

FHFA MORTGAGE ANALYTICS PLATFORM

Version 2.0

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FHFA Mortgage Analytics Platform

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1. Release notes

This version of the white paper incorporates the following two major updates to the FHFA Mortgage Analytics Platform:

1. Re-estimated performing loan equations for 30-year fixed rate, 15-year fixed rate, and 5/1 adjustable-rate mortgages. The re-estimated equations incorporated new explanatory variables important to predicting single-family mortgage delinquency.
2. Replaced the constant mortgage insurance (MI) haircuts with rating-based MI haircuts.

2. Background & Introduction

The Federal Housing Finance Agency (FHFA) maintains a proprietary Mortgage Analytics Platform to support the Agency's strategic plan. The objective of this white paper is to provide interested stakeholders with a detailed description of the platform, as it is one of the tools the FHFA uses in policy analysis. The distribution of this white paper is part of a larger effort to increase transparency on mortgage performance and the analytical tools used for policy analysis and evaluation within the FHFA.

The motivation to build the FHFA Mortgage Analytics Platform derived from the Agency's need for an independent empirical view on multiple policy initiatives. Academic empirical studies may suffer from a lack of high-quality data, while empirical work from inside the industry typically represents a specific view. The FHFA maintains several vendor platforms from which an independent view is possible, yet these platforms tend to be inflexible and opaque. The unique role of the FHFA as regulator and conservator necessitated platform flexibility and transparency to carry out its responsibilities.

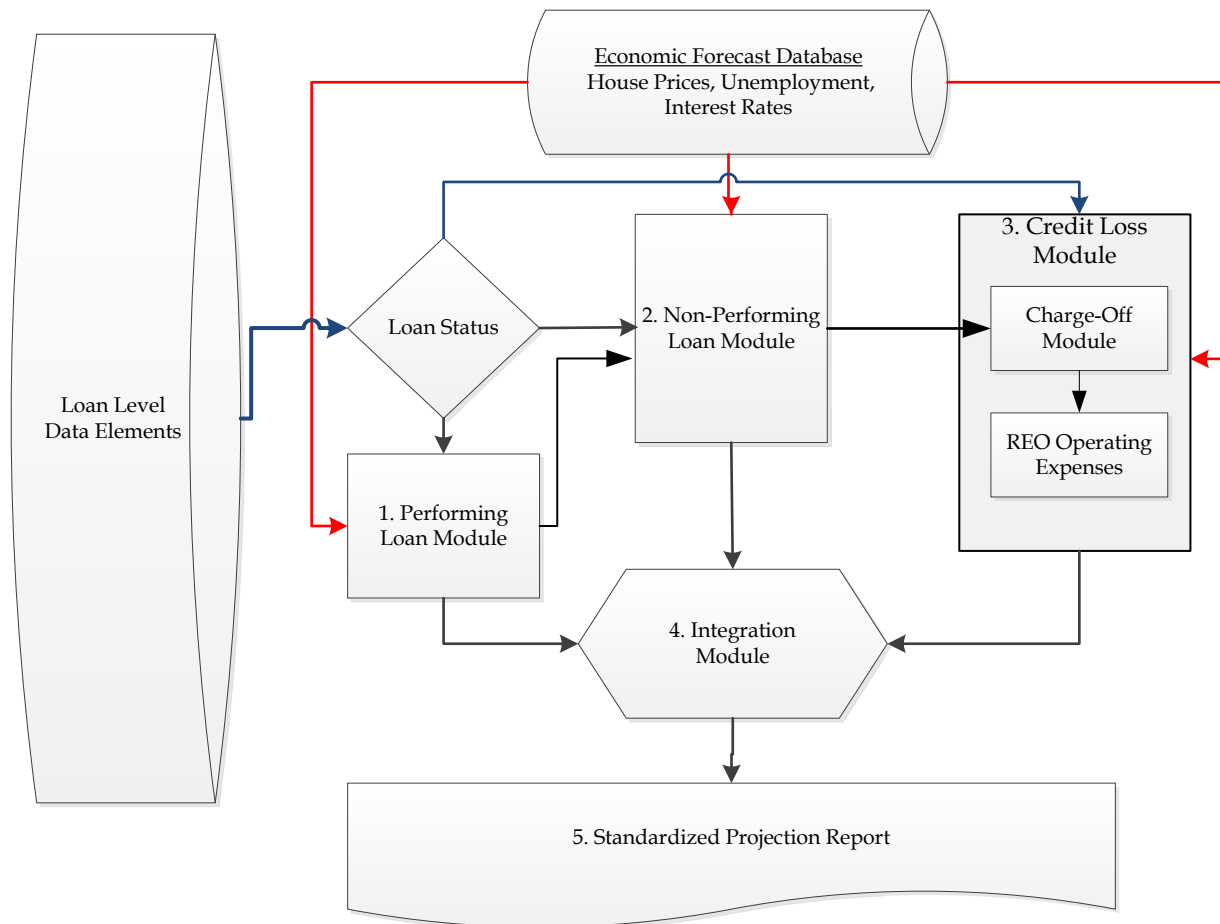
The FHFA Mortgage Analytics Platform is maintained on a continuous basis; as such, the material herein represents the platform as of the publication date of this document. As resources permit, this document will be updated to reflect enhancements to the platform.

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3. FHFA Mortgage Analytics Platform Overview

The platform integrates econometric loan performance models, loan level data and external economic forecasts to project mortgage cash flows. This section offers an overview of the modules and their interconnections.

Figure 1: FHFA Mortgage Analytics Platform



There are two sources of external inputs to the analytics platform: loan level data and economic forecasts. The economic forecasts include projections of house prices, interest rates and unemployment rates through the forecast horizon. Both vendor-supplied economic forecasts and FHFA projections of economic variables are stored in the economic forecast database. These economic forecasts cover a wide range of economic

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environments from baseline to highly optimistic to extremely stressful economic conditions. The economic forecast databases are quarterly.

The loan level data elements are the second source of external inputs; these include approximately thirty variables per loan comprising loan attributes and borrower characteristics. The platform projects mortgage performance from the loan's current age to termination, including foreclosure alternatives and the resolution of real estate owned (REO). The platform applies projected probabilities of termination to performing loan balances such that a portion of the loan prepays, becomes delinquent and may resolve as a default each month. To simplify the discussion within this paper, when a loan is said to prepay (or default), only a portion of the loan is prepaying (or defaulting), not the whole loan. The components of the platform are summarized below and are described in greater detail in subsequent sections of this paper.

1. Performing Loan Module

The primary function of this module is to project monthly loan level prepayment and 90-day delinquency probabilities on performing and modified performing loans. Loans enter into this module if they are current, less than 90 days delinquent, or forecasted to cure from a delinquency during the simulation. The prepayment and delinquency equations are functions of borrower characteristics, loan characteristics, home values and other economic variables. Multiple pairs of prepayment and delinquency equations collectively cover several loan products and modified loans guaranteed or owned by the Enterprises.

2. Non-Performing Loan Module

The primary function of this module is to project lifetime outcomes for delinquent loans. Loans enter into this module if they are 90 to 180 days delinquent at the beginning of the projection, or if they are predicted to become delinquent within the performing loan module. The module outputs four mutually exclusive loan-specific probabilities each month: foreclosure completion (REO), voluntary prepayment, foreclosure alternative resolutions and re-performance (cure). The foreclosure alternative resolutions include deed-in-lieu of foreclosure, pre-foreclosure sale (short sale), and third-party sale. A loan is defined as re-performing when all arrearages are paid and the cure is not due to a modification or restructuring. The models are a function of borrower characteristics, house prices and state legal structures. Unlike the performing loan module where

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multiple product level models are constructed, only one set of equations is estimated for non-performing loans.

3. Credit Loss Module

The primary function of this module is to calculate loan level credit losses and determine the appropriate timing of loss recognition. Loans enter into this module if they are greater than 180 days delinquent at the start of the projection or are projected to generate a credit loss from the non-performing module. Credit losses are measured as charge-offs and REO operating expenses. Charge-offs and REO operating expenses are calculated at the loan level using an accounting approach.

4. The Integration Module

Combines the forecasted performance elements, mortgage contractual terms, and interest rates to generate loan level cash flows. This module outputs are aggregated across loans into the Standardized Projection Report.

5. The Standardized Projection Report

Summarizes projections of portfolio performance measures over the forecast horizon. Key credit loss elements reported in the report are charge-offs and REO operation expenses. Other variables in the report include performing balances, dollars of new 90-day delinquencies, scheduled and unscheduled principal payments, guarantee fee income, and credit enhancement claims.

The subsequent sections of the paper discuss each of the modules in detail. Sections 3 through 5 focus on the design of the econometric behavioral equations, Section 6 reviews the credit loss calculations, and Section 7 covers the calculation of the monthly projections. The appendices include the parameter estimates and back testing results from the modules covered in Sections 3 through 5.

4. Performing Loan Module

The performing loan module contains a set of multinomial logit (MNL) equations whose mutually exclusive outcomes refer to the monthly status of a loan as: current, prepaid, or delinquent. Three product-specific equations were estimated using Fannie Mae loan-level data¹. Product-specific equations consist of the following:

Fixed Rate Products: 30-year FRM and 15-year FRM

Adjustable Rate Products: 5/1 ARM

When possible, the entire historical population of loans was used for estimation. For 30-year FRM loans, a stratified and random sample of the population of loans was selected over the period from 1997 to 2014. Stratification variables included: geography, credit score, origination quarter, property type, loan size, original loan to value (LTV), and occupancy. Marginal distributions of the population and the selected samples were compared to ensure sample representativeness.

These three equations cover loan products that account for approximately 70 percent of the Enterprise mortgages originated since 1995. The remaining loans are comprised mostly of 40-year FRM, 20-year FRM, 10-year FRM, 10/1 ARM, 7/1 ARM, 3/1 ARM, balloon, and step-rate mortgages. In addition, one equation was developed for all modified loans. Section 3.1 details methodological treatment for performing modified loans.

Multinomial Logit Equations

Many authors including Clapp et al (2005) and Jenkins (1995) demonstrate that the MNL provides a convenient method for structuring prepayment and delinquency risks as a discrete-time competing hazard. With estimated parameters, the platform calculates the conditional probability of prepayment and 90-day delinquency as follows:

$$P(\text{prepay}_{i,t}) = \left(\frac{\exp(x_{i,t}' \hat{\beta}_{pp})}{1 + \exp(x_{i,t}' \hat{\beta}_{pp}) + \exp(v_{i,t}' \hat{\beta}_{f90})} \right) \quad (1)$$

¹ The Freddie Mac specific equations were not estimated because FHFA's comprehensive Freddie Mac loan-level database (Mortgage Loan Integration System) was still under construction when the equations were estimated.

$$P(f90_{i,t}) = \left(\frac{\exp(v_{i,t}' \hat{\beta}_{f90})}{1 + \exp(x_{i,t}' \hat{\beta}_{pp}) + \exp(v_{i,t}' \hat{\beta}_{f90})} \right) \quad (2)$$

The probability of remaining current is as follows:

$$P(current_{i,t}) = 1 - P(prepay_{i,t}) - P(f90_{i,t}) \quad (3)$$

$\hat{\beta}_{pp}$ and $\hat{\beta}_{f90}$ in Eqs (1) and (2) represent estimated prepayment and 90-day delinquency parameter vectors. $x_{i,t}$ and $v_{i,t}$ represent covariates in the prepayment and delinquency equations for the i th loan at time period t . The resulting prepayment conditional probability represents the likelihood that loans prepay in time period t , given it has neither prepaid nor become 90 days delinquent in time period $t-1$. The delinquency conditional probability is similarly defined.

4.1 Set of Covariates for the Performing Loan Module

This section reviews a set of covariates, or independent variables, common across the estimated behavioral equations for performing loans. Most continuous covariates were constructed as spline functions, with the spline knot locations varying across models². Appendix B contains parameter estimates, standardized errors, and spline knot locations, while Appendix C contains in-sample back-test plots for each equation.

4.1.1 Loan Age

Loan age reflects the number of months since the loan was originated. Loan age functions in the equations are constructed as a set of age splines, where spline knots were chosen from product-specific hazard curve(s) that best represents the product loan population³.

² The spline specification for continuous independent variables is a common practice in prepayment and default modeling (see Dunskey and Ho (2007), Bajari, Chu, and Park (2008), Tracey Seslen and William C. Wheaton (2010)). An important benefit of the spline specification is that it avoids sudden jumps within a continuous variable while allows for the non-linearity relationship between independent and dependent variable.

³ The historical hazards are plotted from the loan populations even when sampling is required.

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4.1.2 Vintage-Fixed Effects

In lieu of a constant term, each equation was estimated with a series of vintage-specific fixed effects, which capture unobservable changes in underwriting standards and other non-observables uncontrolled in the equation.

4.1.3 Seasonality

All equations include a set of eleven monthly indicator, or dummy, variables to capture seasonality. The omitted month is January.

4.1.4 Original loan-to-value (LTV) ratio

The covariate original loan-to-value (LTV) ratio measures the down payment at origination. Loan size is the balance of the loan at origination and value is the appraised value at origination. The original LTV enters the model as a set of splines. Spline knots are selected based on the distribution of the original LTV in the estimation data.

4.1.4 Credit Score at Origination

Credit scores are typically reported from all three of the credit repositories. However, the equation only uses one credit score per loan. When multiple scores are available per borrower, the equation uses the lower of the two scores if two are reported, and the middle score if three scores are reported. The lowest score across all borrowers is used when co-borrowers are reported in the loan data. Five splines capture the credit score covariate. Spline knots are selected based on the distribution of credit scores in the estimation data.

4.1.5 Spread at Origination (SATO)

The SATO covariate captures the difference between the borrower's mortgage rate and the prevailing mortgage rate reported in the Primary Mortgage Market Survey (PMMS) at origination. SATO captures other unobservable credit-related factors in the transaction. Two SATO splines (two line segments separated by one spline knot) in each set of equations. The median value of the difference between the initial rate on the mortgage and the market rate (PMMS rate) in the month of the first payment determines the knot location.

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4.1.6 Loan Size at Origination

Loan size (in thousands) at origination enters the equation as a series of four splines. Spline knots are selected based on the distribution of loan size in the estimation data.

4.1.7 Loan Purpose

Loan purpose reflects the reason for the mortgage at origination. Loan purpose covariate is constructed as a categorical variable with three values: purchase, cash-out refinance, and rate/term refinance. 'Purchase' refers to base value.

4.1.8 Mortgage Origination Channel

Mortgage origination channel reflects the source of the loan, i.e., whether or not the loan is originated from a third-party, including a broker or correspondent. The non-third-party (i.e., retail) source refers to the base value.

4.1.9 Number of Borrowers

Borrower number refers to a categorical covariate with two values: one-borrower and multiple borrowers. 'Multiple borrowers' refers to the base value.

4.1.10 Debt-to-Income (DTI) Ratio

DTI is the back-end ratio of the sum of the borrower's monthly payment for principal, interest, taxes, homeowners' association fees and insurance, plus all fixed debts to the total monthly income of all borrowers as determined at the time of origination. DTI enters the equations as a series of four splines. The spline knots are selected based on the distribution of DTI in the estimation data.

4.1.11 Property Type

Property type describes the physical structure of the property and is operationalized as a categorical covariate with four values: single family 1-unit, single family 2-4 units, condominium, and manufactured. 'Single family 1-unit' refers to the base value.

4.1.12 Occupancy Type

Occupancy type reflects the borrower's intended use of the property and is operationalized as a categorical covariate with three values: primary residence, investment, and second home. 'Primary residence' serves as the base value.

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4.1.13 HARP Loan indicator

HARP loans refer to an indicator covariate for loans refinanced under the Home Affordable Refinance Program, and consist of two values: Yes or No. 'No' serves as the base value.

4.1.14 Subordinate Financing

Subordination refers to the ratio of the original loan amount of the second lien to the lesser of the appraised value of a loan or the sale price. Subordinate financing enters the equations as cross products, or interaction effects, between dummy covariates created from original loan-to-value and subordinate financing. Values for the subordinate financing cross products are as follows:

Original Loan-to-Value (OLTV) x Subordinate Financing (Subfin)
$(0 < \text{OLTV} \leq 30\%) \times (\text{Subfin} = 0)$
$(0 < \text{OLTV} \leq 30\%) \times (0 < \text{Subfin} \leq 5\%)$
$(0 < \text{OLTV} \leq 30\%) \times (\text{Subfin} > 5\%)$
$(30 < \text{OLTV} \leq 60\%) \times (\text{Subfin} = 0)$
$(30 < \text{OLTV} \leq 60\%) \times (0 < \text{Subfin} \leq 5\%)$
$(30 < \text{OLTV} \leq 60\%) \times (\text{Subfin} > 5\%)$
$(\text{OLTV} > 60\%) \times (\text{Subfin} = 0)$
$(\text{OLTV} > 60\%) \times (0 < \text{Subfin} \leq 5\%)$
$(\text{OLTV} > 60\%) \times (\text{Subfin} > 5\%)$

Base values include cross products with zero subordinate financing.

4.1.15 Time Varying Credit-Equity Function

The credit equity function is the interaction between the original credit score group indicator and spline variables of the current LTV (or mark-to-market LTV) over the observed life of the loan.

There are k groups of credit score indicators. Each borrower's score falls uniquely into one of the five buckets $k=5$. The width of each bucket is based on the distribution observed in the estimation data. The time dependent MTM LTV ratio is expanded into h spline variables. The length and locations of the spline segments are again defined from the estimation data. The credit equity function for the i^{th} loan in period t is defined as:

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$$Credit_Equity_{i,t} = \sum_{h=1}^5 \sum_{k=1}^5 \hat{\beta}_{h,k} Credit_Score_{i,t,k} MTM_LTV_{i,t,h}.$$

Where $Credit_Score_{i,t,k}$ takes the value of zero or one, depending on the loan's credit score, and $MTM_LTV_{i,t,h}$ are a series of spline variables based on the current LTV of the loan. For each combination of credit score groups ($k=1$ to 5) and MTM LTV range ($h=1$ to 5) a $\hat{\beta}_{h,k}$ parameter is estimated.

Estimated Credit Equity Parameters

Credit Score Group	MTM LTV Spline Variables				
	0 to 60	60 to 70	70 to 85	85 to 95	95 to 120
350 to 682	2.921	1.335	1.816	3.463	0.913
682 to 720	2.154	3.384	3.989	3.078	1.444
720 to 750	1.921	4.088	4.650	4.096	1.755
750 to 780	1.485	5.424	5.109	5.571	2.011
780 to 850	1.307	5.306	5.025	6.961	2.125

The above table displays credit equity function parameter estimates (not marginal effects) from the delinquency equation for a 30-year fixed rate mortgage equation. This table demonstrates that the estimated parameter values vary across the MTM LTV spline variables for a given credit score group. A loan remains in one credit score group throughout the simulation yet moves left and right in the table as the loan MTM LTV changes during the simulation.

4.1.16 Time-Varying Refinance Burnout Function

The refinance function is specified as the interaction between a refinance ratio and a burnout factor. The burnout factor captures the difference in the refinancing efficiency between two otherwise identical loans that have gone through different historical interest rate experiences.

The refinance function is defined as follows:

$$refinance_function_{i,t} = refinance_ratio_{i,t} * burnout_factor_{i,t}, \text{ where}$$

$$refinance_ratio_{i,t} = \left(\frac{PMMS_{i,t=0}}{PMMS_{i,t}} \right)$$

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The refinance ratio is constructed as the Primary Mortgage Market Survey (PMMS) rate for the i th loan at origination ($t=0$) to the current period PMMS rate. The PMMS rate is the prevailing mortgage rate for a 30-year fixed rate mortgage at time t . The refinance ratio measures the economic incentive to and devoid of borrower specific credit information. This is in contrast to the spread at origination variable (SATO). The burnout factor is defined in terms of the significantly positive refinance spread cumulated over the age of the mortgage, reflecting missed refinance opportunities. Explicitly, the burnout function is defined as,

$$burnout_factor_{i,t} = \sum_{t=0}^T MAX \left(\frac{PMMS_{i,t=0} - PMMS_{i,t}}{PMMS_{i,t}} - 0.1, 0 \right).$$

We assume that a refinance opportunity occurs whenever the prevailing PMMS rate falls below the contractual mortgage rate by 10 percent.

The burnout refinance function is only included in the prepayment equations for the fixed rate products.

4.1.17 State Unemployment Rate

The unemployment rate refers to a proxy for job loss of the borrower and state-level economic activity. There are four unemployment spline variables in each equation. Spline knot locations are based on the distribution of the unemployment rate of states in the estimation data.

4.1.18 Swap Spread at Origination

The swap spread, measured by the difference between the 10-year and 2-year swap rate, measures the normal slope of the swap curve and serves as a proxy for the state of the macro-economy. Yield curve spread is only included in the prepayment equation.

4.2 Special Treatment of Performing Modified Loans

Performing modified loans include loans that have been modified through Home Affordable Modification Program (HAMP) or the Enterprises' proprietary modification programs and have not re-defaulted (90+ days delinquent). Performing modified loans are treated differently from unmodified performing loans. Modified loans, most of which were seriously delinquent before modification, have a higher likelihood of delinquency than unmodified performing loans. Modification of the mortgage terms (mortgage rate, amortization term and principal forbearance) and the delinquency

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status prior to modification are important variables in projecting the prepayment and re-default behaviors. A single prepayment and re-default model is developed and deployed for all modified loans.

The behavioral equations for modified loans are modeled in the same multinomial logit framework as unmodified performing loans described above. While most of the independent variables and all the economic variables used in the performing loan model are retained in the modified loan model, some independent variables are reconstructed. The reconstructed variables include loan age, seasonality, loan size and the refinance spread. Loan age for modified loans is measured from the modification date, and loan size is the post modification loan balance. Seasonality is captured by a quarterly dummy variable instead of a monthly dummy due to the short performance history of modified loans. The refinance spread is defined as the modified interest rate of the mortgage minus the prevailing mortgage rate and is constructed as a spline variable.

The independent variables for the performing loan behavioral equations that are not retained in the modified loans treatment are original vintage, original down payment, SATO and the credit equity function. Vintage is not considered for the modified loans treatment as most modified Enterprises loans were modified after 2009, and the underwriting environment has not changed significantly from 2009 to 2012. Down payment and SATO are also not retained as these two variables are not meaningful given that loan has been modified. Finally, the credit equity function is excluded to maintain a relatively simple structure for the modified loan equations.

Additional independent variables are added to the behavioral equations for modified loans:

Percentage Change in the Monthly Mortgage Payment

The monthly payment on most modified loans is reduced through interest rate reductions, term extensions or principal forbearance. The percentage change in the monthly mortgage payment is constructed as a spline variable with the knots determined by the selected percentiles of the distribution of the monthly payment percentage change.

Delinquency Status prior to Modification

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The Delinquency Status prior to Modification is constructed as linear spline variables with knots at 3-, 6-, and 12-month delinquency.

Home Price Appreciation since Modification

Home Price Appreciation since Modification is measured as a percentage change of the home price since modification at the state level. Home Price Appreciation is measured at the state level and is constructed as linear spline variables with knots determined by selected percentiles of the distribution of the percentage of the home price change.

The behavioral equations are estimated with performance history on Fannie Mae and Freddie Mac loans from June 2009 to December 2011. The estimated coefficients and back-testing results for the Modified Loan equations are included in Appendices B and C.

5. Non-Performing Loan Module

Loans enter into the non-performing module if they are 90 to 180 days delinquent at the beginning of the projection or if they are predicted to become 90-days or more delinquent (F90) during the forecast horizon. The module computes four mutually exclusive lifetime probabilities conditional on a loan being at least 90 days delinquent: re-performance (cure), voluntary prepayment, alternative foreclosure resolution, and foreclosure completion (REO). The lifetime probability of the loan resolving as real estate owned (REO) is calculated as the residual of one minus the other three computed probabilities. The alternative foreclosure resolutions include deed-in-lieu of foreclosure, pre-foreclosure sale, and third party sale. Re-performance is defined as a loan returning to current status without having been modified or restructured. The loans that are projected to be re-performing are treated as performing loans and are sent back to the Performing Loan Module.

The equations in the non-performing module are estimated simultaneously on a population of loans that became 90 days delinquent for the first time between 1997 and 2012. The estimation data excludes loans that became 90 or more days delinquent and were subsequently modified. Conceptually, the resolution of delinquent loans is jointly determined by the borrower and the servicer. Information on servicers is unobservable; therefore the equations are a function of borrower, house characteristics and state legal structures. The lifetime probability of each of the terminal states is represented below in a competing risks framework:

$$P(\text{LifetimeSale}_{i,t} | f90_{i,t}) = \left(\frac{\exp(x_{i,t}' \hat{\beta}_{FCA})}{1 + \exp(x_{i,t}' \hat{\beta}_{FCA}) + \exp(v_{i,t}' \hat{\beta}_{RPerf}) + \exp(\omega_{i,t}' \hat{\beta}_{PP})} \right)$$

$$P(RPerf_{i,t} | f90_{i,t}) = \left(\frac{\exp(v_{i,t}' \hat{\beta}_{RPerf})}{1 + \exp(x_{i,t}' \hat{\beta}_{FCA}) + \exp(v_{i,t}' \hat{\beta}_{RPerf}) + \exp(\omega_{i,t}' \hat{\beta}_{PP})} \right)$$

$$P(\text{lifetimePrepay}_{i,t} | f90_{i,t}) = \left(\frac{\exp(\omega_{i,t}' \hat{\beta}_{PP})}{1 + \exp(x_{i,t}' \hat{\beta}_{FCA}) + \exp(v_{i,t}' \hat{\beta}_{RPerf}) + \exp(\omega_{i,t}' \hat{\beta}_{PP})} \right), \text{ and}$$

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$$P(\text{LifetimeREO}_{i,t} | f90_{i,t}) = 1 - P(\text{LifetimeSale}_{i,t} | f90_{i,t}) - P(\text{RPerf}_{i,t} | f90_{i,t}) - P(\text{LifetimePrepay}_{i,t} | f90_{i,t})$$

Where $\hat{\beta}_{FCA}$, $\hat{\beta}_{RPerf}$ and $\hat{\beta}_{PP}$ represent the equation specific parameters of exiting by a foreclosure alternative, re-performance and voluntary prepayment of the mortgage. The corresponding independent variable vectors are $x_{i,t}$, $v_{i,t}$ and $\omega_{i,t}$ for the i th loan at the time of the 90 day delinquency event, time t .

The following subsection discusses the construction of the independent variables in the model.

5.1 Independent Variables in the Non-Performing Loan Module

There are seven groups of independent variables in the non-performing loan model, and an intercept term. Similar to the performing modified loan model, only one model is deployed for all non-performing loans. Consideration of explanatory variables is restricted to variables that are observable in the month of the first 90 day delinquency and for which economic forecasts are available.

5.1.1 Current LTV at the Delinquency Date

In order to capture the level of equity or negative equity in the property, the current LTV (MTM LTV) of the loan in the month of the first 90 day delinquency is included as five spline variables. The spline knots are located at 68%, 82%, 99% and 120% current LTV. MTM LTV is calculated from the loan balance on the last paid installment, and house values are updated using the FHFA state-level purchase-only House Price Index.

5.1.2 Original Loan Size

Similar to the performing loan module, original loan size (in thousands) is included in the model by five spline variables with knot locations based on the distribution of loan size in the delinquent loan data. The spline knots are located at \$90k, \$150k, \$232k, and \$360k.

5.1.3 Property Type

The property type is represented by three indicator variables; condominium, planned urban development and manufactured housing. Single family detached residence serves as the comparator.

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5.1.4 Stated Occupancy at Origination

To differentiate between outcomes across owner occupants and non-owner occupants an indicator variable is included in all of the specifications. Relative to owner occupants, non-owner occupants are less likely to re-perform.

5.1.5 Mortgage Insurance Coverage

For loans with mortgage insurance, two spline variables based on the level of insurance coverage are included in the specification. The spline knot is located at 25% coverage. The spline variables for loan without mortgage insurance are set at zero.

5.1.6 Credit Score at Origination

Original credit scores enter into the model as five spline variables with spline knots located at 623, 661, 703, and 750. Original credit scores may no longer accurately represent the borrower's recent payment history, yet they remain statistically significant in the non-performing loan model.

5.1.7 State Unemployment at Delinquency Date

Four unemployment spline variables are included in each model where the selection of the spline knots is based on the distribution of the unemployment rate of the states represented in the input data. The spline knots are located at 5.5, 7.8, and 10.3 percent.

5.1.8 Judicial State Indicator

Lastly, a state legal structure indicator is included to control for variation in state foreclosure laws. The judicial state indicator is set to 1 when the loans is located in the following states: DE, FL, HI, IA, ID, IL, IN, KS, KY, LA, ND, NE, NJ, NM, NY, OH, OK, PA, SC, and SD. In judicial foreclosure states, a lender is required to get a judgment against the borrower and a court order authorizing the sale of the property by an office of the court, (Hayre and Saraf, 2008). The foreclosure timelines in judicial states are longer than non-judicial states. As such, it is necessary to control for the local legal structures when modeling delinquent loan outcomes.

The estimated parameters for the equations of the non-performing loan module are provided in Appendix E.

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6. Credit Loss Module

The Credit Loss Module projects credit losses on loan balances that are 180+ days delinquent at the beginning of the projection period, and on loan balances that are projected to go to either foreclosure completion (i.e., REO) or to a foreclosure-alternative sale from the Non-Performing Loan Module. The platform projects two accounting measures of loss; *Charge-off* and *REO Operating Expenses*.

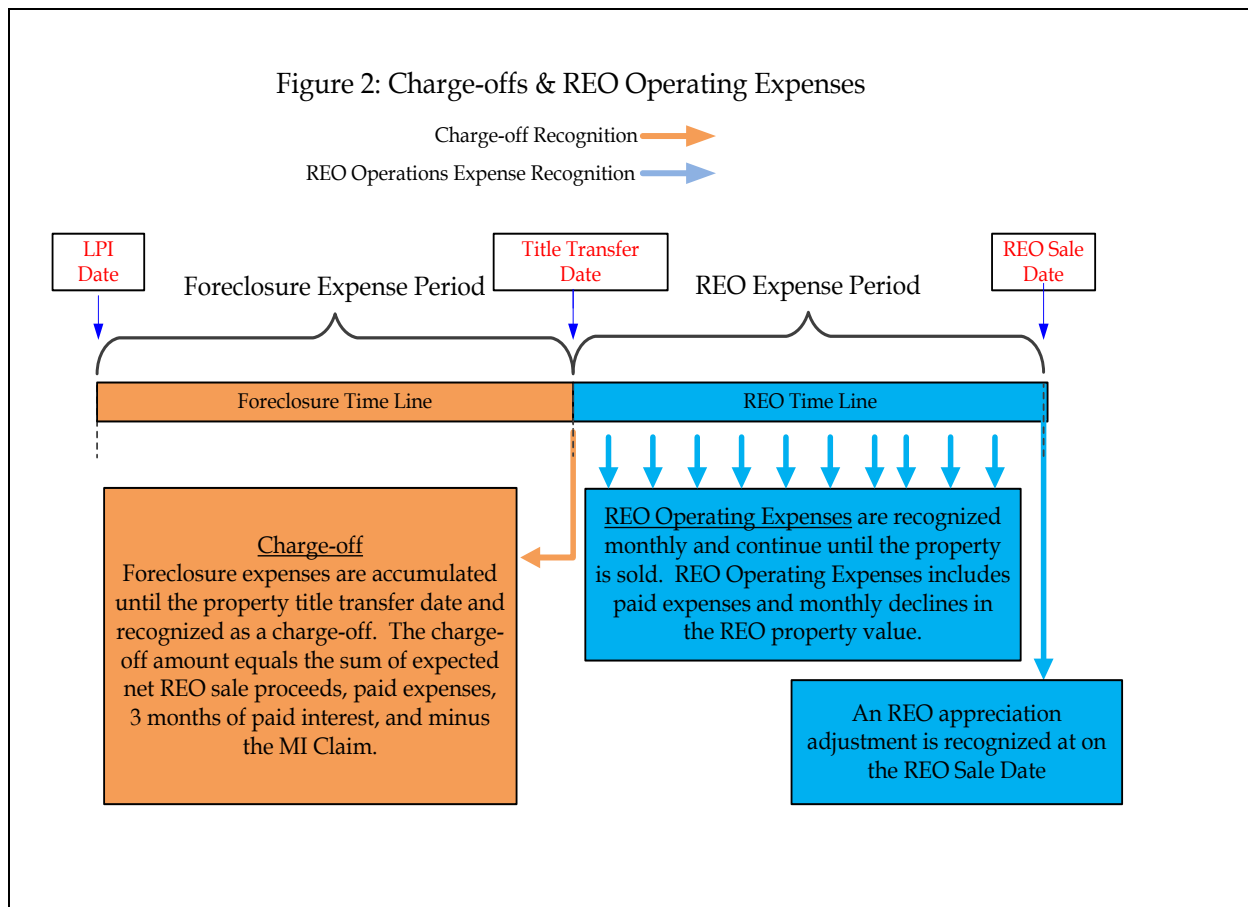


Figure 2 schematically separates the differences between Charge-offs and REO operating expenses over the delinquency and resolution lifecycle. Expense components included in the charge-off measure are accumulated from the borrower's last paid installment (LPI) date to the date of the title transfer. Two forms of title transfers generate credit losses; foreclosure completions and alternative foreclosure resolutions. Loans that complete the foreclosure process and become real estate owned (REO) are charged off at the title transfer date (orange arrow) and begin to generate REO

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operating expenses thereafter. Meanwhile, loans that terminate via an alternative foreclosure resolution are charged off at the title transfer date (orange arrow); these loans do not become REO and therefore do not generate REO operating expenses. The calculation of charge-offs for both forms of title transfer are identical, while only completed foreclosures generate losses captured in REO operating expense.

In contrast to charge-offs, where expenses are accumulated over the foreclosure period and recognized on the title transfer date (orange arrow), REO Operating Expenses are calculated and recognized monthly (blue arrows). The sections below discuss the specifics of the recognition timing, charge-offs amounts, and REO Operations Expenses.

6.1 Charge-Off Timing

Non-performing loans are charged off when the property title is transferred at the completion of the foreclosure process or at the culmination of an alternative foreclosure resolution⁴. The title-transfer timelines are calculated from historical data as the average number of months to complete the process in each state. The platform includes both a long run timeline and a stressed foreclosure timeline. The stressed timeline represents the average foreclosure timeline for loans that completed the foreclosure process (or alternative foreclosure resolution) during the December 2010 to December 2011 period. The long-run average timelines are calculated from foreclosures (and alternatives) completed from January 1995 to December 2011.

Non-performing loans with a level of delinquency greater than the historical state average foreclosure timelines require a special treatment. These loans are assumed to complete foreclosure (or an alternative foreclosure resolution) and be charged off during the first 12 months of the projection. To avoid concentrating all of the charge-offs in a particular month, each of these loans were randomly assigned a charge-off date (based on a uniform distribution) during the first year of the projection.

6.2 Charge-Off Amount

The charge-off amount represents the expected proceeds from the property sale net of all transaction costs, accrued expenses and credit enhancements.

⁴ Alternative foreclosure resolutions include deed-in-lieu of foreclosure, pre-foreclosure sale, and third party sales.

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$$\begin{aligned} \text{ChargeOff} &= \text{Expected Net REO Sale Proceeds} \\ &+ \text{Paid Expenses} + \text{Paid Interest} - \text{MI Claim Amount} \end{aligned}$$

More specifically, the charge-off amount is composed of four components: (1) Expected Net REO Sale Proceeds, (2) Paid Expenses during the Foreclosure Process, (3) Three Months of Lost Interest, and (4) the Mortgage Insurance Claim Amount. Each of these elements is discussed below.

6.2.1 Expected Net REO Sale Proceeds

The expected net REO sale proceeds are calculated as,

$$\text{Expected Net REO Sale Proceeds} = (\text{UPB} * (1 + \text{FC}_{\text{costs}})) - (\text{ReoSalePrice}_{t+k} * (1 - \text{Settlement}_{\text{costs}}))$$

where $(\text{UPB} * (1 + \text{FC}_{\text{costs}}))$ represents the unpaid principal balance (UPB) scaled up by the foreclosure cost factor $(1 + \text{FC}_{\text{costs}})$. The foreclosure cost factor is adapted from the Home Affordable Modification Program Net Present Value (HAMP NPV) model's state-level averages of "Foreclosure and REO costs" as a percentage of UPB⁵. The NPV model documentation indicates that these costs are comprised of the following.

- Attorney and trustee fees
- Possessory and eviction fees and expenses
- Bankruptcy expenses
- Servicer liquidation expenses
- MI premium
- Flood insurance premium
- Title insurance
- Appraisal fees
- Property inspection
- Utilities
- Property maintenance/preservation
- Other foreclosure and holding costs
- Total repairs (capped at \$3,000 to exclude discretionary repairs)
- Participation expenses
- Foreclosure costs paid out at property sale (from HUD-1)

⁵ The HAMP model documentation is available at, https://www.hmpadmin.com//portal/programs/docs/hamp_servicer/npvmodeldocumentationv502.pdf

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These items combine both foreclosure costs (which belong in charge-off) and REO costs (which do not belong in charge-off). To balance out the inclusion of REO cost elements, the “Foreclosure and REO costs” are reduced by half when calculating the charge-off amount. The remaining half is allocated to REO operations expense in Section 5.3.2.

The second part of expected net REO sale proceeds ($ReoSalePrice_{t+k} * (1 - Settlement_{costs})$) captures the expected revenue from the sale of the REO property net of brokerage fees and other settlement costs. REO sales price, denoted as $ReoSalePrice_{t+k}$, represents the expected value at time period t given a foreclosure timeline of k months. REO property typically sells at a depressed price relative to a non-distressed transaction. The REO sale price is calculated in two steps to account for the distressed nature of REO property.

1. The original value of the property is “marked forward” by the percentage change in the FHFA state-level purchase-only house price index between loan origination and charge-off date.
2. The “marked forward” value of the house is haircut by a state-level REO stigma correction.

While many REO sales are cash transactions⁶, the FHFA state-level purchase-only house price index includes a very small percentage of REO purchase transactions. Therefore, it is necessary to adjust the REO property value in step 1 above by a state-level REO stigma. The REO stigma correction maps the relationship between FHFA state-level purchase-only house price index-based home values to distressed REO sales prices. REO stigma correction follows a modified version of the approach used in the HAMP Net Present Value (NPV) model⁷. In contrast to the HAMP NPV model, where REO Sale prices are regressed on home values generated by an automated valuation model (AVM), the AVM prices are replaced by the property values in step 1 above (home values generated from the FHFA state-level purchase-only home price). An REO stigma equation is estimated for each of the 50 states based on Enterprise data. For all alternative foreclosure resolutions, it is assumed that there is no REO stigma.

⁶ See for example, http://www.corelogic.com/blog/authors/molly-boesel/2014/05/cash-sales-made-up-40-percent-of-total-home-sales-in-february.aspx?WT.mc_id=crlg_140519_oBvIb&relq=a1f819d883a44c33952168e917f41adc#.U3osDfldV8E

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The REO Sales price is reduced by settlement costs ($1 - Settlement_{costs}$) as a percentage of the calculated REO disposition sale price, the percentage varies by state. The state-level settlement cost percentages are from the HAMP NPV model.

Settlement Charges include:

- Discount Points
- Loan Origination Fees
- Broker's Bonus
- Broker Commission Fees
- Buyer's Closing Costs (paid by seller only – not total buyer's closing costs)
- Title Fee Cost
- Seller's Closing Costs
- Assessments
- FHA/VA Non-Allowable Costs
- Other Costs
- Wire Fees
- Subtract miscellaneous revenues received at property sale:
 - Per diem amount
 - Other rent/interest amount
 - Prepaid interest amount

6.2.2 Paid Expenses during the Foreclosure Process

There are three groups of expenses that are accumulated from the last paid installment to the foreclosure completion (or alternative foreclosure resolution) date: property taxes, property insurance, and maintenance costs. Lookup tables containing the three average expense rates are calculated from American Community Survey (ACS 2010) by location and property value. Apart from homeowners' association fees or condominium fees, maintenance costs on single family homes are not reported in ACS. As a proxy for monthly maintenance cost on single family homes, it is assumed that the property maintenance costs are equal to one half homeowners' association fees that would have been applied if the home belonged to a homeowners' association.

The expense rates are applied to the property value at loan origination and by geographic state to project these monthly expenses in dollars. The monthly expenses

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are accumulated for every month between LPI date and foreclosure completion date and recognized on the charge-off date.

6.2.3 Paid Interest

The module assumes that the loan servicer advances the borrower's interest payment to investors for three months, and this amount is reimbursed to the loan servicer by the Enterprise when the loan is purchased out of the security. Three months of interest payments are included as an expense in the charge-off amount.

6.2.4 MI Claim Amount

For loans with active MI coverage, the MI claim amount is limited to the insured UPB plus foreclosure expenses. Foreclosure expenses are equal to the expenses in charge-off plus lost interest for all months from the LPI date to foreclosure completion date. As noted in 5.2.3 above, only three months of lost interest is included in the charge-off measure.

The model assumes that the MI Company will exercise their right to buy the foreclosed property (conveyance) in lieu of paying the MI Claim when the MI payment is greater than the sum of the charge-off and REO operating expenses. In the case of conveyance, the value of the property is based on the FHFA state-level purchase-only house price index at the foreclosure completion date, not at the projected REO sale date. Both the charge-off and REO net expenses attributed to the Enterprise are zero when the MI Company purchases the foreclosed property.

For loans with original LTV greater than 80% and with first pay date on or later than July 29, 1999, that coverage is projected to cancel at the earlier of: (a) the month after the loan's amortization LTV reaches 78 percent, and (b) the month in which the loan's age reaches one half its amortization term.⁸ For loans originated before July 29, 1999 where the data indicate that MI coverage is in effect at the beginning of the projection, the coverage is never canceled.

⁸ See 12 U.S. Code § 4902 - Termination of private mortgage insurance regarding the "automatic" and "final" termination provisions of section 3 of the Homeowners Protection Act of 1998. There is no projection of the borrower-initiated cancellation allowable under the Act.

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6.2.5 Mortgage Insurance (MI) haircuts

The calculated MI benefit is subject to the risk that the MI company either fails to meet its obligations (e.g. state regulator places the company into runoff) or the MI company denies the claims. To allow for these forms of counterparty credit risk, the Module reduces the value of the calculated MI benefit by a MI “haircut” percentage.

The MI haircuts of the Credit Loss Module are based on a modified version of Basel’s Advanced Internal Rating Based (IRB) approach which differentiates haircuts between counterparties with different levels of risk measured by the Enterprises’ internal credit rating⁹. The counterparty haircut at each credit rating level is further differentiated by the MI company’s level of concentration in the mortgage insurance business, loan amortization term, and loan payment status.

A look-up table for determining the MI haircut percentage is provided in Appendix D.2.

6.3 REO Operations Expenses

6.3.1 REO Operation Expense Timing

REO operation expenses are calculated and reported one month after foreclosure completion until the REO property is sold. Similar to the foreclosure timings, the platform includes both a long run REO timeline and a stressful timeline. The stressed timeline represents the average state-level timelines for REO properties that were sold between December 2010 and December 2011. The long-run average timelines are calculated from REO sales completed from January 1995 to December 2011. Both sets of REO sale time lines are computed from GSE historical data at the state level.

6.3.2 REO Operation Expense Amount

REO operations expenses are posted monthly and calculated as the sum of (1) paid expenses and (2) mark-to-market REO property value changes. The REO expenses are the same as the expenses included in the charge-off amount; “Paid Expenses” described in Section 5.2.2 and the remaining 50% of the “Foreclosure and REO costs” allocated

⁹ The eight rating levels used to rate counterparties of the Enterprises are described in Appendix D.1.

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across the REO holding period. In contrast to the expenses in the charge-off amount, REO operating expenses are recognized each month while the property is held in inventory.

Mark-to-market REO property values enter into the REO operations expense amount in two parts. During the REO holding period, only declines in the value of the REO property are added to the monthly REO operations expenses. Increases in the REO property value are only included in the REO operating expenses when the property is sold. The mark-to-market property values are computed using projected FHFA state-level purchase-only house price index.

As noted above, if the calculated charge-off excluding the estimated MI payment is negative, both the charge-off and the REO operations expenses that would have been associated with the loan termination are set to zero. It is explicitly assumed that foreclosed or alternative foreclosures cannot generate gains. The best outcome for a non-performing loan is a zero-credit loss.

7. Integration Module

This module integrates the prepayment and default probabilities from the Performing and Non-performing Modules with the outputs from the Credit Loss Module to project monthly loan-level cash flows. The primary outputs include scheduled and unscheduled principal payments, scheduled interest payments, and losses. Ancillary outputs include servicing fees, guaranty fee revenue, and MI payments.

For each mortgage, the unpaid principal balance is projected forward one month by subtracting expected amounts of scheduled, prepaid (unscheduled), and defaulted principal from the performing balance (UPB_{t-1}).

$$UPB_{t+1} = UPB_{t-1} - schedPrinPaid_t - prepayDollars_t - dollarsF90ToPrepay_t - dollarsF90ToReo_t - dollarsF90ToSale_t.$$

For expository purposes the above equation is separated into two parts, (1) scheduled and unscheduled principal, and (2) elements that are subtracted from performing balance that are directed to the credit losses ($dollarsF90ToReo_t$, and $dollarsF90ToSale_t$).

7.1 Scheduled and Unscheduled Related Principal

The scheduled and unscheduled principal payments include scheduled paid principal ($schedPrinPaid_t$) net lifetime losses, unscheduled or prepaid principal ($prepayDollars_t$) from performing balances, and unscheduled or prepaid principal from delinquent loans balances ($dollarsF90toPrepay_t$). More specifically, scheduled principal paid is defined as

$$schedPrinPaid_t = schedPrin_t * (1 - P(lifetimeReo_t | f90_t) - P(lifetimeSale_t | f90_t)).$$

And the remaining component ($1 - P(lifetimeReo_t | f90_t) - P(lifetimeSale_t | f90_t)$) represents the portion of the balance related to foreclosure and foreclosure-alternative as described in the Non-Performing Module, Section 4.

Prepaid dollars on performing loan balances ($prepayDollars_t$) is defined as

$$prepayDollars_t = P(prepay_t) * (UPB_{t-1} - schedPrin_t),$$

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Where $P(\text{prepay}_t)$ represents the probability of prepayment defined in Section 3, Performing Loan Module. The second term in the prepaid dollars equation ($UPB_{t-1} - \text{schedPrin}_t$), represent the loan balances at risk of prepaying not of their scheduled principal payment.

The final source of prepaid dollars is from repayments on non-performing loans. There are three components to $\text{dollarsF90ToPrepay}_t$: (1) the probability of going 90 days delinquent from the performing loan module (Section 3), (2) the lifetime probability of prepaying given that the balance is delinquent from the Non-Performing Module (Section 4), and (3) the unpaid principal balance at risk.

$$\begin{aligned} \text{dollarsF90ToPrepay}_t & \\ &= P(f90_t) * P(\text{lifetimePrepay}_t | f90_t) * (UPB_{t-1} - \text{schedPrin}_t) \end{aligned}$$

7.2 Credit Loss Related Principal

Non-performing loan balances resolving as REO or an alternative foreclosure resolution generate lost principal and contribute to the credit loss measures charge-off and REO operating expenses. These two components of principal are subtracted from the performing unpaid principal balance and represent the delinquent loan balances that are later used to calculate charge-offs.

$$\begin{aligned} \text{dollarsF90ToReo}_t &= P(f90_t) * P(\text{lifetimeReo}_t | f90_t) * UPB_{t-1} \\ \text{dollarsF90ToSale}_t &= P(f90_t) * P(\text{lifetimeSale}_t | f90_t) * UPB_{t-1} \end{aligned}$$

7.3 Credit Loss Measures

Loan balance projected to go to REO or foreclosure-alternative sale lead to principal losses and are recognized as charge-offs. The monthly expected values for foreclosure-related charge-offs can be expressed in terms of the charge-off amount calculated in Section 5,

$$\text{chargeOffDollars}_{t+k} = P(f90_t) * P(\text{lifetimeReo}_t | f90_t) * \text{chargeOff}_{t+k},$$

or, equivalently for both foreclosure complete and alternative foreclosure resolutions,

$$\text{chargeOffDollars}_{t+k} = (\text{dollarsF90ToReo}_t / UPB_{t-1}) * \text{chargeOff}_{t+k}$$

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$$\text{chargeOffDollars}_{t+k} = (\text{dollarsF90ToSale}_t / \text{UPB}_{t-1}) * \text{chargeOff}_{t+k}$$

where chargeOff_{t+k} is the charge-off amount calculated in Section 6 (which would be the charge-off amount if the entire loan balance were going to foreclosure), and $\text{chargeOffDollars}_{t+k}$ is the charge-off amount scaled to take account of the portion of the balance that is projected to go to foreclosure. The k subscript indicates that the charge-off will be realized following the appropriate foreclosure or alternative foreclosure time line.

The logic for REO operating expenses is identical except that the charge-off amount is replaced with the REO Operating expense variable.

8. Standardized Report Elements

The platform generates a summary report containing monthly projections of portfolio performance measures over the forecast horizon. The standard report includes key credit loss elements (charge-offs and REO operation expenses), and many ancillary variables: performing balances, dollars of new 90 day delinquencies, scheduled and unscheduled principal payments, guarantee fee income, and credit enhancement claims.

Custom reports are frequently constructed to meet the needs of new projects, for example, aggregating credit losses by vintage year, credit score group, original LTV, and states. Most custom reports are aggregations of the variables in the standard report.

The primary elements in the standardized report are aggregated across the portfolio and posted in the month of recognition:

- Forecast Date – each row of the report corresponds to a future month during the forecast horizon for which the dollar amount is recognized.
- Performing UPB – is defined in Section 6 and represents aggregate unpaid principal balance in the forecast month that is at risk of defaults and prepayments (see Section 6).
- Scheduled Paid Principal Balance – is defined as aggregate scheduled principal paid on performing balances (see Section 6).
- Unscheduled Paid Principal – is defined as aggregate scheduled principal paid on performing balances. Unscheduled principal includes prepayments from performing and non-performing loans. (see Section 6)
- Dollars of New 90 day Delinquencies (F90Dollars) - is defined as aggregate newly non-performing loan balances.
- Scheduled Interest Net of Fees – is defined as aggregate scheduled interest on loan balances before non-performing balances are removed.
- Paid Interest Net of Fees – is defined as aggregate paid interest on performing loan balances excluding servicing and guarantee fees.
- Paid Guarantee Fees – is defined as aggregate paid guarantee fees on performing loan balances.
- Non-Performing Lifetime Balances- three variables report the terminal outcome on non-performing balances in the future month in which they are recognized.

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For example, loan balances projected to resolve as REO in month t will be recognized in a future date when foreclosure is completed.

- 90 days delinquent balances completing the foreclosure process (REO) is calculated in Section 6 as $P(f90_t) * P(lifetimeReo_t | f90_t) * UPB_{t-1}$
- 90 days delinquent balances completing the alternative foreclosure process is calculated in Section 6 as $P(f90_t) * P(lifetimeSale_t | f90_t) * UPB_{t-1}$
- 90 days delinquent balances resolve as prepayments is calculated as $P(f90_t) * P(lifetimePrepay_t | f90_t) * (UPB_{t-1} - schedPrin_t)$

- Credit Loss Measures
Sections 5 and 6 discusses the construction and timing of both of the credit loss measures, Charge-Off Dollars and REO Operating Expenses.

- Charge-off Subcomponents (See Section 5)
The following components used to calculate charge-off are aggregated across the portfolio and contained in the standard report. These elements are posted in the month of the title transfer (recognition of losses).
 - Non-performing Balances
 - Property Value of Non-Performing Loans
 - Paid Expenses on non-performing loans during the foreclosure process
 - Three months of paid interest
 - 50% of “Foreclosure and REO costs”
 - Mortgage insurance claim amount

- REO Operations Expense Subcomponents (see Section 5)
The follow components used to calculate REO Operating Expenses are aggregated across the portfolio and contained in the standard report. These elements are recognized in the month they occur.
 - Monthly Paid Expenses & 50% of “Foreclosure and REO costs” on REO Properties
 - Mark-to-Market REO Property value declines
 - Mark-to-Market REO Property value increases at REO sale date

9. References

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10. *Appendix A: Spline Construction*

Spline variables are used extensively in the behavioral models, and the general function below is referenced throughout this section. Let $V_i, i = 1, \dots, n$, be the spline variables created; $k_i, i = 1, \dots, n - 1$, be the corresponding spline knot locations; and Var is the variable being splined. Then

$$V_1 = \min(Var, k_1)$$
$$V_i = \max[\min(Var, k_i), k_{i-1}] - k_{i-1} \quad i = 2, \dots, n$$

Spline knot locations are listed in the Parameter Table starting at row 139; both the left knot and the right knot are listed in each row of the table. Selection of the spline knot locations is based on the distribution of the variable within estimation data. Please see Stata Reference Manual "R", page 1057.

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11. Appendix B: Performing Loan Module Model Coefficients

Performing Loan Equation Fannie Mae Fixed Rate 30 Year						Performing Loan Equation Fannie Mae Fixed Rate 30 Year							
Variables	Spline Interval		Prepay Coef.	SE	Default Coef.	SE	Variables	Spline Interval		Prepay Coef.	SE	Default Coef.	SE
	Min	Max						Min	Max				
Age spline variable 1	0	3	0.4231	0.0061	0.0000	(omitted)	Refi_Burnout_43			-4.0643	0.4821	0.0000	(omitted)
Age spline variable 2	3	12	0.0441	0.0010	0.1304	0.0029	Refi_Burnout_53			2.1981	0.3695	0.0000	(omitted)
Age spline variable 3	12	18	-0.0017	0.0011	0.0346	0.0033	Refi_Burnout_14			-1.7979	0.3846	0.0000	(omitted)
Age spline variable 4	18	34	-0.0142	0.0004	0.0040	0.0011	Refi_Burnout_24			4.4805	0.1087	0.0000	(omitted)
Age spline variable 5	34	58	-0.0117	0.0003	-0.0053	0.0008	Refi_Burnout_34			4.3148	0.0880	0.0000	(omitted)
Age spline variable 6	58	67	-0.0311	0.0012	0.0050	0.0032	Refi_Burnout_44			3.0631	0.0714	0.0000	(omitted)
Age spline variable 7	67	69	0.0011	0.0078	-0.0342	0.0207	Refi_Burnout_54			-3.1121	0.0406	0.0000	(omitted)
Age spline variable 8	69	74	-0.0163	0.0037	0.0234	0.0097	Refi_Burnout_55			2.4280	0.0211	0.0000	(omitted)
Age spline variable 9	74	79	-0.0227	0.0035	-0.0184	0.0093	Credit_Equity_11			-1.3394	0.0380	2.7247	0.2038
Age spline variable 10	79	85	-0.0082	0.0032	0.0304	0.0086	Credit_Equity_12			-2.0016	0.0765	1.9346	0.2414
Age spline variable 11	85	88	0.0099	0.0053	-0.0297	0.0150	Credit_Equity_13			-3.0310	0.1114	0.7643	0.2775
Age spline variable 12	88	111	-0.0214	0.0007	0.0029	0.0022	Credit_Equity_14			-3.4524	0.1065	3.3918	0.1895
Age spline variable 13	111	114	-0.0227	0.0079	0.0704	0.0260	Credit_Equity_15			-2.2717	0.0447	0.9527	0.0287
Age spline variable 14	114	118	-0.0020	0.0084	-0.0357	0.0290	Credit_Equity_21			-1.5581	0.0347	1.9039	0.2147
Age spline variable 15	118	123	-0.0267	0.0133	-0.0147	0.0480	Credit_Equity_22			-1.2252	0.0842	2.9934	0.4198
February			0.0785	0.0066	-0.0879	0.0178	Credit_Equity_23			-2.6364	0.1240	1.4532	0.4876
March			0.2154	0.0064	-0.2417	0.0186	Credit_Equity_24			-3.0696	0.1181	5.1282	0.3122
April			0.2426	0.0064	-0.2401	0.0186	Credit_Equity_25			-2.0117	0.0464	1.3999	0.0371
May			0.1878	0.0065	-0.2080	0.0185	Credit_Equity_31			-1.6082	0.0324	1.5032	0.2300
June			0.2395	0.0065	-0.1729	0.0183	Credit_Equity_32			-1.0364	0.0832	4.0312	0.5594
July			0.2931	0.0064	-0.1002	0.0180	Credit_Equity_33			-2.2767	0.1237	0.9690	0.6493
August			0.2712	0.0064	-0.0712	0.0179	Credit_Equity_34			-2.4184	0.1185	6.6554	0.4136
September			0.1138	0.0065	-0.0145	0.0176	Credit_Equity_35			-1.9343	0.0477	1.7065	0.0453
October			0.1577	0.0064	-0.0087	0.0175	Credit_Equity_41			-1.7298	0.0319	0.8581	0.2569
November			0.1372	0.0065	0.0629	0.0172	Credit_Equity_42			-0.5166	0.0783	5.4895	0.7179
December			0.1915	0.0064	0.0100	0.0174	Credit_Equity_43			-2.1558	0.1187	2.0727	0.8284
Cohort 1997			-13.1081	0.1484	-6.4564	0.1515	Credit_Equity_44			-2.0262	0.1148	7.1962	0.5129
Cohort 1998			-13.1502	0.1480	-6.7154	0.1498	Credit_Equity_45			-1.7122	0.0455	1.8712	0.0521
Cohort 1999			-13.2202	0.1482	-6.4534	0.1502	Credit_Equity_51			-1.8309	0.0344	0.9908	0.2916
Cohort 2000			-13.1587	0.1484	-6.0694	0.1517	Credit_Equity_52			-0.0325	0.0895	4.4898	0.9289
Cohort 2001			-13.2549	0.1484	-6.3170	0.1509	Credit_Equity_53			-2.0905	0.1391	0.9925	1.1813
Cohort 2002			-13.3498	0.1484	-6.4081	0.1508	Credit_Equity_54			-1.4857	0.1339	9.0480	0.7325
Cohort 2003			-13.4061	0.1485	-6.5776	0.1504	Credit_Equity_55			-1.6957	0.0524	1.7462	0.0616
Cohort 2004			-13.4985	0.1487	-6.3763	0.1505	Orig UPB Spline 1	0.0	99.0	0.0110	0.0001	-0.0010	0.0003
Cohort 2005			-13.6393	0.1487	-6.2853	0.1501	Orig UPB Spline 2	99.0	145.1	0.0051	0.0001	0.0009	0.0003
Cohort 2006			-13.8671	0.1485	-6.0557	0.1499	Orig UPB Spline 3	145.1	214.4	0.0035	0.0001	0.0028	0.0002
Cohort 2007			-14.0622	0.1485	-5.9249	0.1499	Orig UPB Spline 4	214.4	417.0	0.0018	0.0000	0.0017	0.0001
Cohort 2008			-14.0935	0.1486	-6.0007	0.1506	SATO Spline 1	-8.00	0.11	0.8148	0.0051	0.4598	0.0172
Cohort 2009			-14.2356	0.1485	-6.9745	0.1529	SATO Spline 2	0.11	4.00	0.4145	0.0041	0.3909	0.0075
Cohort 2010			-14.4667	0.1487	-7.2490	0.1551	Unemp Rate Spline 1	0.00	4.66	0.0299	0.0042	0.2430	0.0175
Cohort 2011			-14.5959	0.1487	-7.3827	0.1581	Unemp Rate Spline 2	4.66	5.91	0.0167	0.0041	0.0969	0.0150
Cohort 2012			-14.4481	0.1464	-7.9951	0.1605	Unemp Rate Spline 3	5.91	7.93	-0.0832	0.0026	0.1315	0.0073
Cohort 2013			-14.7412	0.1469	-7.9801	0.1646	Unemp Rate Spline 4	7.93	12.00	-0.0341	0.0016	0.0325	0.0025
Swap spread			-0.2279	0.0023	0.0000	(omitted)	Cash out loan			-0.0901	0.0037	0.2097	0.0104
Orig LTV Spline 1	0.00	0.65	1.0520	0.0261	-0.1189	0.1310	Rate refi loan			-0.0245	0.0034	0.1900	0.0108
Orig LTV Spline 2	0.65	0.75	0.8178	0.0596	0.4928	0.2086	DTI Spline 1	0.00	0.28	0.1774	0.0385	0.7145	0.1657
Orig LTV Spline 3	0.75	0.80	1.1073	0.0960	0.0598	0.2905	DTI Spline 2	0.28	0.33	-0.1799	0.1155	2.9016	0.4075
Orig LTV Spline 4	0.80	1.20	1.0127	0.0295	0.1709	0.0402	DTI Spline 3	0.33	0.38	0.0419	0.1345	1.9578	0.4105
Credit Score Spline 1	0.00	0.67	2.4997	0.0830	-7.3308	0.1362	DTI Spline 4	0.38	0.43	-0.3933	0.1428	1.5351	0.3842
Credit Score Spline 2	0.67	0.71	1.4320	0.2681	-10.7365	0.7675	DTI Spline 5	0.43	0.48	-0.3773	0.1398	1.1044	0.3357
Credit Score Spline 3	0.71	0.75	1.2040	0.2924	-13.3151	1.1520	DTI Spline 6	0.48	1.50	-0.0880	0.0462	0.6039	0.1039
Credit Score Spline 4	0.75	0.78	1.4236	0.3002	-15.2608	1.5326	harp			-0.7331	0.0159	0.3961	0.0414
Credit Score Spline 5	0.78	0.85	-0.1768	0.3017	-7.4299	1.9045	Condominium			0.0135	0.0048	-0.0511	0.0139
Refi_Burnout_10			4.3507	0.1536	0.0000	(omitted)	Manufactured home			-0.6926	0.0204	0.0436	0.0359
Refi_Burnout_20			4.2089	0.1519	0.0000	(omitted)	Second home			-0.1596	0.0070	-0.0791	0.0234
Refi_Burnout_30			4.8886	0.1741	0.0000	(omitted)	Third party origination			0.0632	0.0026	0.1712	0.0078
Refi_Burnout_40			5.3091	0.2039	0.0000	(omitted)	One borrower			-0.0895	0.0026	0.5220	0.0085
Refi_Burnout_50			5.0900	0.1551	0.0000	(omitted)	Mult units			-0.3957	0.0085	0.0432	0.0223
Refi_Burnout_11			3.0564	0.0862	0.0000	(omitted)	Investment Property			-0.2993	0.0060	0.0813	0.0157
Refi_Burnout_21			7.5988	0.4318	0.0000	(omitted)	ltv_sub11			0.0000	(omitted)	0.0000	(omitted)
Refi_Burnout_31			-1.6312	1.0324	0.0000	(omitted)	ltv_sub12			0.0000	(omitted)	0.0000	(omitted)
Refi_Burnout_41			-4.0902	1.4226	0.0000	(omitted)	ltv_sub13			0.0000	(omitted)	0.0000	(omitted)
Refi_Burnout_12			5.2149	0.0806	0.0000	(omitted)	ltv_sub14			0.0430	0.0567	-0.4685	0.5790
Refi_Burnout_22			4.1306	0.2971	0.0000	(omitted)	ltv_sub21			0.0580	0.0574	-0.4535	0.5789
Refi_Burnout_32			13.3729	0.5119	0.0000	(omitted)	ltv_sub22			-0.0942	0.0314	0.5802	0.1764
Refi_Burnout_42			9.3706	0.4448	0.0000	(omitted)	ltv_sub23			0.0597	0.0239	0.0212	0.1214
Refi_Burnout_52			3.8816	0.4499	0.0000	(omitted)	ltv_sub24			-0.0103	0.0225	0.1231	0.1114
Refi_Burnout_13			8.8929	0.1999	0.0000	(omitted)	ltv_sub31			-0.0302	0.0118	0.3571	0.0520
Refi_Burnout_23			3.5256	0.3003	0.0000	(omitted)	ltv_sub32			0.0324	0.0157	-0.0652	0.0472
Refi_Burnout_33			-10.3720	0.4323	0.0000	(omitted)	ltv_sub33			0.0080	0.0123	0.0104	0.0345
Refi_Burnout_43			-4.0643	0.4821	0.0000	(omitted)	ltv_sub34			-0.0806	0.0062	0.3019	0.0136
Refi_Burnout_53			2.1981	0.3695	0.0000	(omitted)							

FHFA Mortgage Analytics Platform

Performing Loan Equation
Fannie Mae Fixed Rate 15 Year

Variables	Spline Interval		Prepay Coef.	SE	Default Coef.	SE
	Min	Max				
Age Spline 1	0	2	0.8637	0.0327	0.0000	(omitted)
Age Spline 2	2	4	0.4661	0.0088	0.7966	0.0636
Age Spline 3	4	12	0.0729	0.0011	0.0778	0.0081
Age Spline 4	12	20	0.0274	0.0009	0.0718	0.0061
Age Spline 5	20	28	-0.0012	0.0010	0.0439	0.0062
Age Spline 6	28	30	-0.0055	0.0048	0.0033	0.0280
Age Spline 7	30	34	-0.0307	0.0028	-0.0025	0.0154
Age Spline 8	34	40	-0.0116	0.0016	0.0162	0.0085
Age Spline 9	40	52	-0.0202	0.0008	0.0096	0.0040
Age Spline 10	52	60	-0.0175	0.0016	0.0118	0.0068
Age Spline 11	60	63	-0.0225	0.0049	-0.0019	0.0204
Age Spline 12	63	69	-0.0066	0.0027	0.0135	0.0108
Age Spline 13	69	75	0.0042	0.0024	0.0161	0.0095
Age Spline 14	75	83	-0.0101	0.0014	0.0017	0.0060
Age Spline 15	83	109	0.0050	0.0004	0.0126	0.0018
Age Spline 16	109	118	-0.0244	0.0003	0.0194	0.0021
February			0.0055	0.0065	-0.1084	0.0313
March			0.1846	0.0062	-0.2469	0.0325
April			0.2123	0.0061	-0.2881	0.0330
May			0.1706	0.0062	-0.2430	0.0327
June			0.1998	0.0062	-0.2306	0.0326
July			0.2366	0.0061	-0.1749	0.0321
August			0.2394	0.0061	-0.2094	0.0323
September			0.1288	0.0063	-0.0944	0.0312
October			0.1847	0.0062	-0.1353	0.0315
November			0.1213	0.0063	0.1593	0.0292
December			0.1543	0.0062	0.0049	0.0302
Cohort 1997			-8.4858	0.0921	-6.4327	0.3662
Cohort 1998			-8.5011	0.0834	-6.8142	0.3115
Cohort 1999			-8.3020	0.0825	-6.0362	0.2694
Cohort 2000			-7.4624	0.0807	-5.1304	0.2441
Cohort 2001			-7.8672	0.0804	-5.5249	0.2414
Cohort 2002			-8.0727	0.0803	-5.6637	0.2408
Cohort 2003			-8.5200	0.0804	-5.7828	0.2409
Cohort 2004			-8.4544	0.0804	-5.5631	0.2409
Cohort 2005			-8.4124	0.0805	-5.5892	0.2411
Cohort 2006			-8.1837	0.0806	-5.5082	0.2420
Cohort 2007			-8.0949	0.0807	-5.4510	0.2425
Cohort 2008			-8.0322	0.0807	-5.4505	0.2429
Cohort 2009			-8.3642	0.0807	-6.2013	0.2461
Cohort 2010			-8.5239	0.0806	-6.3510	0.2473
Cohort 2011			-8.8115	0.0807	-6.3081	0.2488
Cohort 2012			-9.5031	0.0808	-6.4619	0.2508
Cohort 2013			-9.8731	0.0817	-6.3476	0.2571
Swap spread			-0.2972	0.0020	0.0000	(omitted)
HARP loan			-0.3467	0.0178	0.1977	0.0848
Rate refi loan			0.0007	0.0042	0.2851	0.0256
Cash out loan			0.0366	0.0042	0.4783	0.0244
Mult units			-0.3315	0.0083	0.0505	0.0371
Condominium			0.0769	0.0053	-0.0324	0.0320
Manufactured home			-0.4220	0.0174	-0.2245	0.0505
Investment property			-0.1518	0.0061	0.0408	0.0265
Second home			-0.0524	0.0070	-0.1032	0.0459
Third-party origination			0.0838	0.0025	0.1547	0.0137
One borrower			-0.0294	0.0025	0.5638	0.0142

Performing Loan Equation
Fannie Mae Fixed Rate 15 Year

Variables	Spline Interval		Prepay Coef.	SE	Default Coef.	SE
	Min	Max				
Orig. LTV Spline 1	0.00	0.47	2.9058	0.0271	-1.5755	0.2525
Orig. LTV Spline 2	0.47	0.63	0.5394	0.0346	-0.6098	0.2247
Orig. LTV Spline 3	0.63	0.75	1.3755	0.0421	0.4333	0.2155
Orig. LTV Spline 4	0.75	1.20	1.3033	0.0426	-0.5485	0.1508
ltv_sub12			0.0261	0.0262	0.0656	0.2706
ltv_sub13			-0.0124	0.0269	0.0668	0.2805
ltv_sub14			-0.0528	0.0156	0.1777	0.1407
ltv_sub22			0.0811	0.0134	-0.0451	0.1079
ltv_sub23			0.0591	0.0130	0.1322	0.0990
ltv_sub24			0.0024	0.0072	0.1064	0.0521
ltv_sub32			0.0875	0.0131	-0.0512	0.0722
ltv_sub33			0.0751	0.0120	0.0324	0.0680
ltv_sub34			0.0463	0.0088	0.2577	0.0430
Credit Score Spline 1	0.000	0.703	0.7792	0.0686	-10.1902	0.1819
Credit Score Spline 2	0.703	0.743	1.6192	0.1948	-13.4062	1.2529
Credit Score Spline 3	0.743	0.771	2.2224	0.2879	-17.8375	2.6584
Credit Score Spline 4	0.771	0.792	1.3189	0.3677	-17.6913	4.5800
Credit Score Spline 5	0.792	0.850	-0.8578	0.4406	0.0034	6.2063
Credit Equity_11			-8.2051	0.0450	5.7162	0.3414
Credit Equity_12			2.1454	0.1015	4.6909	0.3841
Credit Equity_13			-1.4440	0.0923	3.8774	0.3110
Credit Equity_14			-1.8251	0.0737	2.8767	0.2294
Credit Equity_15			-3.2974	0.0864	2.4404	0.1346
Credit Equity_21			-8.3742	0.0404	5.1350	0.3652
Credit Equity_22			2.0645	0.1054	4.7925	0.6618
Credit Equity_23			-1.6964	0.1022	4.1597	0.5886
Credit Equity_24			-1.1564	0.0828	1.8761	0.4272
Credit Equity_25			-2.8821	0.0948	3.6964	0.2049
Credit Equity_31			-8.6366	0.0383	5.4047	0.4149
Credit Equity_32			2.2246	0.1067	3.7262	0.9126
Credit Equity_33			-1.5436	0.1067	3.9437	0.8690
Credit Equity_34			-0.9081	0.0883	2.0162	0.6308
Credit Equity_35			-2.8329	0.1039	4.7878	0.2555
Credit Equity_41			-8.9831	0.0385	4.6513	0.5137
Credit Equity_42			2.5756	0.1052	5.1661	1.2307
Credit Equity_43			-1.6706	0.1078	3.8549	1.1915
Credit Equity_44			-0.6668	0.0910	2.7292	0.8663
Credit Equity_45			-2.5600	0.1082	4.3512	0.3728
Credit Equity_51			-9.1308	0.0480	4.6898	0.6938
Credit Equity_52			2.5064	0.1333	4.6471	1.8153
Credit Equity_53			-1.8169	0.1360	1.4727	1.8664
Credit Equity_54			-0.4667	0.1132	4.2323	1.3646
Credit Equity_55			-2.3739	0.1287	2.9961	0.6575
Orig UPB Spline 1	0	79	0.0065	0.0002	-0.0070	0.0007
Orig UPB Spline 2	79	117	0.0042	0.0001	-0.0033	0.0007
Orig UPB Spline 3	117	172	0.0042	0.0001	0.0009	0.0005
Orig UPB Spline 4	172	417	0.0021	0.0000	0.0008	0.0002
SATO Spline 1	-8.0	-0.5	0.3369	0.0045	0.3054	0.0259
SATO Spline 2	-0.5	4.0	0.1989	0.0041	0.1243	0.0120
DTI Spline 1	0.00	0.20	-0.2666	0.0547	-0.2623	0.4019
DTI Spline 2	0.20	0.29	0.1477	0.0548	1.6276	0.3525
DTI Spline 3	0.29	0.39	-0.0127	0.0472	2.5019	0.2480
DTI Spline 4	0.39	0.43	-0.0780	0.0262	0.5790	0.1120
Unemp Rate Spline 1	0.00	5.10	-0.0156	0.0040	0.0571	0.0265
Unemp Rate Spline 2	5.10	6.30	0.1571	0.0042	0.1301	0.0261
Unemp Rate Spline 3	6.30	8.00	0.0199	0.0030	0.2567	0.0167
Unemp Rate Spline 4	8.00	11.00	-0.0428	0.0015	0.0400	0.0059

FHFA Mortgage Analytics Platform

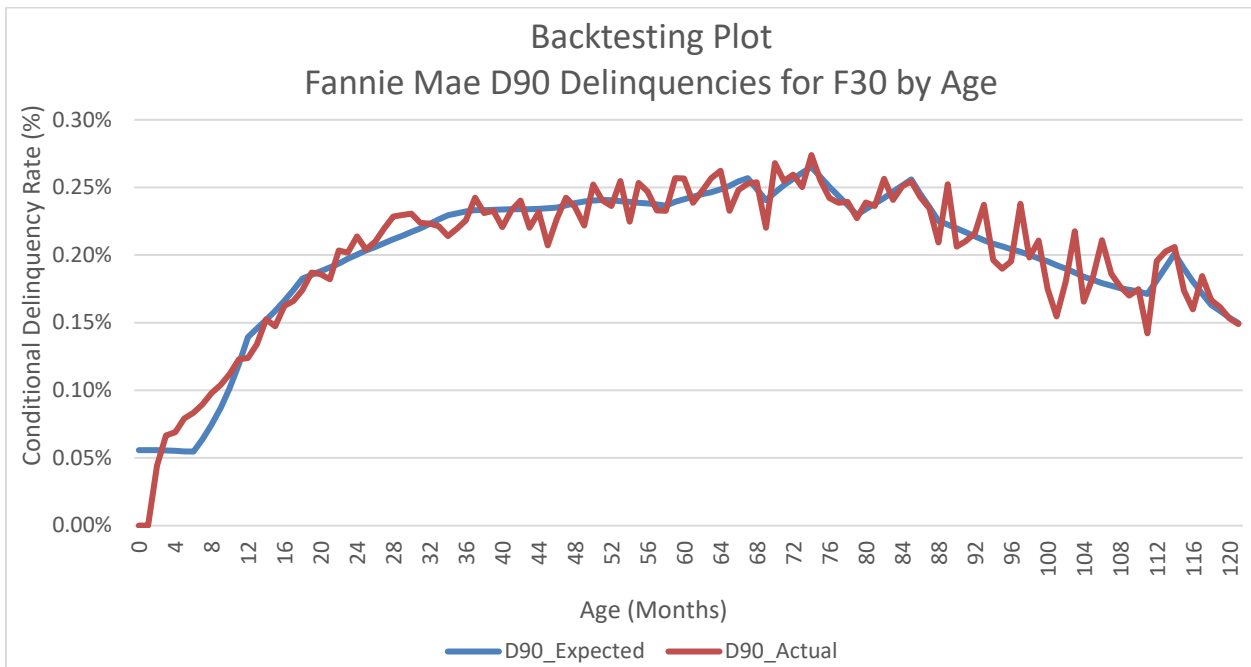
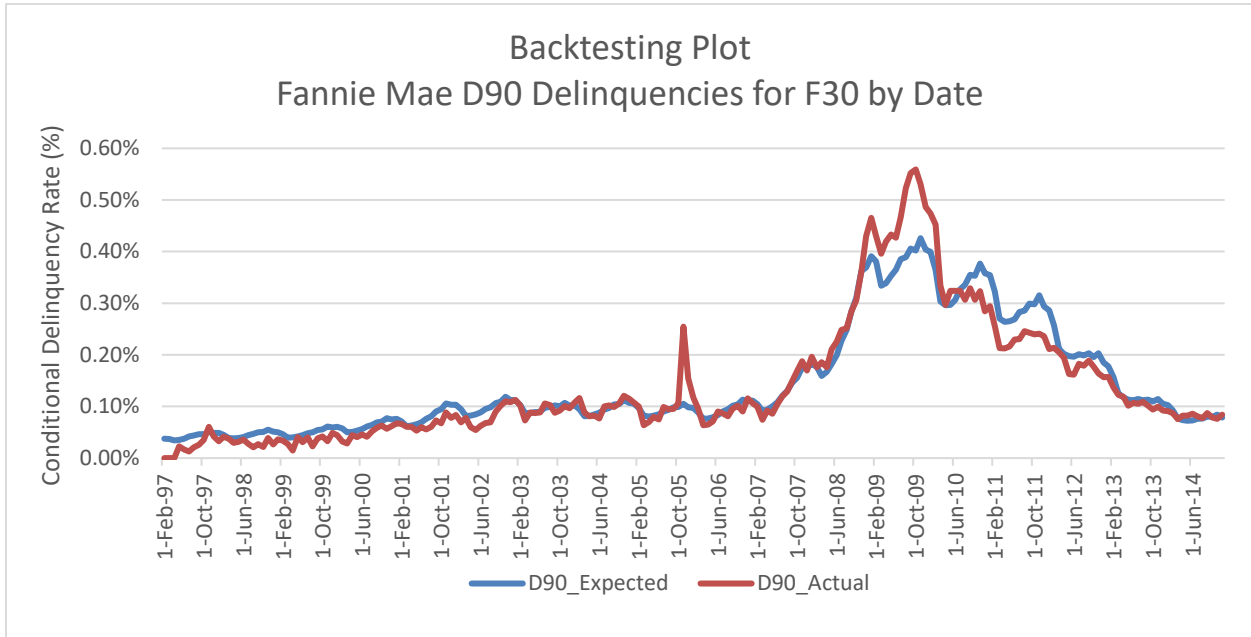
Performing Loan Equation
Fannie Mae 5/1 ARM

Variables	Spline Interval		Prepay Coef.	SE	Default	
	Min	Max			Coef.	SE
Age Spline 1	0	2	0.5765	0.0210	0.0000	(omitted)
Age Spline 2	2	4	0.3891	0.0065	1.1391	0.0402
Age Spline 3	4	12	0.0661	0.0009	0.1140	0.0035
Age Spline 4	12	20	-0.0016	0.0008	0.0516	0.0023
Age Spline 5	20	28	0.0016	0.0009	0.0034	0.0023
Age Spline 6	28	30	-0.0342	0.0046	-0.0094	0.0101
Age Spline 7	30	34	0.0089	0.0026	-0.0061	0.0054
Age Spline 8	34	40	-0.0095	0.0015	-0.0107	0.0030
Age Spline 9	40	52	0.0125	0.0007	-0.0046	0.0014
Age Spline 10	52	60	0.0763	0.0012	0.0001	0.0025
Age Spline 11	60	63	-0.3269	0.0044	-0.0955	0.0086
Age Spline 12	63	69	-0.0245	0.0030	-0.0367	0.0053
Age Spline 13	69	75	-0.0824	0.0032	-0.0095	0.0053
Age Spline 14	75	83	0.0053	0.0022	-0.0079	0.0037
Age Spline 15	83	109	0.0021	0.0006	0.0095	0.0013
Age Spline 16	109	118	-0.0205	0.0007	0.0221	0.0020
February			0.0810	0.0063	-0.0377	0.0134
March			0.2600	0.0061	-0.1358	0.0138
April			0.2741	0.0061	-0.0974	0.0137
May			0.2894	0.0060	-0.1276	0.0139
June			0.3362	0.0060	-0.0931	0.0138
July			0.3065	0.0060	-0.1067	0.0138
August			0.3113	0.0060	-0.0897	0.0137
September			0.1616	0.0062	-0.0488	0.0135
October			0.1954	0.0062	-0.0187	0.0134
November			0.0996	0.0063	-0.0087	0.0133
December			0.1665	0.0062	-0.0087	0.0133
Cohort 1997			-8.3173	0.0730	-11.8978	0.2106
Cohort 1998			-8.2103	0.0714	-11.8468	0.1938
Cohort 1999			-7.7503	0.0704	-11.5993	0.1848
Cohort 2000			-6.9945	0.0701	-11.3916	0.1805
Cohort 2001			-7.1560	0.0701	-11.5580	0.1766
Cohort 2002			-7.2516	0.0698	-11.3474	0.1704
Cohort 2003			-7.7267	0.0698	-10.9851	0.1690
Cohort 2004			-7.8397	0.0698	-10.7211	0.1686
Cohort 2005			-7.9523	0.0698	-10.7077	0.1685
Cohort 2006			-7.8338	0.0700	-10.5751	0.1685
Cohort 2007			-7.8618	0.0702	-10.5467	0.1687
Cohort 2008			-7.6906	0.0702	-10.8463	0.1692
Cohort 2009			-7.8436	0.0703	-12.0809	0.1753
Cohort 2010			-7.8094	0.0701	-12.1911	0.1739
Cohort 2011			-7.8362	0.0702	-12.2972	0.1806
Cohort 2012			-8.1843	0.0707	-12.8207	0.2266
Cohort 2013			-8.2205	0.0730	-12.5747	0.3345
swap_spread			-0.1781	0.0019	0.0000	(omitted)
HARP loan			-0.6215	0.0203	0.5382	0.0597
Rate refi loan			0.0247	0.0032	0.1941	0.0082
Cash out loan			-0.0290	0.0036	0.1701	0.0087
Mult units			-0.3044	0.0096	0.0540	0.0172
Condominium			-0.0515	0.0033	-0.1657	0.0074
Manufactured home			-0.5036	0.0458	0.8917	0.1004
Investment property			-0.3898	0.0055	-0.0778	0.0104
Second home			-0.2728	0.0052	-0.0629	0.0113
Third-party origination			0.0490	0.0024	0.0541	0.0058
One borrower			-0.0763	0.0025	0.5004	0.0069

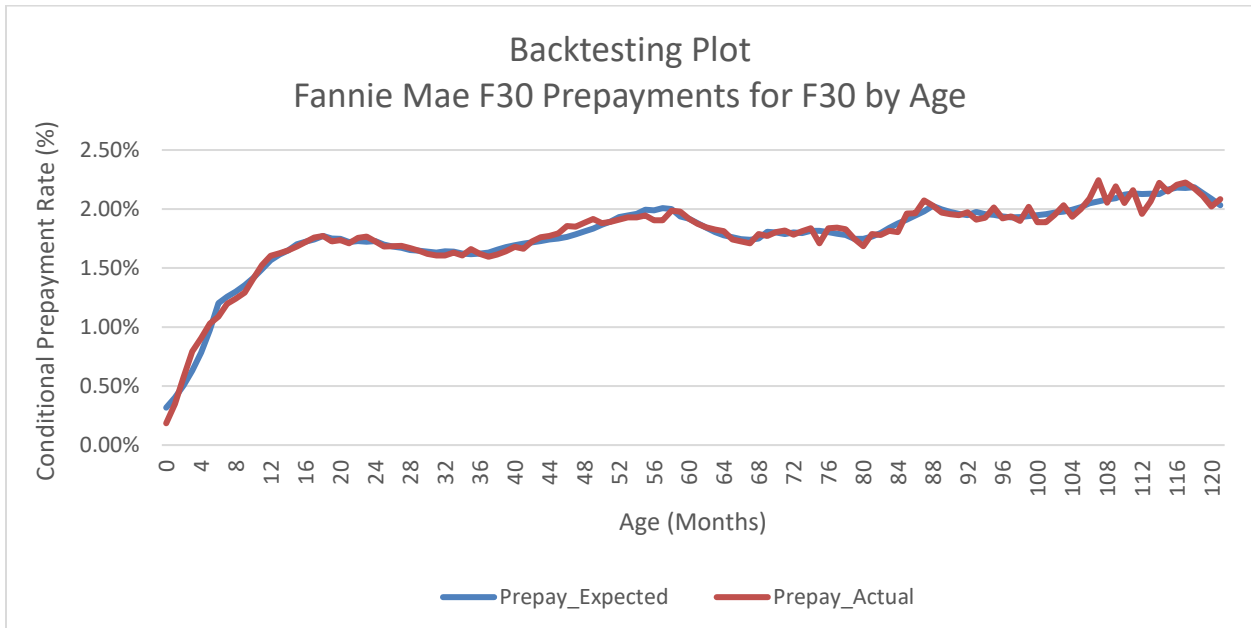
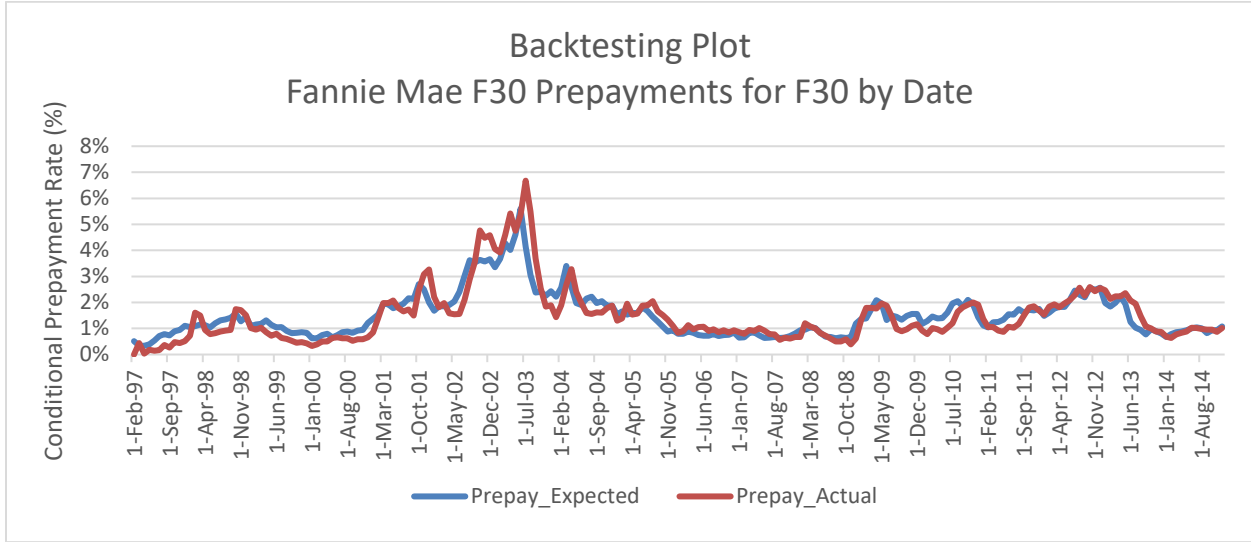
Performing Loan Equation
Fannie Mae 5/1 ARM

Variables	Spline Interval		Prepay Coef.	SE	Default	
	Min	Max			Coef.	SE
Orig. LTV Spline 1	0.00	0.66	1.3918	0.0209	0.6579	0.1250
Orig. LTV Spline 2	0.66	0.79	1.7197	0.0450	0.5490	0.1324
Orig. LTV Spline 3	0.79	1.00	1.6300	0.4428	5.4120	1.1027
Orig. LTV Spline 4	1.00	1.20	2.7891	0.0350	0.0688	0.0629
ltv_sub12			-0.0210	0.0417	0.3814	0.3808
ltv_sub13			-0.0991	0.0432	-1.4093	1.0010
ltv_sub14			-0.0431	0.0240	0.1301	0.2397
ltv_sub22			-0.0020	0.0199	0.0252	0.1144
ltv_sub23			-0.0467	0.0195	0.0944	0.0954
ltv_sub24			-0.0640	0.0097	0.6101	0.0403
ltv_sub32			-0.0076	0.0128	0.0548	0.0315
ltv_sub33			-0.0115	0.0097	0.0363	0.0200
ltv_sub34			-0.1180	0.0042	0.3652	0.0077
Credit Score Spline 1	0.000	0.698	0.8122	0.0788	-4.1889	0.1443
Credit Score Spline 2	0.698	0.730	1.5246	0.2693	-6.5618	0.6007
Credit Score Spline 3	0.730	0.758	2.1605	0.2910	-11.2948	0.8235
Credit Score Spline 4	0.758	0.784	0.6362	0.2922	-11.4919	1.0668
Credit Score Spline 5	0.784	0.850	-0.3793	0.3122	-4.9560	1.4688
Credit Equity_11			-1.3350	0.0272	3.3291	0.1695
Credit Equity_12			-2.2822	0.0757	1.6853	0.2664
Credit Equity_13			-4.6631	0.1132	1.8870	0.2862
Credit Equity_14			-4.9799	0.1060	3.5332	0.1524
Credit Equity_15			-4.7748	0.0788	0.9122	0.0286
Credit Equity_21			-1.4961	0.0249	2.4533	0.1763
Credit Equity_22			-1.5574	0.0849	3.2200	0.4090
Credit Equity_23			-4.5710	0.1272	3.7937	0.4120
Credit Equity_24			-4.7706	0.1180	5.0224	0.1968
Credit Equity_25			-4.2162	0.0759	1.0402	0.0317
Credit Equity_31			-1.5689	0.0232	1.9670	0.1841
Credit Equity_32			-1.4725	0.0831	5.1743	0.5105
Credit Equity_33			-4.2828	0.1262	1.3967	0.5089
Credit Equity_34			-4.0962	0.1165	9.5242	0.2280
Credit Equity_35			-3.8679	0.0728	0.2181	0.0091
Credit Equity_41			-1.7039	0.0223	1.6767	0.1961
Credit Equity_42			-1.2440	0.0806	5.1347	0.6308
Credit Equity_43			-3.5960	0.1262	2.5210	0.6665
Credit Equity_44			-3.4585	0.1158	7.6503	0.3152
Credit Equity_45			-3.5417	0.0686	1.5105	0.0419
Credit Equity_51			-1.8622	0.0246	1.2863	0.2266
Credit Equity_52			-0.7924	0.0988	5.6263	0.9232
Credit Equity_53			-2.5188	0.1596	2.5757	1.0390
Credit Equity_54			-2.9628	0.1440	8.4677	0.4951
Credit Equity_55			-3.1474	0.0807	1.5820	0.0627
Orig UPB Spline 1	0	132	0.0041	0.0001	0.0001	0.0003
Orig UPB Spline 2	132	191	0.0019	0.0001	0.0031	0.0002
Orig UPB Spline 3	191	270	0.0010	0.0001	0.0026	0.0001
Orig UPB Spline 4	270	417	0.0010	0.0000	0.0005	0.0001
SATO Spline 1	-8.00	-0.65	0.3211	0.0035	0.2693	0.0134
SATO Spline 2	-0.65	4.00	0.2407	0.0036	0.4636	0.0049
DTI Spline 1	0.00	0.25	0.4075	0.0369	0.6765	0.1523
DTI Spline 2	0.25	0.34	-0.0810	0.0522	2.0047	0.1501
DTI Spline 3	0.34	0.43	-0.4577	0.0516	1.3809	0.1112
DTI Spline 4	0.43	0.45	-0.0175	0.0318	-0.0445	0.0720
Unemp Rate Spline 1	0.0	4.9	0.0069	0.0035	0.0856	0.0151
Unemp Rate Spline 2	4.9	6.1	0.1036	0.0040	0.3353	0.0137
Unemp Rate Spline 3	6.1	8.2	0.0120	0.0027	0.2453	0.0063
Unemp Rate Spline 4	8.2	11.0	0.0303	0.0018	0.0828	0.0026

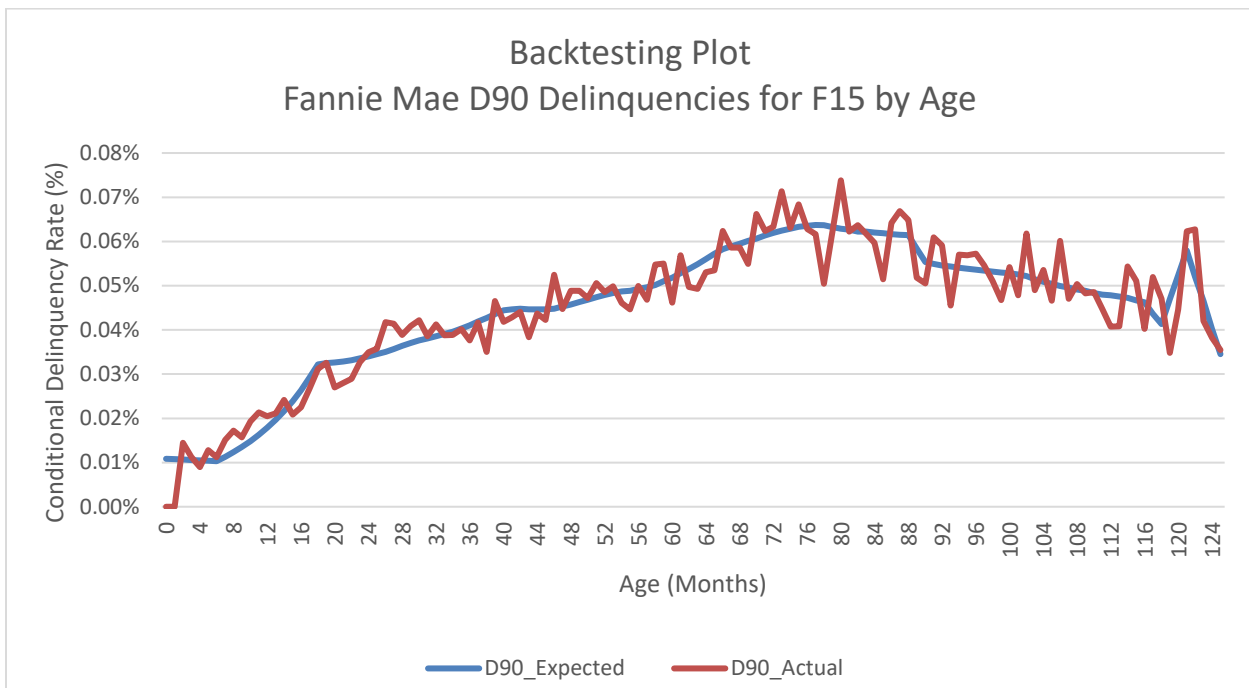
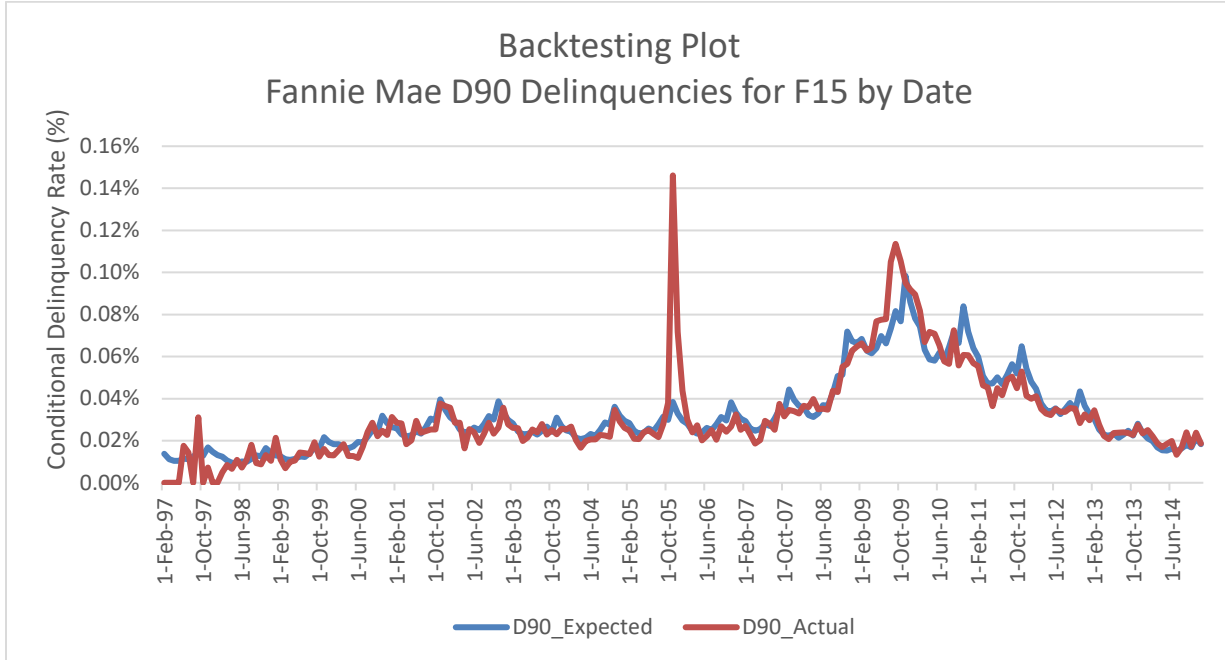
12. Appendix C: Back-Testing Plots



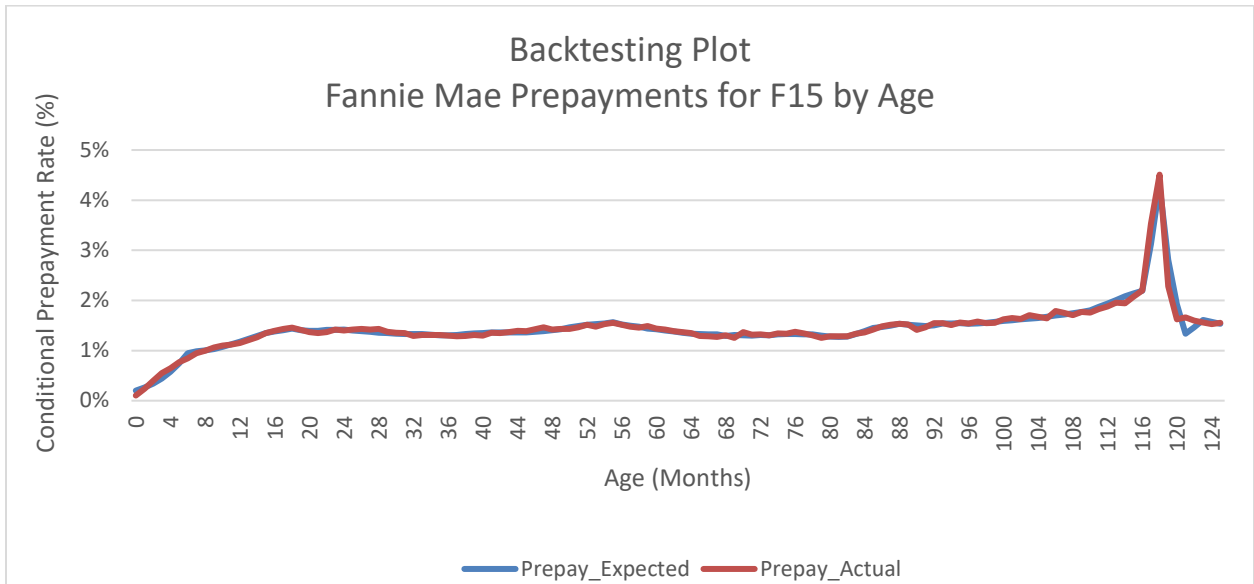
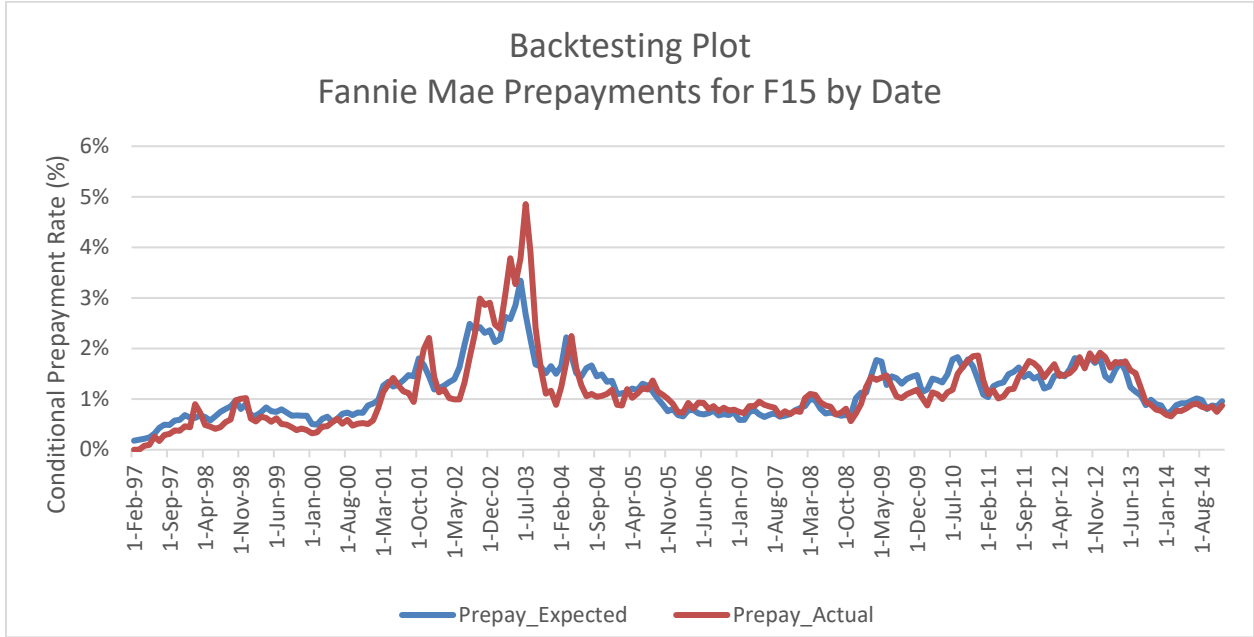
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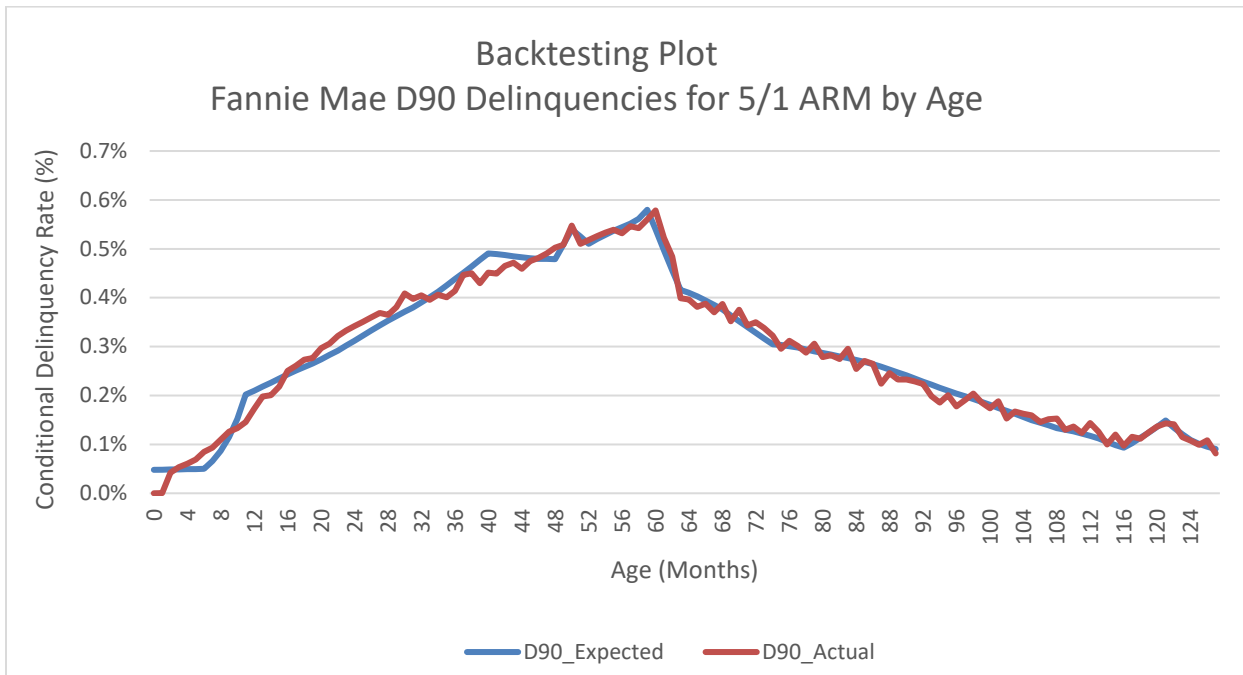
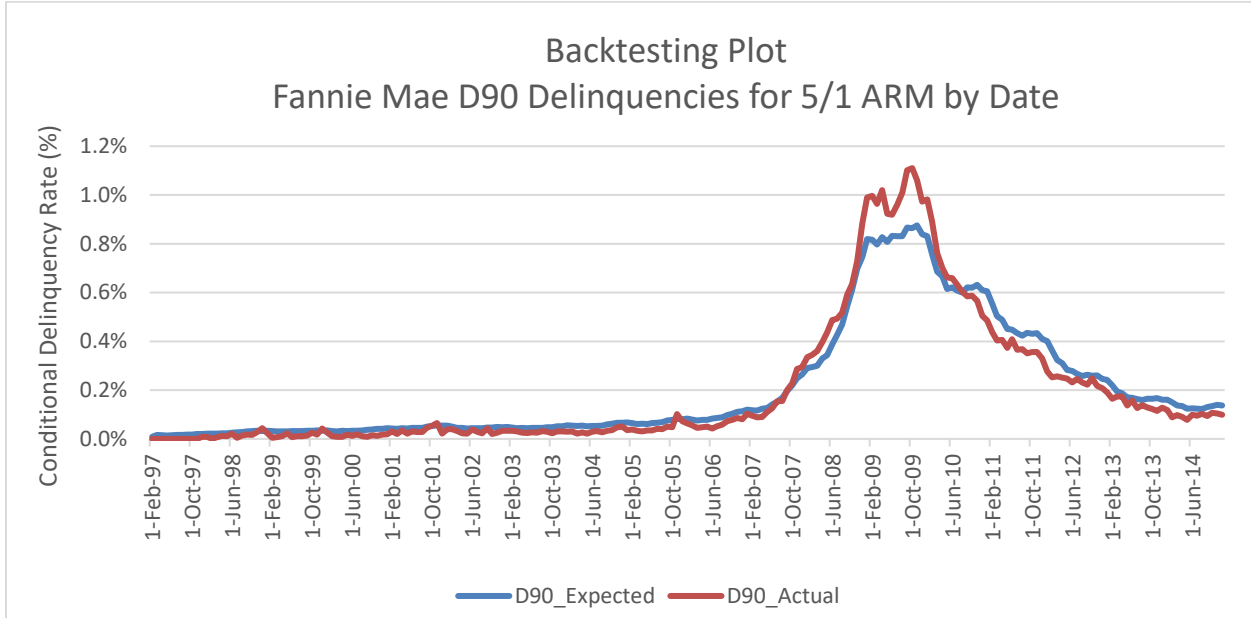
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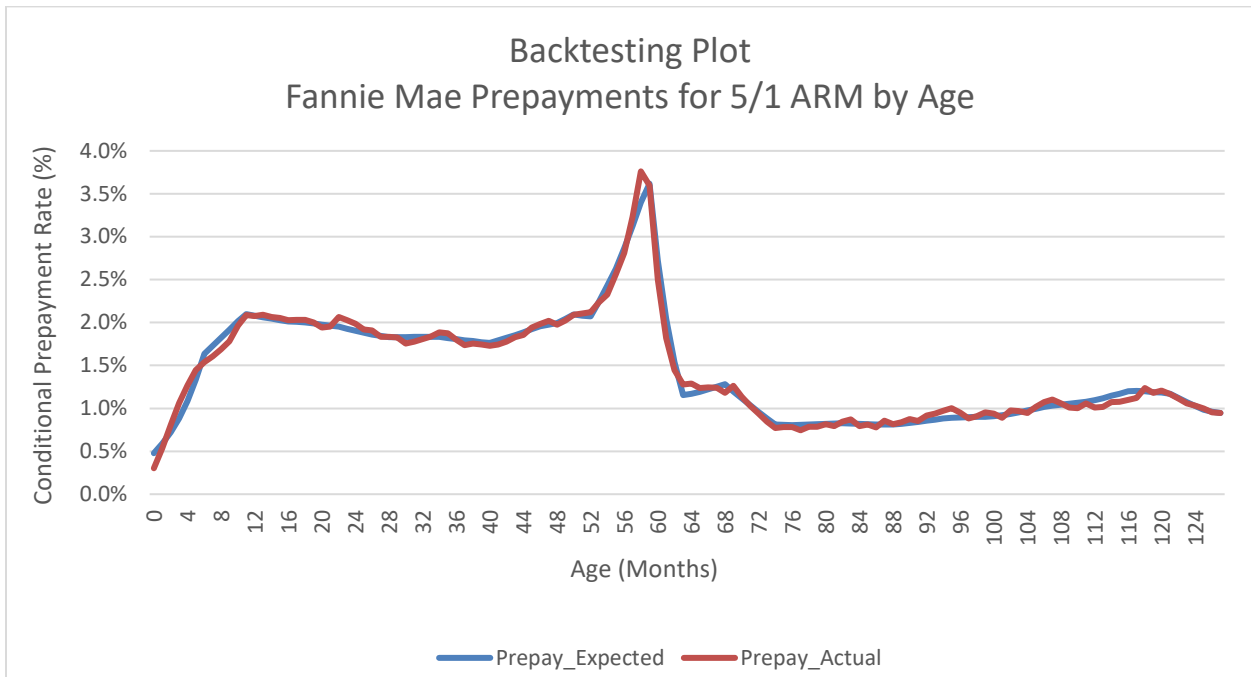
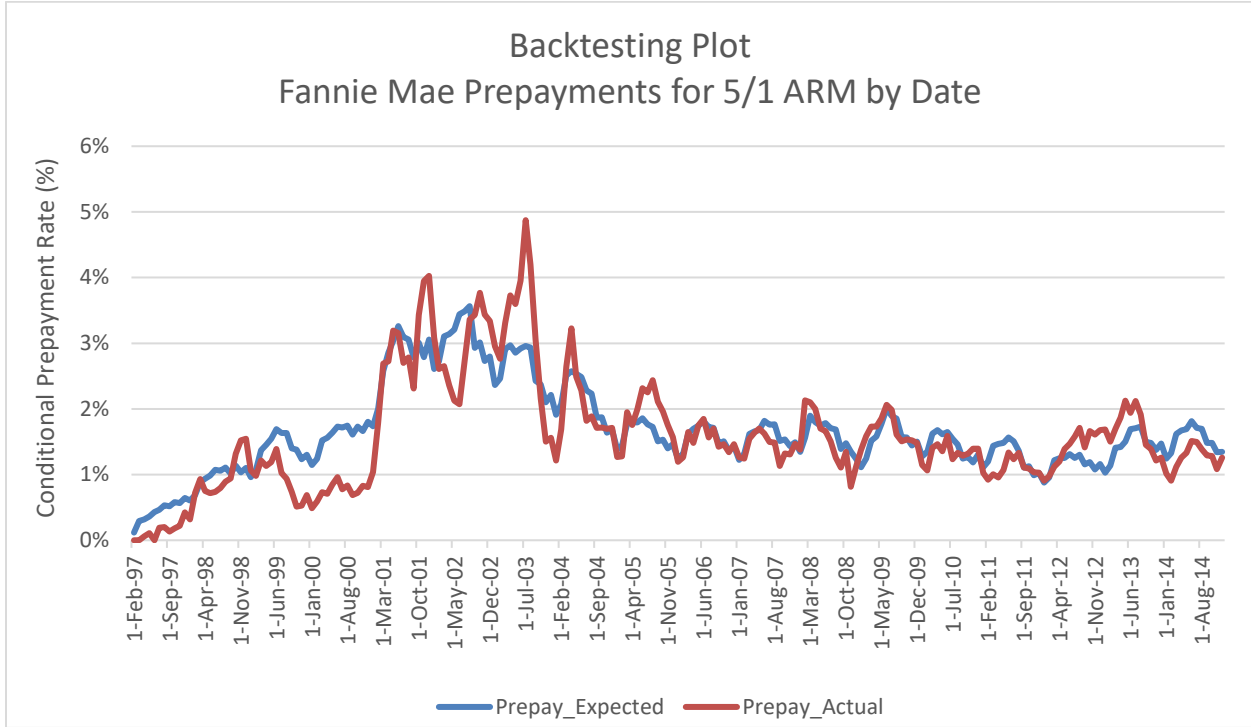
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13. *Appendix D.1: The Enterprises' MI Company Credit Rating Description*

Counterparty Rating	Description
1	The counterparty is exceptionally strong financially. The counterparty is expected to meet its obligations under foreseeable adverse events.
2	The counterparty is very strong financially. There is negligible risk the counterparty may not be able to meet all of its obligations under foreseeable adverse events.
3	The counterparty is strong financially. There is a slight risk the counterparty may not be able to meet all of its obligations under foreseeable adverse events.
4	The counterparty is financially adequate. Foreseeable adverse events will have a greater impact on '4' rated counterparties than higher rated counterparties.
5	The counterparty is financially questionable. The counterparty may not meet its obligations under foreseeable adverse events.
6	The counterparty is financially weak. The counterparty is not expected to meet its obligations under foreseeable adverse events.
7	The counterparty is financially extremely weak. The counterparty's ability to meet its obligations is questionable.
8	The counterparty is in default on an obligation or is under regulatory supervision.

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14. Appendix D.2: MI Haircut Percentages

MI Company Rating	Concentration Risk: Not High			Concentration Risk: High		
	New Originations, Performing Seasoned, and Reperforming Loans		Non- Performing Loans	New Originations, Performing Seasoned, and Reperforming Loans		Non- Performing Loans
	30 Yr Product	20/15 Yr Product		30 Yr Product	20/15 Yr Product	
1	1.8%	1.3%	0.6%	2.8%	2.0%	0.9%
2	4.5%	3.5%	2.0%	7.3%	5.6%	3.2%
3	5.2%	4.0%	2.4%	8.3%	6.4%	3.9%
4	11.4%	9.5%	6.9%	17.2%	14.3%	10.4%
5	14.8%	12.7%	9.9%	20.9%	18.0%	14.0%
6	21.2%	19.1%	16.4%	26.8%	24.2%	20.8%
7	40.0%	38.2%	35.7%	43.7%	41.7%	39.0%
8	47.6%	46.6%	45.3%	47.6%	46.6%	45.3%

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15. Appendix E: Non-Performing Loan Equation

Parameters

Non-Performing Loan Equations

Multinomial Logit Lifetime Loan Resolutions with Foreclosure Complete as the Control

Variable	Spline Interval		Prepayment			Foreclosure Alternative			Reperformance		
	min	max	Coef.	Std. Err.	z	Coef.	Std. Err.	z	Coef.	Std. Err.	z
Constant			6.8012	0.0817	83.24	-7.1386	0.1800	-39.7	1.9469	0.1290	15.1
Credit Score Spline 1	0	0.623	-3.3696	0.1256	-26.83	3.1252	0.2491	12.55	0.7523	0.2010	3.74
Credit Score Spline 2	0.62	0.661	-8.5704	0.2718	-31.53	0.9142	0.4070	2.25	-6.7018	0.3919	-17.1
Credit Score Spline 3	0.66	0.703	-2.9533	0.2735	-10.8	3.0389	0.3247	9.36	-3.6828	0.3791	-9.71
Credit Score Spline 4	0.7	0.75	0.6599	0.2999	2.2	4.6398	0.2941	15.77	-1.0831	0.4032	-2.69
Credit Score Spline 5	0.75	0.85	5.7309	0.4614	12.42	5.2081	0.4209	12.37	1.8918	0.6039	3.13
Non Owner Occupied			-0.3727	0.0097	-38.48	-0.1870	0.0097	-19.4	-0.4872	0.0139	-34.97
Condominium Structure			0.0951	0.0102	9.32	0.1269	0.0098	12.9	-0.1908	0.0150	-12.72
Manufactured Housing			-0.4123	0.0228	-18.12	-0.5082	0.0409	-12.4	-0.0523	0.0296	-1.77
Planned Urban Dev.			-0.0620	0.0093	-6.64	0.1629	0.0089	18.34	-0.0823	0.0133	-6.2
Judicial State			0.3835	0.0056	68.62	0.5306	0.0074	72.1	0.4851	0.0080	61
MI Coverage % Spline 1	0	0.25	1.0543	0.0309	34.1	-2.3442	0.0398	-58.8	0.1733	0.0466	3.72
MI Coverage % Spline 2	0.25	0.7	-1.8812	0.1211	-15.54	0.0924	0.1711	0.54	-0.5262	0.1933	-2.72
MTM LTV @ F90 Spline 1	0	0.68	-6.0206	0.0418	-143.9	2.2740	0.1348	16.87	-5.5332	0.0503	-110.1
MTM LTV @ F90 Spline 2	0.68	0.82	-5.8659	0.0687	-85.36	3.0179	0.1201	25.13	-5.5557	0.0996	-55.76
MTM LTV @ F90 Spline 3	0.82	0.99	-5.7765	0.0747	-77.31	0.9289	0.0715	12.99	-4.0467	0.1025	-39.47
MTM LTV @ F90 Spline 4	0.99	1.2	-0.5050	0.0581	-8.69	1.5465	0.0284	54.47	-1.7260	0.0686	-25.16
Unemployment Spline 1	0	5.5	-0.1839	0.0047	-38.87	-0.0150	0.0103	-1.46	-0.1296	0.0081	-16.01
Unemployment Spline 2	5.5	7.8	-0.2614	0.0048	-54.54	0.1337	0.0067	19.87	0.2916	0.0068	42.77
Unemployment Spline 3	7.8	10.3	-0.1101	0.0055	-19.87	0.1713	0.0050	34.49	0.1439	0.0062	23.17
Unemployment Spline 4	10.3	14	0.0459	0.0075	6.13	0.1107	0.0047	23.32	0.1886	0.0066	28.44
Orig. UPB Spline 1	0	94	0.0083	0.0002	40.84	0.0094	0.0005	19.81	0.0067	0.0003	23.02
Orig. UPB Spline 2	94	150	0.0029	0.0002	15.77	0.0090	0.0003	31.81	0.0003	0.0003	1.2
Orig. UPB Spline 3	150	232	-0.0031	0.0002	-20.72	0.0044	0.0002	29.05	-0.0013	0.0002	-6.12
Orig. UPB Spline 4	232	360	0.0005	0.0001	4.75	0.0024	0.0001	29.56	0.0003	0.0001	2.08