fannie’s MDO share, and the need for management assumptions for market shares and liquidation adjustments (modeling solutions in the near term may not be possible). There is ample room for improvement on the model specifications and on assumptions, which the modeling team and ESR continue to investigate on an-ongoing basis.

*Reviewed by:*

*Date:*

Setting of Model Dials

In this section we present model vetting results from the testing done in 2017 Q4 with a particular focus on the setting of model dials for the 2017 Q2 Corporate Forecast and the 2017 DFAST Severe projections (from the perspective of January 2017).

Unadjusted Model Outputs

In the charts immediately above, the raw model output differs from the official forecasted values from the 2017 Q2 forecast. Purchase acquisitions are slightly lower, while refi acquisitions begin higher and then are much lower for the duration of the foreasted period.

Adjusted Model Outputs

As the first tables below show, the purchase acquisitions are ~2% too small on average to match the ESR purchase acquisition volumes. As the model is designed to take the ESR volumes as given, we consider this to be an implementation issue. In particular, based on analysis not shown, this is due to an issue with loans balances reaching the conforming loan and being removed from the the targeted purchase acquisition pool. This will be addressed in a future model update, but for now we assume the 2% error will perisist and we scale up the purchase acquisition target from ESR by 2%. The second table below shows the results of this approach, indicating that the model volumes are now approximately equal to the targeted purchase volumes. This is confirmed in the two charts below.

Table: Unadjusted Purchase Acquisition Prediction

|  |  |  |  |
| --- | --- | --- | --- |
| **Forecast Date** | **ESR PMM Forecast** | **Model PMM Forecast** | **Difference** |
| 201704 | 20,099,999,982 | 19,685,000,000 | 2.06% |
| 201705 | 24,033,333,384 | 23,537,000,000 | 2.07% |
| 201706 | 28,065,700,502 | 27,521,000,000 | 1.94% |
| 201707 | 25,027,756,039 | 24,477,000,000 | 2.20% |
| 201708 | 25,984,609,811 | 25,494,000,000 | 1.89% |
| 201709 | 23,027,275,024 | 22,519,000,000 | 2.21% |
| 201710 | 21,577,411,253 | 21,128,000,000 | 2.08% |
| 201711 | 20,294,576,397 | 19,871,000,000 | 2.09% |
| 201712 | 21,925,195,580 | 21,467,000,000 | 2.09% |
| 201801 | 15,024,938,531 | 14,716,000,000 | 2.06% |

Table: 2% Scaled Purchase Acquisition Prediction

|  |  |  |  |
| --- | --- | --- | --- |
| **Forecast Date** | **ESR PMM Forecast** | **Model PMM Forecast** | **Difference** |
| 201704 | 20,099,999,982 | 20,077,920,310 | 0.11% |
| 201705 | 24,033,333,384 | 24,016,303,335 | 0.07% |
| 201706 | 28,065,700,502 | 28,072,612,078 | -0.02% |
| 201707 | 25,027,756,039 | 24,968,792,011 | 0.24% |
| 201708 | 25,984,609,811 | 26,004,131,656 | -0.08% |
| 201709 | 23,027,275,024 | 22,965,090,240 | 0.27% |
| 201710 | 21,577,411,253 | 21,556,375,706 | 0.10% |
| 201711 | 20,294,576,397 | 20,273,464,288 | 0.10% |
| 201712 | 21,925,195,580 | 21,897,116,360 | 0.13% |
| 201801 | 15,024,938,531 | 15,009,915,627 | 0.10% |

We now turn to refinance acquisitions. Here we are particularly interested in the dial settings that recover the 2017 Q2 Corporate Forecast. In general, we are interested in identifying dials that recover management view, which may differ from model prediction, and this exercise represents a particular example.

In order to adjust the refi volumes, in this case, we need to rely on the set of dials , and described above. In the case of the 2017 Q2 forecast, we first note that the raw prediction is too low to match management’s view in the 2017 Q2 forecast. In this case, we operate through the following steps to adjust acquisition volumes:

1. Adjust within historical bounds to hit target refi volumes.[[5]](#footnote-5)
2. Adjust (or ) to account for cases where historical bounds of are binding.
3. Adjust conditional on the value of dials in volumes to achieve an expected book size.
4. Given new , adjust (and for cases when is bounded).

The charts below show the refi volumes and book volumes for the case where was used to adjust refi acquisitions only. The refi acquisitions match across the model and the official 2017 Q2 Corporate Forecast. The book, however, is growing faster in the model than the expect value at the time of the 2017 Q2 forecast (15% in SFM versus 6% expected over 5 years). We are currently working on using the dials to adjust the book volume in line with management expectation.[[6]](#footnote-6)

Conclusion

This model provides a way to estimate historical PMM and Refi mortgage originations and a forecast of future mortgage originations so that the company can estimate mortgage acquisitions. The current proposed specification is a considerable enhancement over the previously proposed LFM5.0 in that (1) it has transparent connection between economic environment and forecasted activity (2) it links Refi UPB and LTV to prepay profile.

As part of any macro or aggregate forecasting, it is often necessary to combine pure modeling elements with management assumptions or policy change. LFM5.1 model allow user to adjust forecasts to account for changes in outlook and align with other groups within the company (ESR/SFF Revenue) without resorting to overrides.

References

1. Fout, Hamilton (2015). “Mortgage Market Refi Originations Forecast Model”. Whitepaper.
2. Velz, Orawin (2015). “Purchase Money Mortgage Originations Forecast Model”. Whitepaper.
3. Fout, Hamilton (2015). “ESR Acquisitions Flow Forecast”. Whitepaper.
4. LFM New Loan Acquisition Model (2015), Whitepaper.

Appendices

## Forthcoming/In Progress

## Model Diagram (see following page)

## SAS estimation data sets and code

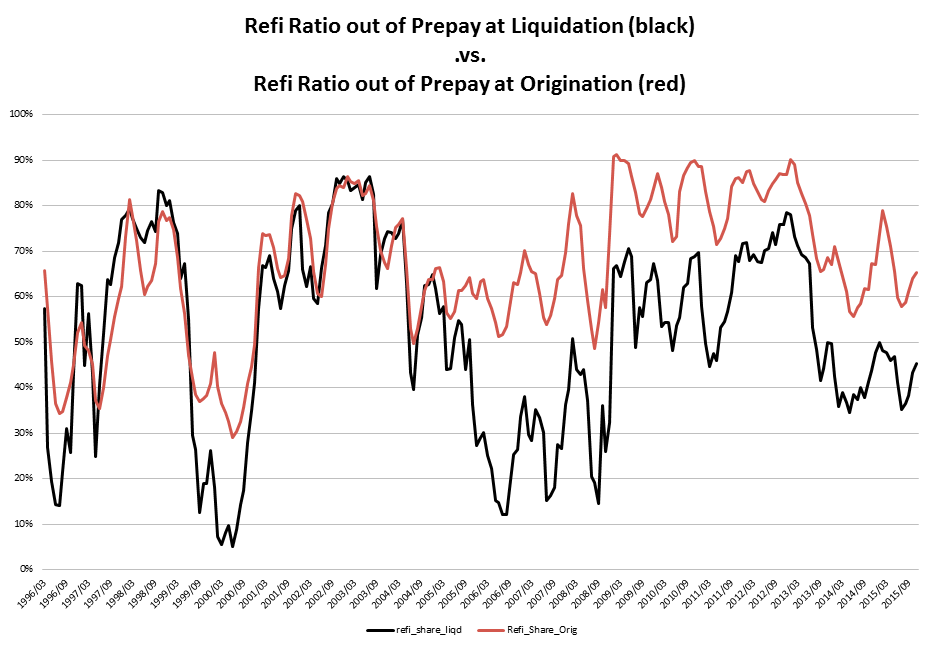
## Updated Business Procedures

1. Calculating Historic Bonds of

In the chart below, we calculate two views of the refi share of total voluntary prepay (or ). The black line is from the SFM internal model prediction of the share of refi prepay, where the refi ratio equals predicted refi prepay over predicted total prepay.

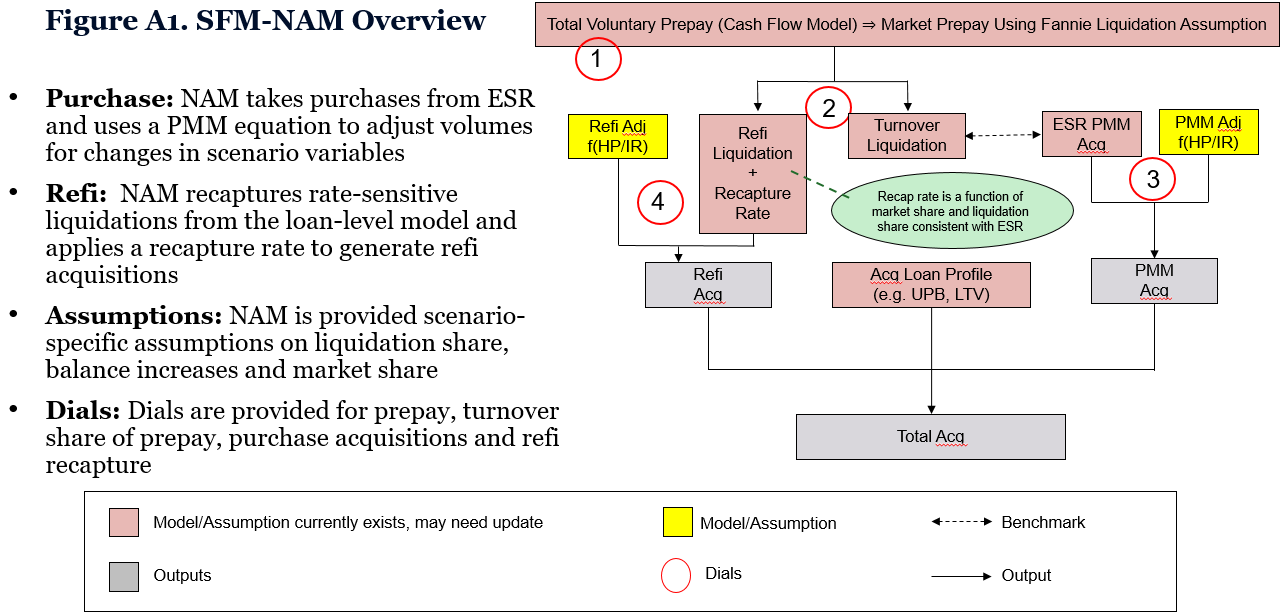
The red line calculates the refi ratio as the sum of total refi originations divided by total originations less first time homebuyer purchase originations.

From this analysis we conclude that should be bounded between 10% and 70%.



*Reviewed by:*

*Date:*



1. Velz, Orawin (2015). “Purchase Money Mortgage Originations Forecast Model”. Whitepaper. [↑](#footnote-ref-1)
2. Fout, Hamilton (2015). “Mortgage Market Refi Originations Forecast Model”. Whitepaper. [↑](#footnote-ref-2)
3. Fout, Hamilton (2015). “ESR Acquisitions Flow Forecast”, Whitepaper, Page 21, Section “DFAST/Management Stress Process Overview”. [↑](#footnote-ref-3)
4. This dial is not necessary in that it can be identically implemented by directly overvwriting the refi liquidations using the second dial. This third dial has been included, however to allow for ease in adjusting volumes. [↑](#footnote-ref-4)
5. The historical bounds are set using historical data to approximate the ratio of refi total voluntary prepay to total voluntary prepay (this is refrerred to as the refi ratio or ). For more details, see Appendix IV. [↑](#footnote-ref-5)
6. For more details please see the document [Scaling Liquidations to Adjust Refi Acquisitions and Book Volumes](http://sharepoint/exec-sites/EMMA/Setup%20Guides%20and%20Useful%20Resources/EaR/Scaling%20Liquidations%20to%20Adjust%20Refi%20and%20Book%20Size.docx). [↑](#footnote-ref-6)