Fiscal Year 2022 Independent Actuarial Review

of

Mutual Mortgage Insurance Fund Economic Value of Forward Mortgage Insurance-In-Force

November 14, 2022

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November 14, 2022

The Honorable Julia Gordon
Assistant Secretary for Housing and Federal Housing Commissioner
U.S. Department of Housing and Urban Development (HUD)
451 Seventh Street, S.W., Room 9100
Washington, D.C. 20410

Contract: Fiscal Year 2022 Actuarial Studies of The FHA Mutual Mortgage Insurance Fund.

Dear Ms. Gordon:

RMA Associates, LLC (RMA) is pleased to submit this report as required by Task 1 of the engagement for Independent Actuarial Studies of The FHA Mutual Mortgage Insurance Fund on Economic Value of Forward Mortgage Insurance-In-Force, under contract number 86615722C00009.

This report is prepared based on data as of September 30, 2022, to provide an estimate of the Economic Net Worth and the details of the Cash Flow Net Present Value (Cash Flow NPV) of the Mutual Mortgage Insurance (MMI) Forward Loan portfolio as of the end of Fiscal Year 2022. Comparisons between this estimate and the corresponding estimate as of the end of Fiscal Year 2021, evaluation under various scenarios, and detailed information about the models used to develop the estimate are also included.

I, Roosevelt Mosley, Jr., FCAS, MAAA, CSPA, am responsible for the content and conclusions outlined in the report. I am a Fellow of the Casualty Actuarial Society and a Member of the American Academy of Actuaries. I am qualified to render the actuarial opinion contained herein under the qualification standards for actuaries issuing statements of actuarial opinion in the United States that are promulgated by the American Academy of Actuaries.

RMA remains available for any questions or comments you have regarding the report and its conclusions.

Respectfully,

Roosevelt Mosley, Jr., FCAS, MAAA, CSPA
Principal & Consulting Actuary

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Table of Contents

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Summary of Findings

RMA Associates, LLC teamed with Pinnacle Actuarial Resources, Inc. for this review. Hereinafter, the two entities are referred to as RMA. This report presents the results of RMA's independent actuarial review of the Economic Value associated with Forward mortgages insured by the Mutual Mortgage Insurance Fund (MMI or Fund) for Fiscal Year 2022.

The Economic Value associated with Home Equity Conversion Mortgages (HECM or HECM loans) are analyzed separately and are excluded from this report. In the remainder of this report, the term MMI refers to Forward mortgages and excludes HECM.

Below we summarize the findings associated with each of the required deliverables.

Deliverable 1: Produce a written Actuarial Study for Forward that provides actuarial central estimates of MMI Economic Net Worth as of the end of Fiscal Year 2022 and assesses HUD's estimates of Economic Net Worth.

The Economic Net Worth is defined as cash available to the Fund plus the Net Present Value (NPV) of all future cash outflows and inflows that are expected to result from the mortgages currently insured by the MMI.

As of the end of Fiscal Year 2022, RMA's Actuarial Central Estimate (ACE) of the MMI Forward Cash Flow NPV is positive **$46.764 billion**.

The total capital resource as reported in the Annual Report to Congress Regarding the Status of the FHA Mutual Mortgage Insurance Fund is positive $89.512 billion as of the end of Fiscal Year 2022. Thus, the ACE of the Economic Net Worth of the MMI is positive $136.276 billion. The total capital resource is comprised of two accounts: a financing account and a capital reserve account. The financing account covers the estimated losses over the life of the loan cohorts, and the capital reserve covers losses that exceed what is carried in the financing account.

Deliverable 2: Include a review of the risk characteristics of existing MMI loans including commentary on how such characteristics have changed in recent years.

A review of the risk characteristics of existing MMI loans, and a commentary on how these risk characteristics have changed, is included in Section 4.

Deliverable 3: Apply the final Forward actuarial model to the existing portfolio to produce conditional (and cumulative) claim, prepayment, and loss-given-default rates at various levels of aggregation across loans, and for individual policy years and policy year-quarter. Cash-flow summaries should also be provided for major categories (e.g., premium revenues, claim expenses and recoveries or net loss due to claims, with affected loan counts and balances).

Appendix G shows the interim and final claim rates, non-claim termination rates and loss severities by cohort. Each of these elements is calculated for each year of developed experience, and final projections are also included. Cash flow summaries by major category and credit subsidy cohort are shown below and discussed in more detail in Sections 2 and 3.

Table 1: Projected Cash Flow Summaries

Cash Flow Category	Net Present value of Cash Flow
Mortgage Insurance Premium	78,925,005,291
Loss Incurred	-15,456,171,448
Loss Mitigation Expense	-2,412,265,199
HAMP Expense	-52,577,632,209
HAMP Recovery	38,285,133,996

Deliverable 4: To promote transparency of the Studies' assessments, the Studies should identify methodological vulnerabilities that may occur in its actuarial models or in HUD's analyses of Economic Net Worth. This discussion should evaluate the scope and scale of such vulnerabilities in creating possible forecast risk and suggest possible lines of research in these areas. The Studies should assess and comment upon HUD's own models that estimate Economic Net Worth for methodological vulnerabilities and compare HUD's methodologies with those in the Studies.

The assumptions and judgments on which the Cash Flow NPV estimates are based are summarized in Section 5 of this report. Appendix B shows the specifications and assumptions related to the transition models. Appendix C details the loss severity models. Section 3 describes the economic assumptions incorporated into the Cash Flow NPV estimates and the sensitivity of the estimates to alternative economic scenarios. Section 5 and Appendix E summarize the assumptions associated with the cash flow analysis.

Section 3 provides a discussion of the economic conditions that could result in material adverse change to the Cash Flow NPV.

Appendix F provides a discussion of the HUD methodologies for estimating Economic Net Worth, a comparison of HUD modeling methodology to the methodology used in this study, and methodological vulnerabilities of the HUD models.

Deliverable 5: The Studies should include historical data on changes in program terms as well as relevant loan and borrower characteristics (e.g., credit scores, loan-to-value ratios) by cohort and other sub-populations. Loan performance data (claim rates, prepayment rates, severity, and recovery rates) both historical and projected shall be presented in the "finger-table" formats (arrayed by cohort and policy years for different loan products).

A review of the risk characteristics of existing MMI loans, and a commentary of how these risk characteristics have changed is included in Section 4. Appendix G shows the interim and final

claim rates, non-claim termination rates and loss severities by cohort. Each of these elements is calculated for each year of developed experience, and final projections are also included.

Deliverable 6: The Contractor should use the President's Economic Assumptions, provided by Office of Risk Management and Regulatory Affairs (ORMRA), for the actuarial central estimates of the Studies. However, in addition to the central single path economic forecast, the Studies shall test alternative economic forecasts for stress-testing and sensitivity analysis to estimate ranges of reasonableness.

RMA's ACE of Cash Flow NPV is based on the Economic Assumptions for the 2023 Budget from the Office of Management and Budget (OMB Economic Assumptions). RMA also estimated Cash Flow NPV outcomes based on economic scenarios from Moody's Analytics (Moody's). The Cash Flow NPV results based on these scenarios are shown in Table 2.

Table 2: Range of Cash Flow NPV Outcomes Based on OMB & Moody's Scenarios

Economic Scenario	Fiscal Year 2022 Cash Flow NPV
RMA ACE	46,764,070,430
Baseline	45,469,695,907
Alternative 0 - Upside (4th Percentile)	49,025,087,162
Alternative 1 - Upside (l0th Percentile)	48,628,309,202
Alternative 2 - Downside (75th Percentile)	42,809,775,044
Alternative 3 - Downside (90th Percentile)	36,040,380,940
Alternative 4 - Downside (96th Percentile)	27,873,038,828
Slower Trend Growth	41,135,631,895
Stagflation	28,917,834,850
Next-Cycle Recession	39,822,660,799
Low Oil Price	47,299,532,979

The range of results based on the Moody's estimates is positive $27.873 billion to positive $49.025 billion.

In addition, RMA has estimated a range of outcomes based on 100 randomly generated stochastic simulations of key economic variables. Based on these simulations, the range of Cash Flow NPV estimates is negative $15.899 billion to positive $52.604 billion.

The lower bound of the results from the 100 randomly generated scenarios is significantly lower than the results from any of the Moody's scenarios. This is because the scenarios are generated differently. The Moody's scenarios are based on expectations, where the higher percentiles represent scenarios closer to the worst case expected scenario. The 100 randomly generated scenarios are based on historical variation and are not related to expectations. Therefore, the simulated scenarios can represent more extreme scenarios than those developed by Moody's.

The Cash Flow NPV estimate provided by the Federal Housing Administration (FHA) to be used in the FHA's Annual Report to Congress is positive $37.089 billion. Based on RMA's ACE and range of reasonable estimates, we conclude that the FHA estimate of Cash Flow NPV to be used in the FHA's Annual Report to Congress is reasonable.

RMA's Cash Flow NPV by cohort is shown below for the largest negative outcome and the largest positive outcome based on the stochastic simulation results.

Table 3: Range of Cash Flow NPV Estimates - Forward Portfolio

Cohort	Largest Negative	Largest Positive	RMA ACE
1992	0	0	0
1993	-40,136	-56,937	-56,189
1994	-335,171	-489,730	-460,650
1995	-230,418	-995,866	-854,566
1996	-692,973	-3,211,805	-2,333,664
1997	-1,004,312	-5,974,813	-3,996,677
1998	-1,769,525	-12,369,599	-9,360,418
1999	-2,736,044	-20,976,919	-16,085,689
2000	-1,086,337	-18,442,439	-16,240,845
2001	-5,322,205	-44,206,752	-33,574,098
2002	-13,975,353	-83,321,222	-65,750,642
2003	-50,528,804	-111,946,908	-91,357,660
2004	-52,521,564	-171,088,545	-143,840,333
2005	-37,225,906	-165,841,032	-146,331,032
2006	-14,294,241	-164,565,602	-136,158,864
2007	-11,740,196	-221,188,201	-185,142,873
2008	-43,653,874	-533,765,631	-445,270,904
2009	-386,534,173	-594,486,063	-537,592,857
2010	-358,009,464	-684,226,719	-560,410,224
2011	-295,109,050	-463,639,357	-378,482,835
2012	-710,859,483	-664,705,657	-493,472,081
2013	-1,937,007,841	-918,060,095	-702,495,342
2014	-344,755,327	979,392,527	959,127,254
2015	-384,076,389	1,682,665,658	1,770,723,171
2016	-472,906,766	2,567,316,101	2,525,442,590
2017	-406,513,971	3,017,844,786	2,854,624,441
2018	-153,353,147	2,403,865,575	2,267,535,443
2019	-208,927,299	2,845,860,167	2,604,437,633
2020	-2,749,123,771	9,876,394,601	8,869,163,950
2021	-5,881,821,106	18,553,078,426	16,582,038,663
2022	-1,372,809,312	15,561,031,053	12,300,245,728
Total	-15,898,964,158	52,603,889,003	46,764,070,430

Deliverable 7: To provide comparability to HUD estimates of Economic Net Worth, the Contractor shall use Federal Credit Reform Act discounting assumptions and procedures.

The RMA estimates of Economic Net Worth have been developed using the Federal Credit Reform Act discounting assumptions.

Deliverable 8: This Study should use stochastic or Monte Carlo simulations of future economic conditions including for interest rates and house price appreciation. The objective of these requirements is to illustrate the sensitivity of forecasts to economic uncertainty and other forms of forecast error.

Additional economic assumptions were generated using Monte Carlo simulations and Moody's economic scenarios. These results are discussed in further detail in Section 3.

Deliverable 9: Provide econometric appendices to the Study that include variable specifications and statistical output from all regressions in the Studies.

Appendix B: Transition Models shows the predictive model parameters and goodness of fit measures for the Transition models. Appendix C: Loss Severity Models shows the parameters and goodness of fit measures for the Loss Severity models. See the Section 3: Binomial Model Results, and Section 4: Model Validation sections in Appendix B: Transition Models and the Model Parameters, and Model Validation sections in Appendix C: Loss Severity Models.

Executive Summary

The 1990 Cranston-Gonzalez National Affordable Housing Act (NAHA) requires an independent actuarial analysis of the economic value of the FHA and Department of Housing and Urban Development's (HUD's) MMI. Enacted on July 30, 2008, the Housing and Economic Recovery Act of 2008 (HERA) moved the requirement for an independent actuarial review into 12 USC 1708(a)-(4).

HERA also moved several additional programs into the MMI. One of the programs is the HECM program, which are reverse mortgages. HECMs are analyzed separately and excluded from this report. In the remainder of this report, the term MMI refers to Forward mortgages and excludes HECMs.

The primary purpose of this actuarial analysis is to estimate the Economic Net Worth of the current book of business. The Economic Net Worth is defined as cash available to the Fund plus the NPV of all future cash outflows and inflows that are expected to result from the mortgages currently insured by the MMI.

We have calculated a range of estimates using economic projections from the OMB Economic Assumptions for the 2023 Budget, ten economic projection scenarios from Moody's and a stochastic simulation approach.

Based on our analysis, we estimate that the Cash Flow NPV as of the end of Fiscal Year 2022 is positive $46.764 billion. We also estimate that the range of Cash Flow NPV based on randomly generated economic scenarios is between negative $15.899 billion and positive $52.604 billion.

The total capital resource as reported in the Annual Report to Congress Regarding the Status of the FHA Mutual Mortgage Insurance Fund is positive $89.512 billion as of the end of Fiscal Year 2022. Thus, the estimated Economic Net Worth of the MMI is positive $136.276 billion.

Impact of Economic Forecasts

The Cash Flow NPV of the MMI depends on many factors. One of the most important set of factors is the prevailing economic conditions over the next 30 years, and most critically during the next 10 years. We incorporate the most significant factors in the U.S. economy affecting the performance of the mortgages insured by the MMI using the following variables in our models:

- 30-year fixed rate mortgage (FRM) rates
- 10-year Constant Maturity Treasury (CMT) rates
- Three-year CMT rates
- One-year CMT rates
- Housing price index (HPI)
- Unemployment rates

The projected Cash Flow NPV of FHA's books of business is affected by changes in these economic variables. The ACE in this report is derived from using the required OMB Economic Assumptions.

We have also estimated the Cash Flow NPV of the MMI under ten economic scenarios from Moody's. These scenarios are:

1. Baseline
2. Alternative 0 – Upside (4th Percentile)
3. Alternative 1 – Upside (10th Percentile)
4. Alternative 2 – Downside (75th Percentile)
5. Alternative 3 – Downside (90th Percentile)
6. Alternative 4 – Downside (96th Percentile)
7. Slower-Trend Growth
8. Stagflation
9. Next-Cycle Recession
10. Low Oil Price

These scenarios do not represent the full range of possible future economic paths but represent a considerable variation of economic conditions. Therefore, they provide insights into the projected Cash Flow NPV of the MMI under a range of economic environments.

The summary of the estimated Cash Flow NPV resulting from each scenario is shown in Table 4.

Table 4: Projected Forward Cash Flow NPV Using Alternative Economic Scenarios

Economic Scenario	Fiscal Year 2022 Cash Flow NPV
RMA ACE	46,764,070,430
Baseline	45,469,695,907
Alternative 0 - Upside (4th Percentile)	49,025,087,162
Alternative 1 - Upside (l0th Percentile)	48,628,309,202
Alternative 2 - Downside (75th Percentile)	42,809,775,044
Alternative 3 - Downside (90th Percentile)	36,040,380,940
Alternative 4 - Downside (96th Percentile)	27,873,038,828
Slower Trend Growth	41,135,631,895
Stagflation	28,917,834,850
Next-Cycle Recession	39,822,660,799
Low Oil Price	47,299,532,979

We also randomly generated 100 stochastic simulations of key economic variables. Based on these simulations, the range of Cash Flow NPV estimates is negative $15.899 billion to positive $52.604 billion.

Distribution and Use

This report is being provided to FHA for its use and the use of makers of public policy in evaluating the Economic Net Worth of the MMI. Permission is hereby granted for its distribution on the condition that the entire report, including the exhibits and appendices, is distributed rather than any excerpt. RMA also acknowledges that this report will be included in the FHA's Annual Report to Congress, and permission is granted for this purpose as well. We are available to answer any questions that may arise regarding this report.

Any third parties receiving the report should recognize that the furnishing of this report is not a substitute for their own due diligence and should place no reliance on this report or the data contained herein that would result in the creation of any express or implied representation, warranty, duty, or liability by RMA to the third party.

Our conclusions are predicated on several assumptions as to future conditions and events. These assumptions, which are documented in subsequent sections of the report, must be understood to place our conclusions in their appropriate context. In addition, our work is subject to inherent limitations, which are also discussed in this report.

Reliances and Limitations

Listed in Section 5 are the data sources RMA has relied upon in our analysis. We have relied on the accuracy of these data sources in our calculations. If it is subsequently discovered that the underlying data or information is erroneous, then our calculations would need to be revised accordingly.

We have relied on a significant amount of data and information from external sources without audit or verification. This includes economic data projected over the next 30 years from Moody's and OMB. However, we did review as many elements of the data and information as practical for reasonableness and consistency with our knowledge of the mortgage insurance industry. It is possible that the historical data used to develop our estimates may not be predictive of future default and claim experience. We have not anticipated any extraordinary changes to the legal, social, or economic environment which might affect the number or cost of mortgage defaults beyond those contemplated in the economic scenarios described in this report. To the extent that the realized economic conditions deviate significantly from these assumptions, the Economic Net Worth projections may differ, perhaps significantly, from actual results.

A substantial source of uncertainty relates to the impact of the COVID-19 pandemic which emerged in 2020 and continues to impact the MMI program in 2022. This uncertainty could impact the projection of Cash Flow NPV in several different ways, including distortion of historical patterns due to changes in MMI claims handling and changes in loan origination exposure. Some of these uncertainties may also impact the settlement of claims that began prior to COVID-19 being declared a pandemic. We have developed projection methods to incorporate the impact of COVID-19, however as its effects continue to emerge, these effects could materially impact our projections.

The predictive models used in this analysis are based on a theoretical framework and certain assumptions. This model structure predicts the rates of default, claim, loss and prepayment based on a number of individual mortgage characteristics and economic variables. The models are built by applying predictive modeling techniques to actual historical experience of FHA-insured mortgages. The parameters of the predictive models are estimated over a wide variety of mortgages originated since 1975 and their performance under the range of economic conditions and mortgage market environments experienced during the past 47 years. The predictive models are combined with assumptions about future behavior of current mortgage endorsements and certain key economic assumptions to produce future projections of the performance of the existing mortgages insured by the MMI.

RMA is not qualified to provide formal legal interpretation of federal legislation or FHA policies and procedures. The elements of this report that require legal interpretation should be recognized as reasonable interpretations of the applicable statutes, regulations, and administrative rules.

Section 1: Introduction

Scope

HUD and FHA engaged RMA to perform the annual independent Actuarial Review of the MMI. This study is required by 12 USC 1708(a)-(4) and must be completed in compliance with the Federal Credit Reform Act as implemented and all applicable Actuarial Standards of Practice promulgated by the Actuarial Standards Board of the American Academy of Actuaries (ASOPs). This study provides an analysis of the financial position of MMI as of September 30, 2022 using data through September 30, 2022.

The MMI is a group of accounts of the federal government which record transactions associated with the FHA's guarantee programs for single family mortgages. Currently, the FHA insures approximately 7.39 million forward mortgages under the MMI and 325,250 reverse mortgages under the HECM program.

Per 12 USC 1711-(f), FHA must endeavor to ensure that the MMI maintains a capital ratio of not less than 2.0%. The capital ratio is defined as the ratio of capital to the MMI obligations on outstanding mortgages (IIF). Capital is defined as cash available to the Fund plus the Net Present Value (NPV) of all future cash outflows and inflows that are expected to result from the mortgages currently insured by the MMI.

The deliverables included in this study, as defined by the Statement of Work, are as follows:

Produce a written Actuarial Study for Forward that provides the actuarial central estimate of MMI Economic Net Worth as of the end of the subject Fiscal Year and assesses HUD's estimates of Economic Net Worth.

Include a review of the risk characteristics of existing MMI loans including commentary on how such characteristics have changed in recent years.

Apply the final Forward actuarial models to the existing portfolio to produce conditional (and cumulative) claim, prepayment, and loss-given-default rates at various levels of aggregation across loans, and for individual policy years and policy year-quarter. Cash-flow summaries should also be provided for major categories (e.g., premium revenues, claim expenses and recoveries or net loss due to claim, with affected loan counts and balances).

To promote transparency of the Studies' assessments, the Studies should identify methodological vulnerabilities that may occur in its actuarial models or in HUD's analyses of Economic Net Worth. This discussion shall evaluate the scope and scale of such vulnerabilities in creating possible forecast risk and suggest possible lines of research in

these areas. The Studies should assess and comment upon HUD's own models that estimate Economic Net Worth for methodological vulnerabilities and compare HUD's methodologies with those in the Studies.

The Studies should include historical data on changes in program terms as well as relevant loan and borrower characteristics (e.g., credit scores, loan-to-value ratios) by cohort and other sub-populations. Loan performance data (claim rates, prepayment rates, severity, and recovery rates) both historical and projected shall be presented in the "finger-table" formats (arrayed by cohort and policy years for different loan products).

The Contractor should use the President's Economic Assumptions (PEA), provided by ORMRA for the actuarial central estimates (ACEs) of the Studies. However, in addition to the central single path economic forecast, the Studies shall test alternative economic forecasts for stress-testing and sensitivity analysis to estimate ranges of reasonableness.

To provide comparability to HUD estimates of Economic Net Worth, the Contractor shall use Federal Credit Reform Act discounting assumptions and procedures.

This Study shall use stochastic or Monte Carlo simulations of future economic conditions, including for interest rates and house price appreciation. The objective of these requirements is to illustrate the sensitivity of forecasts to economic uncertainty and other forms of forecast error.

Provide econometric appendices to the Study that include variable specifications and statistical output from all regressions in the Studies.

Background

Congress created FHA in 1934. The FHA "provides mortgage insurance on loans made by FHA-approved lenders. FHA insures mortgages on single family and multifamily properties, residential care facilities and hospitals throughout the United States and its territories."[1] The mortgage insurance provided was done so through the establishment of the MMI.

HUD was established in 1937 by the U.S. Housing Act of 1937. The current mission of HUD is:

> *…to create strong, sustainable, inclusive communities and quality affordable homes for all. HUD is working to strengthen the housing market to bolster the economy and protect consumers; meet the need for quality affordable rental homes; utilize housing as a platform*

[1] https://www.hud.gov/program_offices/housing/fhahistory

for improving quality of life; build inclusive and sustainable communities free from discrimination, and transform the way HUD does business.[2]

The National Affordable Housing Act (NAHA), enacted in 1990, introduced a minimum capital requirement for the MMI.[3] By 1992, the capital ratio was to be at least 1.25%, and by 2000 the capital ratio was to be no less than 2.0%. The capital ratio is defined by NAHA as the ratio of capital to unamortized IIF. NAHA also implemented the requirement that an independent actuarial study of the MMI be completed annually. The Housing and Economic Recovery Act (HERA) amended 12 USC 1708(a)-(4) to include the requirement for the annual Actuarial Study.

Given the purpose of HUD and FHA, availability of mortgages to a broad segment of the home-buying market is important to promote and strengthen the U.S. housing market. However, the capital requirements established by NAHA can potentially conflict with the desire for widespread availability of mortgage insurance. Since the implementation of NAHA, many of the steps taken by HUD have attempted to balance broader availability of mortgage insurance and the financial stability of the MMI.

Mortgage Insurance Premiums

Adequate mortgage insurance premium (MIP) is key in maintaining the economic strength of the MMI, but the level of MIP can also impact the ability of potential home buyers to afford a home. A summary of the adjustments in MIP since 1991 is shown below:

- In 1991, it was established that MIP would be determined as the combination of an upfront MIP and a yearly premium which was a percentage of the remaining outstanding mortgage balance each year.[4] Overall, this represented an increase in MIP, which was needed to help meet the new capital requirement established by NAHA.

- In 1994, the upfront MIP was decreased by 75 basis points to 2.25%.[5] This was in response to improved financial experience of the MMI.

- In 1996, the upfront MIP was decreased by 25 basis points to 2.00% for first-time homebuyers that received mortgage counseling prior to purchasing their home.[6] This was implemented based on the success of a pilot program which showed that first-time homebuyers who received this counseling had better default experience.

[2] https://portal.hud.gov/hudportal/HUD?src=/about/mission
[3] Public Law 101-625, 101st Congress, November 28, 1990, Section 332.
[4] Mortgagee Letter 91-26, May 30, 1991: Single Family Insurance Processing for Risk Based Insurance Premiums.
[5] Mortgagee Letter 94-14, March 31, 1994: Single Family Loan Production – Reduced Upfront Mortgage Insurance Premium (UFMIP).
[6] Mortgagee Letter 96-48, August 28, 1996: Single Family Production – Reduction in Up-Front Mortgage Insurance Premiums (UFMIP) for First-Time Homebuyers Who Receive Housing Counseling.

- In 1997, the upfront MIP was decreased by an additional 25 basis points to 1.75% for first-time homebuyers that received mortgage counseling prior to purchasing their home. In total, the upfront MIP was 50 basis points lower than it would be for a homebuyer who did not receive counseling.[7]

- In 2000, in recognition of the improved experience of the MMI, several changes were implemented. First, the upfront MIP was reduced by 75 basis points to 1.50%. Second, the upfront MIP refund schedule was shortened to five years instead of seven years. Third, a provision to cancel the annual MIP once the loan-to-value (LTV) ratio was 78% or less was implemented. Also, the discount in the upfront MIP for first-time homebuyers that received counseling was discontinued.[8]

- In April of 2010, upfront MIP was increased by 75 basis points to 2.25%.[9] This increase in premium was in response to the housing and economic crisis of 2008 and was the first in a series of increases over the next three years.

- In October of 2010, upfront MIP was decreased but annual MIP was increased significantly.[10] Overall, this resulted in an increase in MIP.

- In 2011, the annual MIP was increased by 25 basis points.[11]

- In 2012, the annual MIP was increased by 10 basis points.[12]

- In 2013, several changes were implemented related to annual MIP. First, the term for collection of MIP was extended to 11 years for mortgages with an initial LTV ratio of 90% or less, and for 30 years for mortgages with an initial LTV ratio of greater than 90%. Second, mortgages with terms of 15 years or less and LTV ratio of 78% or less at the time of origination, which were exempt from MIP, would no longer be exempt. Lastly, the annual MIP was increased by 5 to 10 basis points for mortgages with terms of 15 years or less and LTV ratios of 78% or less at origination.[13]

[7] Mortgagee Letter 97-37, August 13, 1997: Single Family Production – Further Reduction in Up-Front Mortgage Insurance Premiums (UFMIP) for First-Time Homebuyers Who Receive Housing Counseling.
[8] Mortgagee Letter 2000-38, October 27, 2000: Single Family Loan Production – Further Reduction in Upfront Mortgage Insurance Premiums and Other Mortgage Insurance Premium Changes.
[9] Mortgagee Letter 2010-02, January 21, 2010: Increase in Upfront Premiums for FHA Mortgage Insurance.
[10] Mortgagee Letter 2010-28, September 1, 2010: Changes to FHA Mortgage Insurance Premiums.
[11] Mortgagee Letter 2011-10, February 14, 2011: Annual Mortgage Insurance Premium Changes and Guidance on Case Numbers.
[12] Mortgagee Letter 2012-04, March 6, 2012: Single Family Mortgage Insurance: Annual and Up-Front Mortgage Insurance Premium – Changes.
[13] Mortgagee Letter 2013-04, January 31, 2013: Revision of Federal Housing Administration (FHA) policies concerning cancellation of the annual Mortgage Insurance Premium (MIP) and increase to the annual MIP.

- As a result of improved financial experience, in 2015 annual MIP rates were decreased by 50 basis points for loans with terms greater than 15 years.[14]

- In 2017, a decrease was proposed for annual MIP rates,[15] but this decrease was suspended later in the year.[16]

Down Payment and Closing Costs

The source of funds for down payment and closing costs has been a significant issue for HUD. There are limitations on closing costs and down payment assistance that can be provided by sources other than the borrower or family, and there have been several mortgagee letters addressing this issue. Allowing assistance with down payments and closing costs increases the opportunity for more people to achieve homeownership. Historically, however, mortgages for which a larger percentage of the down payment and closing costs were provided by sources other than the borrowers own funds have demonstrated poorer performance. A summary of mortgagee letters addressing this is provided below:

- Prior to 1992, closing costs could not be financed as part of the loan. In 1992, the limitation on financing of closing costs was removed, but mortgages were still subject to LTV ratio limits.[17] This provision was implemented to make it easier for homebuyers to meet the down payment requirements.

- In 1996, HUD allowed family members to lend the borrower 100% of the down payment.[18] This also was intended to make it easier for individuals and families to achieve homeownership.

- Two provisions were implemented in 1998. First, it was prohibited for the seller or any other party to pay mortgage interest for the buyer. In addition, any interest rate buydown could not result in a reduction in the interest rate of more than 2% below the note rate. These changes were implemented to avoid a significant increase in the payment amount

[14] Mortgagee Letter 2015-01, January 9, 2015: Reduction of Federal Housing Administration (FHA) annual Mortgage
Insurance Premium (MIP) rates and Temporary Case Cancellation Authority.
[15] Mortgagee Letter 2017-01, January 9, 2017: Reduction of Federal Housing Administration (FHA) Annual Mortgage Insurance Premium (MIP) Rates.
[16] Mortgagee Letter 2017-07, January 20, 2017: Suspension of Mortgagee Letter 2017-01 – Reduction of Federal Housing Administration (FHA) Annual Mortgage Insurance Premium (MIP) Rates.
[17] Mortgagee Letter 92-39, October 16, 1992: Single Family Loan Production - Elimination of Limit on Financing Closing Costs.
[18] Mortgagee Letter 96-58, October 23, 1996: Single Family Loan Production - Secondary Financing from Family Members.

once the seller-paid mortgage interest funds were depleted or the interest rate buydown term was complete.[19]

- In 2000, guidance was provided by HUD to mortgagees to ensure that the source of the gifts to buyers is documented, and the person giving the gift must certify that the funds did not come from someone with an interest in the transaction. This was implemented to combat a practice of the sellers providing funds to family members of the buyer that would then be used for the down payment.[20]

- Section 2113 of the Housing and Economic Recovery Act of 2008 prohibited down payment contributions from a seller or any other person or entity that would financially benefit from the transaction.[21]

- In 2019, guidance by HUD was provided to clarify the rules associated with funds being provided by a governmental source for down payment assistance. The mortgagee letter requires the mortgagee to verify that the funds provided by the government agency were transferred to the Borrower before or at the time of closing, and that the governmental agency was acting in its legal capacity in providing these funds. Documentation is also required from the government that the agency has the authority to provide the funds, and from an attorney for the government entity verifying that the property is within the government agency's jurisdiction. There can be no direct transfer of assistance from the government agency to the mortgagee, and there can be no requirement that the loan be transferred to a specific mortgagee as a condition of receiving assistance from the government agency.[22] This guidance was subsequently suspended until further notice[23] and ultimately rescinded.[24]

Homebuyer Counseling

Counseling for homebuyers was encouraged historically by FHA with the idea that if homebuyers were educated on issues of homeownership and mortgages, they would be less likely to default on

[19] Mortgagee Letter 98-1, January 2, 1998: Single Family Loan Production - Underwriting Adjustable Rate Mortgages, Interest Buydowns, Homeownership Counseling and Other Credit Policy Issues
[20] Mortgagee Letter 2000-28, August 7, 2000: Gift Documentation, Mortgage Forms and other Credit Policy and Appraisal Issues.
[21] https://www.congress.gov/110/plaws/publ289/PLAW-110publ289.pdf
[22] Mortgagee Letter 19-06, April 18, 2019: Downpayment Assistance and Operating in a Governmental Capacity.
[23] Mortgagee Letter 19-10, July 23, 2019: Suspension of the Effective Date of Mortgagee Letter 2019-06, *Downpayment Assistance and Operating in a Governmental Capacity*.
[24] Mortgagee Letter 19-12, August 13, 2019: Rescission of Mortgagee Letters 2019-06, *Downpayment Assistance and Operating in a Governmental Capacity*; 2019-07, *Extension of the Effective Date of Mortgagee Letter 2019-06, Downpayment Assistance and Operating in a Governmental Capacity*; and 2019-10, *Suspension of the Effective Date of Mortgagee Letter 2019-06, Downpayment Assistance and Operating in a Governmental Capacity*.

the mortgage and would be more responsible homeowners. The history of mortgagee letters related to homebuyer counseling is outlined below:

- In 1993, a pilot counseling program for pre-purchase and pre-foreclosure situations was announced.[25]

- In 1996, after the pilot counseling program, the upfront MIP was decreased by 25 basis points for first-time homebuyers who completed homeownership counseling.[26] Just one year later in 1997, the upfront MIP was decreased by an additional 25 basis points for first-time homebuyers who completed homeownership counseling.[27] This discount was provided to recognize the expected improvement in default experience.

  In 1998, a mortgagee letter was released indicating that the homeownership counseling program would be reviewed. This was in response to homeownership counseling programs that were being used that did not meet FHA guidelines. While the requirements of the counseling program were that it should involve 15 to 20 hours of instruction, there were cases where homebuyers were provided with workbooks without additional interaction or instruction. The guidelines of the homeownership counseling program were reiterated in this letter.[28]

- In 2000, in conjunction with an overall reduction in upfront MIP, the homeownership counseling discount was discontinued.[29]

Automated Underwriting Systems

Beginning in 1995, the use of automated underwriting systems (AUSs) began to increase. Theoretically, the use of AUSs increases the availability of mortgages, and improves the efficiency and speed of mortgage processing. The following are key events in the history of AUS's:

- In 1995, HUD approved usage of AUSs. Mortgagees had to request permission to use these systems and receive approval from HUD.[30]

[25] Mortgagee Letter 93-28, September 20, 1993: Prepurchase and Foreclosure Prevention Counseling Demonstration.
[26] Mortgagee Letter 96-48, August 28, 1996: Single Family Production - Reduction in Up-Front Mortgage Insurance Premiums (UFMIP) for First-Time Homebuyers Who Receive Housing Counseling.
[27] Mortgagee Letter 97-37, August 13, 1997: Single Family Production - Further Reduction in Up-Front Mortgage Insurance Premiums (UFMIP) for First-Time Homebuyers Who Receive Housing Counseling.
[28] Mortgagee Letter 98-1, January 2, 1998: Single Family Loan Production - Underwriting Adjustable Rate Mortgages, Interest Buydowns, Homeownership Counseling and Other Credit Policy Issues.
[29] Mortgagee Letter 2000-38, October 27, 2000: Single Family Loan Production - Further Reduction in Upfront Mortgage Insurance Premiums and Other Mortgage Insurance Premium Changes
[30] Mortgagee Letter 95-7, January 27, 1995: Single Family Loan Production - Revised Underwriting Guidelines and Other Policy Issues.

- In 1996, criteria were established for the approval by HUD of AUSs.[31]

- In 1998, FHA approved Freddie Mac's Loan Prospector for underwriting FHA-insured mortgages, using a scorecard that was custom-estimated for FHA endorsed loans. FHA also made a substantial number of revisions to its credit policies and reduced documentation requirements for loans assessed by Loan Prospector. This was the first time that FHA incorporated an AUS in its insurance endorsement process. Fannie Mae's Desktop Underwriter and PMI Mortgage Services' Automated Underwriting Risk Analysis (AURA) were approved to underwrite FHA mortgages in 1999, followed soon thereafter by Countrywide Funding Corporation's Countrywide Loan-Underwriting Expert System (CLUES) and JP Morgan-Chase's Zippy. Beginning in May 2004, all approved AUSs applied FHA's Technology-Open-To-Approved-Lenders (TOTAL) mortgage scorecard to evaluate loan applications for possible automated approval for FHA insurance. Initially, more than two-thirds of loans submitted generally received automated approval, eliminating the need for manual underwriting reviews. Since May 2004, HUD required lenders to submit borrower credit scores. Starting in July 2008, all loans were to be submitted through FHA's TOTAL scorecard. Additional guidance issued in February 2011 prohibited the use of the TOTAL scorecard on streamline refinance (SR) transactions.

Adjustable-Rate Mortgages

Adjustable-rate mortgages (ARMs) are mortgages where the interest rate adjusts over the life of the loan. The interest rate adjustments are tied to interest rate indexes, such as CMT rates. The interest rate at the beginning of the loan is typically lower than corresponding rate for the prevailing fixed rate mortgage and increases over the early years of the loan. The initial interest rate can be fixed for a varying period (one year, three years, five years, etc.) and, after the fixed interest rate period, can change annually. Most ARMs also have a lifetime cap on how much the interest rate can increase relative to the initial interest rate.

Historically, the default rates related to ARMs have been higher than the default rates for fixed rate mortgages. This is based in part on the fact that as the interest rate increases, the monthly mortgage payment increases, and, as a result, the likelihood of borrower defaults increases. However, there is an offsetting impact, as the likelihood of prepayments decrease as interest rates increase. To address this, HUD has issued a series of mortgagee letters related to ARMs:

- In 1998, HUD issued guidance that for ARMs, borrowers must qualify using mortgage payments based on the contract or initial rate plus one percent, which effectively represents the second-year interest rate. This applied to all mortgages with LTV ratios of greater than or equal to 95%. In addition, it prohibited any form of a temporary interest rate buydown.

[31] Mortgagee Letter 96-34, July 10, 1996: Single Family Loan Production - Automated Underwriting Systems.

This was because the payment shock associated with the termination of the buydown was causing default rates to increase to an unacceptable level.[32]

- In 2004, HUD expanded mortgage insurance availability to cover three-, five-, seven- and 10-year ARMs.[33]

- In 2007, the one-year London Interbank Offered Rate (LIBOR) was added as an acceptable index for ARMs.[34]

Foreclosure Avoidance and Loss Mitigation Programs

The pre-foreclosure sale (PFS) program allows mortgagors to sell their homes and use the proceeds to satisfy their mortgage debt obligations even if the proceeds were less than owed. Ultimately, these programs help limit the number of defaults that turn into claims, and limit the losses sustained by MMI when a claim occurs. There are also certain situations where HUD can pursue a deficiency judgment against the borrower if they PFS amount does not cover the mortgage balance if it is consistent with state law.

Over the years, FHA has issued many mortgagee letters related to foreclosure and loss mitigation:

- In 1996, a mortgagee letter was released to provide information on the loss mitigation procedures, including special forbearance plans, mortgage modifications, PFSs, deeds in lieu of foreclosure and partial claims. The primary objective was to keep the homeowner in the home, and if that was not possible then the objective was disposition of the property without full foreclosure.[35]

- In 2008, due to the increase in defaults resulting from the housing crisis, FHA released a mortgagee letter reminding mortgagees of PFS as an option and consolidated the provisions of the PFS program into one place. This letter also updated provisions of the PFS to better address the mortgage crisis.[36]

- In 2010, FHA released a mortgagee letter announcing enhancements to the FHA refinance program to allow responsible borrowers an opportunity to stay in their homes. This could occur if the lender agreed to write off at least 10% of the principal balance and if the remaining loan provisions were met.[37]

[32] Mortgagee Letter 98-1, January 2, 1998: Single Family Loan Production - Underwriting Adjustable Rate Mortgages, Interest Buydowns, Homeownership Counseling and Other Credit Policy Issues.
[33] Mortgagee Letter 2004-10, March 19, 2004: Adjustable Rate Mortgages.
[34] Mortgagee Letter 2007-13, October 12, 2007: Adjustable Rate Mortgages—Addition of LIBOR Index.
[35] Mortgagee Letter 96-61, November 12, 1996: FHA Loss Mitigation Procedures - Special Instructions.
[36] Mortgagee Letter 2008-43, December 24, 2008: Pre-Foreclosure Sale (PFS) Program - Utilizing the PFS Loss Mitigation Option to Assist Families Facing Foreclosure.
[37] Mortgagee Letter 2010-23, August 6, 2010: FHA Refinance of Borrowers in Negative Equity Positions.

- In 2011, FHA issued guidance requiring a trial payment program prior to completing a permanent loan modification or partial claim. During the trial payment period, the borrower must complete three months of payments at the amount that will continue under the modification.[38]

- In 2012, FHA revised the Loss Mitigation Home Retention Options to reduce the claims against the MMI and help more borrowers stay in their homes. These revisions included eliminating the maximum back-end debt to income ratio; eliminating the restriction on the principal, interest, taxes, and insurance that can be included in the claim; and, eliminating the requirement that the existing mortgage be no more than 12 months past due.[39]

- In 2013, FHA established updated requirements for PFSs and Deed in Lieu (DIL) requirements. These changes included the use of the Deficit Income Test (DIT) – a test to determine if expenses exceed income and whether a hardship exists – and the elimination of the financial hardship/deficit income PFS requirement for servicemen who have received a Permanent Change of Station order.[40]

- In 2013, additional modifications were made to the FHA Loss Mitigation Home Retention Options. These changes included defining continuous income that can be considered in the transaction, allowing for arrearages to be included in partial claims, and allowing for modifications for mortgagors in bankruptcy.[41]

- In 2014, the updated PFS guideline required a minimum marketing period of 15 calendar days for all PFS transactions. It also clarified that non-arms-length transactions are permitted only if they are necessary to comply with state law.[42]

- Also in 2014, FHA issued a mortgagee letter to increase the use of Claims Without Conveyance of Title (CWCOT) procedures. This letter also established that the Commissioner's Adjusted Fair Market Value must be used for all foreclosure sales and PFS efforts.[43]

- In 2018, FHA issued a mortgagee letter implementing special loss mitigation processes for victims of Hurricanes Irma, Harvey and Maria and the California Wildfires. These

[38] Mortgagee Letter 2011-28, August 15, 2011: Trial Payment Plan for Loan Modifications and Partial Claims under Federal Housing Administration's Loss Mitigation Program.
[39] Mortgagee Letter 2012-22, November 16, 2012: Revisions to FHA's Loss Mitigation Home Retention Options.
[40] Mortgagee Letter 2013-23, July 9, 2013: Updated Pre-Foreclosure Sale (PFS) and Deed in Lieu (DIL) of Foreclosure Requirements.
[41] Mortgagee Letter 2013-32, September 20, 2013: Update to FHA's Loss Mitigation Home Retention Options.
[42] Mortgagee Letter 2014-15, July 10, 2014: Updated Requirements for Pre-Foreclosure Sales (PFS) and Deeds in Lieu (DIL) of Foreclosure.
[43] Mortgagee Letter 2014-24, November 26, 2014: Increasing Use of FHA's Claims Without Conveyance of Title (CWCOT) Procedures.

procedures were implemented to help homeowners stay in their homes and reduce losses to FHA.[44]

- Later in 2018, FHA issued a mortgagee letter in response to continued elevated default rates and lower utilization of loss mitigation options in Puerto Rico and the U.S. Virgin Islands. This mortgagee letter expanded loss mitigation assistance to borrowers in default.[45]

- In 2019, HUD incorporated additional changes to further streamline and revise Loss Mitigation Procedures for Presidentially Declared Major Disaster Areas (PDMDAs).[46]

COVID-19 Pandemic

On March 13, 2020, by Proclamation 9994, the President of the United States proclaimed that the COVID-19 outbreak in the United States constitutes a national emergency as of March 1, 2020. As a result, for a period many jurisdictions reduced services, businesses closed, and other activities were curtailed. In addition, the pandemic impeded the ability of Americans to work and provide for their families. This directly impacted the financial wellbeing of individuals, families, and businesses. Furthermore, many Americans were asked to remain in their homes to stem the tide of COVID-19 as many states implemented shelter-in-place orders.

COVID-19 is still a national emergency, and it is not yet clear when this declaration will end. To ensure families are not displaced during this critical period, several mortgagee letters have been issued.

- March 18, 2020: Properties secured by FHA-insured mortgages were subject to a 60-day moratorium on foreclosures. This moratorium applied to the initiation of foreclosures and foreclosures in process.[47] On May 14, 2020, the foreclosure moratorium was extended

[44] Mortgagee Letter 2018-01, February 22, 2018: Loss Mitigation for borrowers with FHA-insured mortgages whose property and/or place of employment is located in Presidentially-Declared Major Disaster Areas, adversely affected by Hurricanes Harvey, Irma, Maria, certain California wildfires that occurred in October 2017 (FEMA-DR-4344) or certain California Wildfires, Flooding, Mudflows, and Debris Flows that occurred in December 2017 (FEMA-DR-4353).
[45] Mortgagee Letter 2018-05, August 15, 2018: Updated Loss Mitigation for mortgagees servicing mortgage loans for borrowers with FHA-insured mortgages whose property and/or place of employment is located in the Presidentially-Declared Major Disaster Areas (PDMDAs) of Puerto Rico Hurricane Maria DR-4339 or Virgin Islands Hurricane Maria DR-4340 and Disaster Foreclosure Moratorium for certain FHA-insured mortgages secured by properties located in areas of Puerto Rico and the U.S. Virgin Islands that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has declared to be eligible for Individual Assistance (Affected Counties) as a result of Hurricane Maria (Puerto Rico Hurricane Maria DR-4339 and Virgin Islands Hurricane Maria DR-4340).
[46] Mortgagee Letter 2019-14, August 29, 2019: Updates to FHA's Loss Mitigation Options for Borrowers in Presidentially-Declared Major Disaster Areas (PDMDAs)
[47] Mortgagee Letter 2020-04, March 18, 2020: Foreclosure and Eviction Moratorium in connection with the Presidentially Declared COVID-19 National Emergency.

through June 30, 2020.[48] On June 17, 2020, the moratorium was extended through August 31, 2020,[49] and on August 27, 2020 the moratorium was extended through December 31, 2020.[50] On December 17, 2020, the moratorium was extended through February 28, 2021.[51] On January 21, 2021, the moratorium was extended through March 31, 2021.[52] On February 16, 2021, the moratorium was extended through June 30, 2021.[53] On June 25, 2021, the moratorium was extended through July 31, 2021.[54] On July 30, 2021, the moratorium was extended through September 30, 2021.[55] Deadlines for the first legal action and reasonable diligence times were extended by 90 days from the date of the expiration of the moratorium. On February 7, 2022, the extension of deadlines for the first legal action and reasonable diligence timeframe were clarified such that these timeframes were extended by 180 days from the latter of the end of the borrower's COVID-19 Forbearance or the expiration of the foreclosure moratorium.[56]

- March 27, 2020: Rules for re-verification of employment were adjusted to account for the fact that many businesses were closed during shelter-in-place orders. Also, changes were made to FHA Appraisal Protocols to allow for exterior only and desktop appraisals in order to maintain appropriate social distancing.[57] On May 14, 2020, the applicability of these

[48] Mortgagee Letter 2020-13, May 14, 2020: Extension of Foreclosure and Eviction Moratorium in connection with the Presidentially-Declared COVID-19 National Emergency and New Reporting Requirements Related to FHA Single Family's CARES Act Loss Mitigation Options.
[49] Mortgagee Letter 2020-19, June 17, 2020: Extension of Foreclosure and Eviction Moratorium in Connection with the Presidentially-Declared COVID-19 National Emergency.
[50] Mortgagee Letter 2020-27, August 27, 2020: Extension of Foreclosure and Eviction Moratorium in Connection with the Presidentially-Declared COVID-19 National Emergency.
[51] Mortgagee Letter 2020-43, December 17, 2020: Extension of Foreclosure and Eviction Moratorium in Connection with the
Presidentially-Declared COVID-19 National Emergency.
[52] Mortgagee Letter 2021-03, January 21, 2021: Extension of Foreclosure and Eviction Moratorium in Connection with the
Presidentially-Declared COVID-19 National Emergency.
[53] Mortgagee Letter 2021-05, February 16, 2021: Extensions of Single Family Foreclosure and Eviction Moratorium, Start Date of COVID-19 Initial Forbearance, and HECM Extension Period; Expansion of COVID-19 Loss Mitigation Options
[54] Mortgagee Letter 2021-15, June 25, 2021: Extension of the Foreclosure and Eviction Moratorium in Connection with the
Presidentially-Declared COVID-19 National Emergency, Further Expansion of the COVID-19 Forbearance and the COVID-19 Home Equity Conversion Mortgage (HECM) Extensions, and Establishment of the COVID-19 Advance Loan Modification (COVID-19 ALM).
[55] Mortgagee Letter 2021-19, July 30, 2021: Extension of the Foreclosure-Related Eviction Moratorium and Expiration of
the Foreclosure Moratorium in Connection with the Presidentially-Declared COVID-19 National Emergency.
[56] Mortgagee Letter 2022-02, February 7, 2022: Technical Update to the Extension of the Deadlines for the First Legal
Action and Reasonable Diligence Time Frame.
[57] Mortgagee Letter 2020-05, March 27, 2020: Re-verification of Employment and Exterior-Only and Desktop-Only Appraisal Scope of Work Options for FHA Single Family Programs Impacted By COVID-19.

changes were extended through June 30, 2020.[58] On June 29, 2020, the applicability of these changes were extended through August 31, 2020.[59] On August 28, 2020, the applicability of these changes was extended through October 31, 2020.[60] On October 28, 2020, the applicability of these changes was extended through December 31, 2020.[61] On December 17, 2020, the applicability of these changes was extended through February 28, 2021.[62] On February 23, 2021, the applicability of these changes was extended through June 30, 2021.[63]

- April 1, 2020: Borrowers who experienced an adverse impact on their ability to make on-time mortgage payments were eligible for forbearance for an initial period of six months, and this initial period could be extended by up to six additional months. While in forbearance, the borrower must be evaluated for loss mitigation options.[64] On July 8, 2020, HUD issued a mortgagee letter detailing the full suite of loss mitigation options available for borrowers affected by COVID-19.[65] On October 20, 2020, the date for approving a COVID-19 forbearance was extended to December 31, 2020.[66] On December 17, 2020, the date for approving a COVID-19 forbearance was extended to February 28, 2021.[67] On January 26, 2021, the date for approving a COVID-19 forbearance was extended to March

[58] Mortgagee Letter 2020-14, May 14, 2020: Extension of the Effective Date of Mortgagee Letter 2020-05, Re-verification of Employment and Exterior-Only and Desktop-Only Appraisal Scope of Work Options for FHA Single Family Programs Impacted By COVID-19.
[59] Mortgagee Letter 2020-20, June 29, 2020: Re-Extension of the Effective Date of Mortgagee Letter 2020-05, Re-verification of Employment and Exterior-Only and Desktop-Only Appraisal Scope of Work Options for FHA Single Family Programs Impacted By COVID-19.
[60] Mortgagee Letter 2020-28, August 28, 2020: Re-Extension of the Effective Date of Mortgagee Letter (ML) 2020-05, Reverification of Employment and Exterior-Only and Desktop-Only Appraisal Scope of Work Options for the Federal Housing Administration (FHA) Single Family programs impacted by the Coronavirus Disease of 2019 (COVID-19).
[61] Mortgagee Letter 2020-37, October 28, 2020: Extension of Re-verification of Employment Guidance and Updated Appraisal Scope of Work Option for Federal Housing Administration (FHA) Single Family Programs Impacted by the Coronavirus Disease of 2019 (COVID-19).
[62] Mortgagee Letter 2020-47, December 17, 2020: Extension of Re-verification of Employment and Exterior only Appraisal
scope of work option for Federal Housing Administration (FHA) Single Family programs impacted by the Coronavirus Disease of 2019 (COVID-19).
[63] Mortgagee Letter 2021-06, February 23, 2021: Extension of Re-verification of Employment and Exterior-Only Appraisal
scope of work (SOW) option for Federal Housing Administration (FHA) Single Family programs impacted by the Coronavirus Disease of 2019 (COVID-19).
[64] Mortgagee Letter 2020-06, April 1, 2020: FHA's Loss Mitigation Options for Single Family Borrowers Affected by the Presidentially-Declared COVID-19 National Emergency in Accordance with the CARES Act.
[65] Mortgagee Letter 2020-22, July 8, 2020: FHA's COVID-19 Loss Mitigation Options.
[66] Mortgagee Letter 2020-34, October 20, 2020: Update to the Date for Approving a COVID-19 Forbearance or COVID19 Home Equity Conversion Mortgage (HECM) Extension.
[67] Mortgagee Letter 2020-44, December 17, 2020: Second Update to the COVID-19 Forbearance Start Date and the COVID19 Home Equity Conversion Mortgage (HECM) Extension Period.

31, 2021.[68] On February 16, 2021, the date for approving a COVID-19 forbearance was extended to June 30, 2021.[69] This extension also expanded mitigation options, including adding additional forbearance options, increasing borrower eligibility for COVID-19 forbearance, and removing the restriction that borrowers can receive only one COVID-19 home retention option. On June 25, 2021, the date for approving a COVID-19 forbearance was extended to July 31, 2021.[70] On September 27, 2021, HUD provided an additional six months of COVID-19 Forbearance when the initial forbearance was requested between July 1, 2021 and September 30, 2021, and also established an initial Forbearance period of up to six months when requested between October 1, 2021 and the end of the COVID-19 National Emergency.[71] This mortgagee letter also introduced an Advance Loan Modification, which could significantly reduce the payment for borrowers.

- June 4, 2020: Mortgages in forbearance due to the effects of COVID-19 were allowed to be endorsed by HUD if at the time of the closing the buyer met all necessary requirements and the mortgage was current at the time of forbearance.[72] On November 25, 2020, the applicability of this endorsement guidance was extended through December 31, 2020.[73] On December 17, 2020, this endorsement guidance was extended through March 31, 2021.[74]

- June 12, 2020: Claims for loss mitigation options were allowed to be submitted electronically.[75]

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[68] Mortgagee Letter 2021-04, January 26, 2021: Update to the COVID-19 Forbearance Start Date and the COVID-19 Home
Equity Conversion Mortgage (HECM) Extension Period.
[69] Mortgagee Letter 2021-05, February 16, 2021: Extensions of Single Family Foreclosure and Eviction Moratorium, Start Date of COVID-19 Initial Forbearance, and HECM Extension Period; Expansion of COVID-19 Loss Mitigation Options
[70] Mortgagee Letter 2021-15, June 25, 2021: Extension of the Foreclosure and Eviction Moratorium in Connection with the
Presidentially-Declared COVID-19 National Emergency, Further Expansion of the COVID-19 Forbearance and the COVID-19 Home Equity Conversion Mortgage (HECM) Extensions, and Establishment of the COVID-19 Advance Loan Modification (COVID-19 ALM).
[71] Mortgagee Letter 2021-24, September 27, 2021: Extension for COVID-19 Forbearance and COVID-19 Home Equity
Conversion Mortgage (HECM) Extensions.
[72] Mortgagee Letter 2020-16, June 4, 2020: FHA Catalyst: Case Binder Module – Single Family Forward and Home Equity Conversion Mortgage (HECM) Electronic Endorsement Submission.
[73] Mortgagee Letter 2020-29, November 25,2020. Extension of Temporary Guidance for Endorsement of Mortgages under
Forbearance for Borrowers Affected by the Presidentially-Declared COVID19 National Emergency consistent with the Coronavirus Aid, Relief, and Economic Security (CARES) Act.
[74] Mortgagee Letter 2020-45, December 17, 2020: Extension of Temporary Guidance for Endorsement of Mortgages under
Forbearance for Borrowers Affected by the Presidentially-Declared COVID19 National Emergency consistent with the Coronavirus Aid, Relief, and Economic Security (CARES) Act.
[75] Mortgagee Letter 2020-18, June 12, 2020: FHA Catalyst: Claims Module - Single Family Forward Loss Mitigation Home Retention Claims.

- July 23, 2021: HUD established COVID-19 Recovery Loss Mitigation Options, which included the COVID-19 Standalone Partial Claim, the COVID-19 Recovery Modification, and the COVID-19 Non-Occupant Loan Modification.[76]

- April 18, 2022: HUD established a 40-year loan option loan modification as part of the COVID-19 recovery loss mitigation options.[77]

The COVID-19 pandemic, the shelter-in-place orders and the modifications to the loss mitigation and forbearance guidelines have had a significant impact on the Cash Flow NPV of the MMI. We have considered these impacts as part of our analysis and will highlight throughout the report how COVID-19 has impacted our analysis and the Cash Flow NPV projections.

Current and Future Market Environment

In addition to the policies related to the MMI, the default and claim rates and ultimately the Cash Flow NPV of the MMI are dependent on the economic environment. As interest rates increase, mortgage rates tend to increase, which in turn causes default rates to increase.

The general health of the economy impacts the value of homes. As home values increase, losses to the MMI will tend to decrease as the value received in the disposition of a home increases. Also, as the general health of the economy improves, the demand for mortgages increases. This generally results in an increase in the demand for mortgages endorsed by the MMI for mortgage insurance.

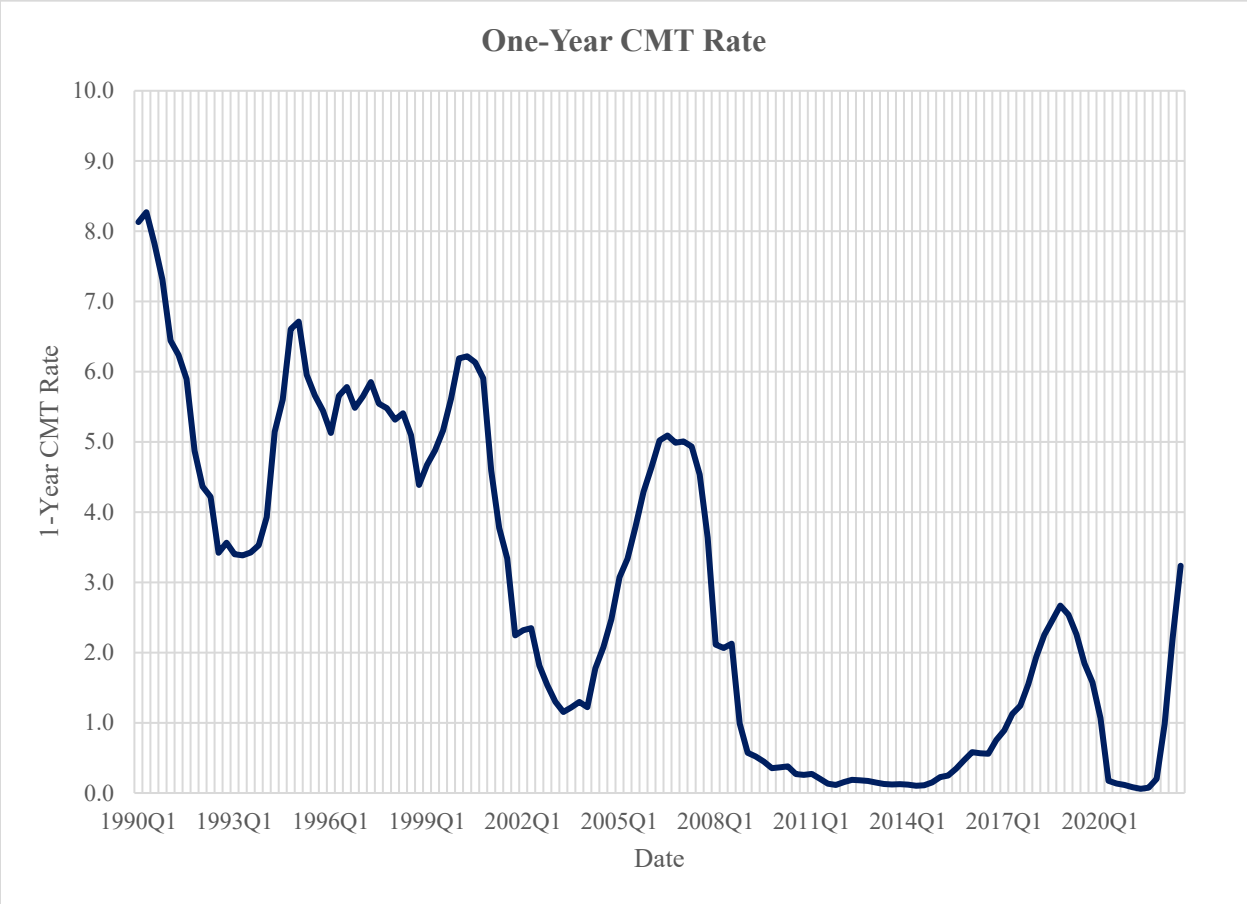
The impacts of COVID-19 on the economy have been significant. For some of the economic variables considered in the analysis, the impact of COVID-19 has caused levels that have not been seen historically. Throughout the analysis, we have incorporated the impact of COVID-19 on economic and other variables and the Cash Flow NPV.

Interest Rates

Figure 1 shows the historical one-year CMT rate since 1990.

[76] Mortgagee Letter 2021-18, July 23, 2021: COVID-19 Recovery Loss Mitigation Options.
[77] Mortgagee Letter 2022-07, April 18, 2022: Update to the COVID-19 Recovery Loss Mitigation Options.

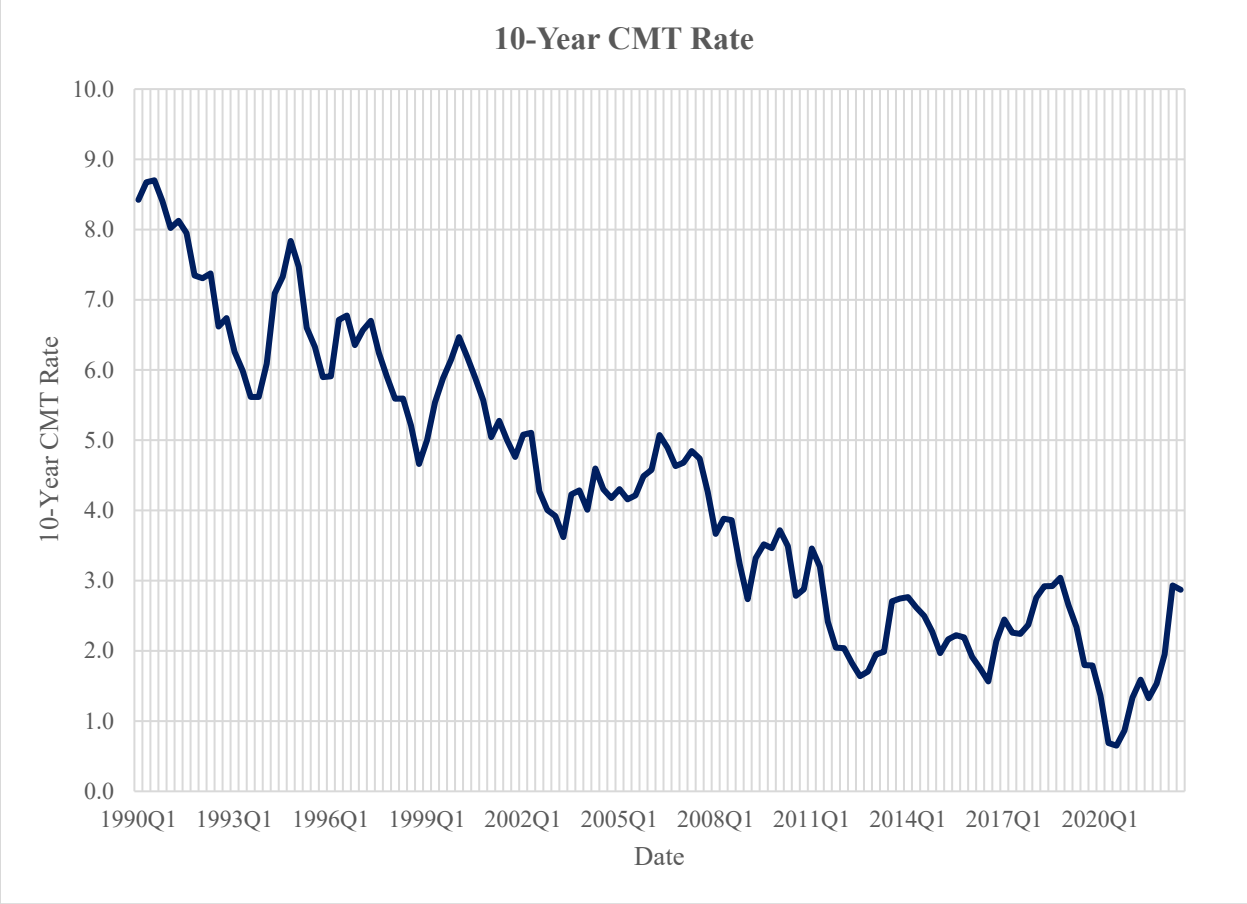
Figure 1: One-Year CMT Rate



In 2008, in response to the housing crisis and economic recession, the Federal Reserve began decreasing interest rates as part of an active monetary policy. At the beginning of 2007, the one-year CMT rate was around 5%. Over the next seven years, the rate dropped steadily to a low of 0.1% in the second quarter of 2014. After 2014, the rate began increasing again to a high of 2.7% by December 2018. Since that time, the rate had been decreasing, and as of the second quarter of 2021 reached 0.06%, the lowest level since the one-year CMT rate began in 1953. This drop was due to monetary policy in response to the economic impact of COVID-19. As of the third quarter of 2022, the rate has risen to 3.24%.

Figure 2 shows the 10-year CMT rate since 1990.

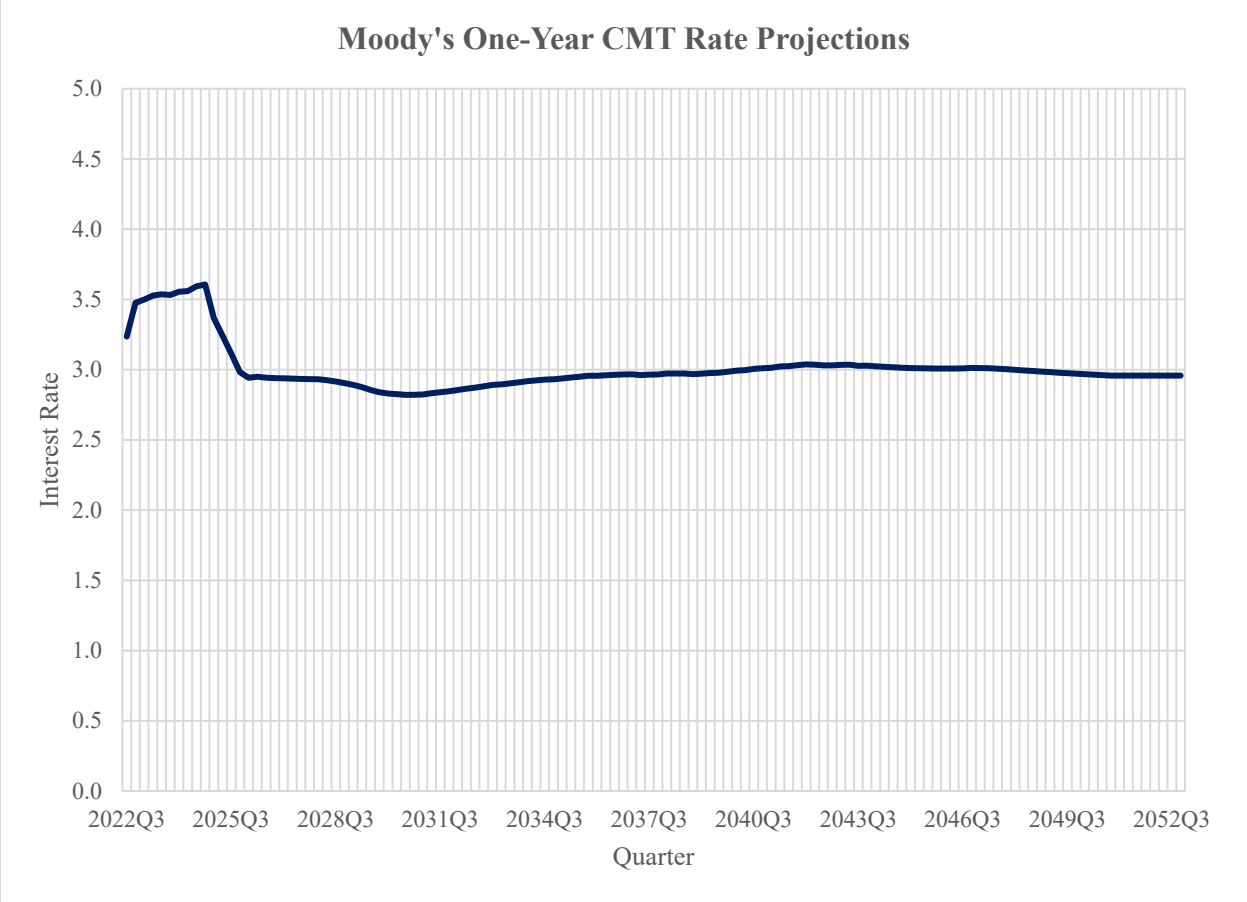
Figure 2: 10-Year CMT Rate



The 10-year CMT rate shows a similar trend, although the changes are not as significant. In mid-2007, the 10-year CMT rate was over 5%. Since that time, the rate dropped to under 2% in 2012. After 2012, the rate increased to just over 3.0% by December 2018. The rate had since been decreasing, and due to the economic impacts of COVID-19 had dropped to 0.64% by the third quarter of 2020, the lowest level in the last 30 years. Since then, the rate has increased to 2.87% as of the third quarter of 2022.

For the purposes of projecting Cash Flow NPV, it is required that RMA produce an estimate using the projection figures from the OMB. In addition to OMB projections, RMA has also used Moody's economic projections to generate a range of indications of the economic value. Figure 3 shows the one-year CMT rate projection from Moody's Baseline Scenario.

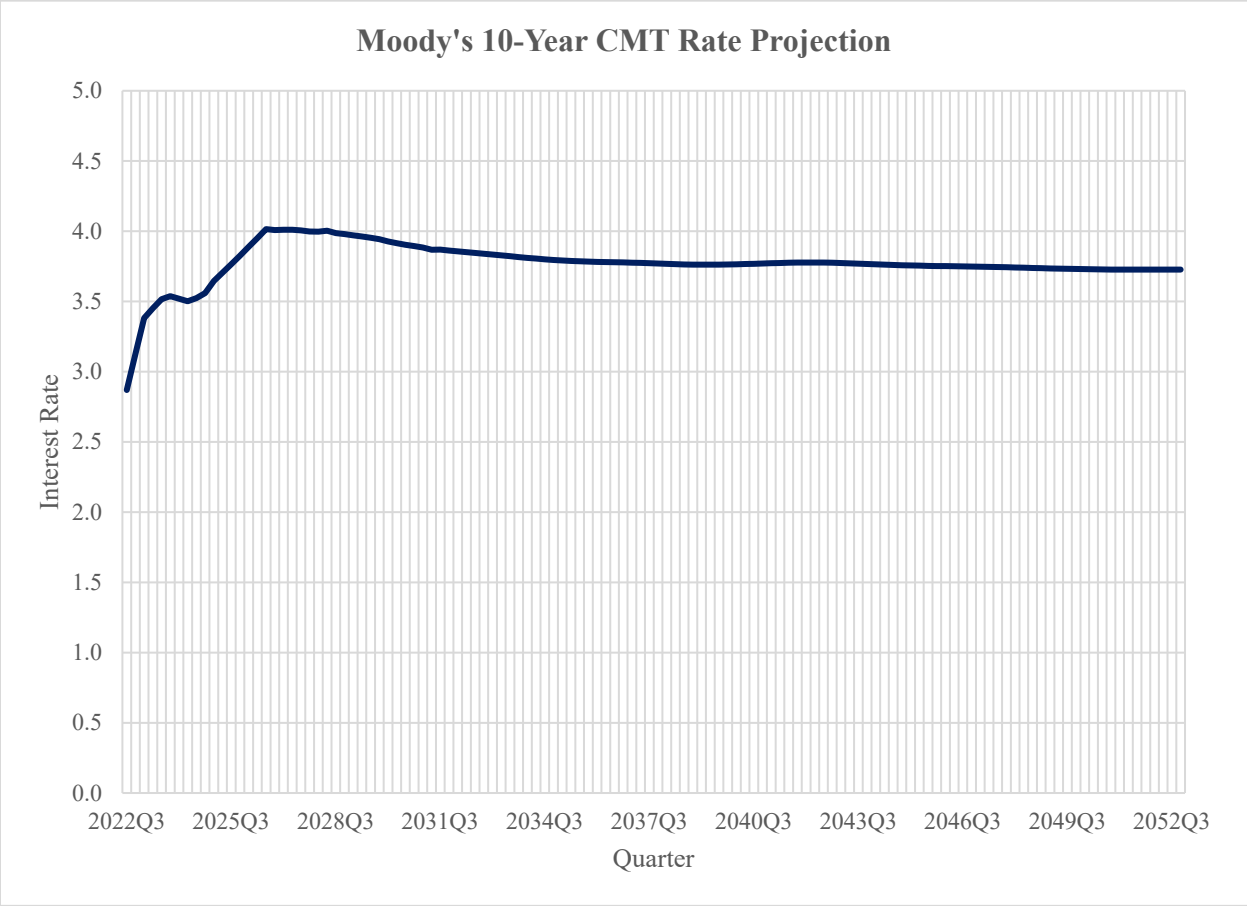
Figure 3: One-Year CMT Rate Projections



Moody's projections show increases in the one-year CMT rate. The rate increases to 3.6% by 2024, and then decreases to 2.8% by 2030. The projection then remains in the range of 2.9% to 3.0% for the rest of the projection period.

The 10-year CMT rate projection from Moody's is shown in Figure 4.

Figure 4: 10-Year CMT Rate Projection

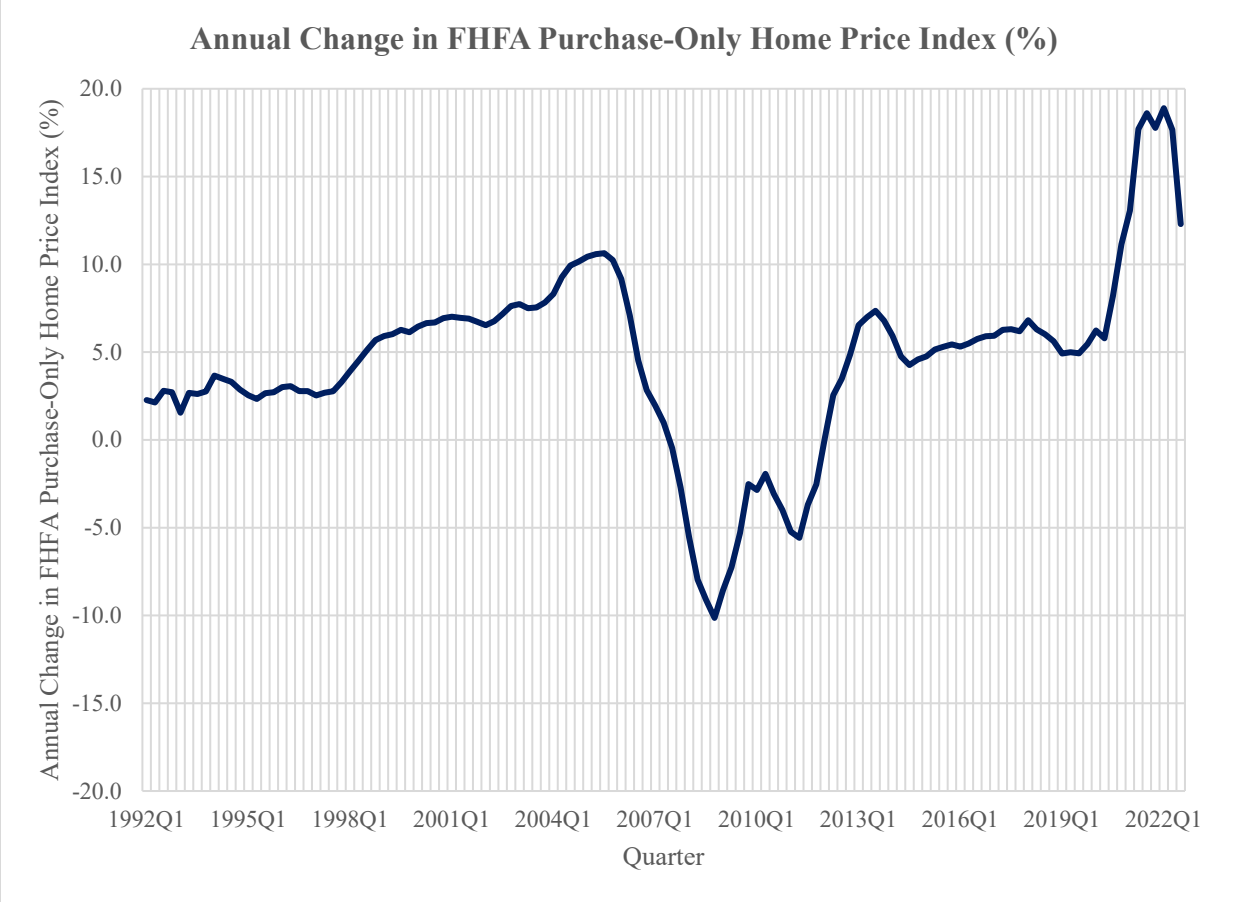


The 10-year CMT rate increases to 4.0% by 2026, and then decreases to a long-term average of just over 3.7.

Home Price Index Growth

The growth rate in home prices will have an impact on the volume of mortgages endorsed by FHA, the percentage of defaults in mortgages and the ultimate cost of the mortgage insurance claims. The annual percentage change in the historical Federal Housing Finance Agency (FHFA) Purchase Only House Price Index by quarter is shown in Figure 5.

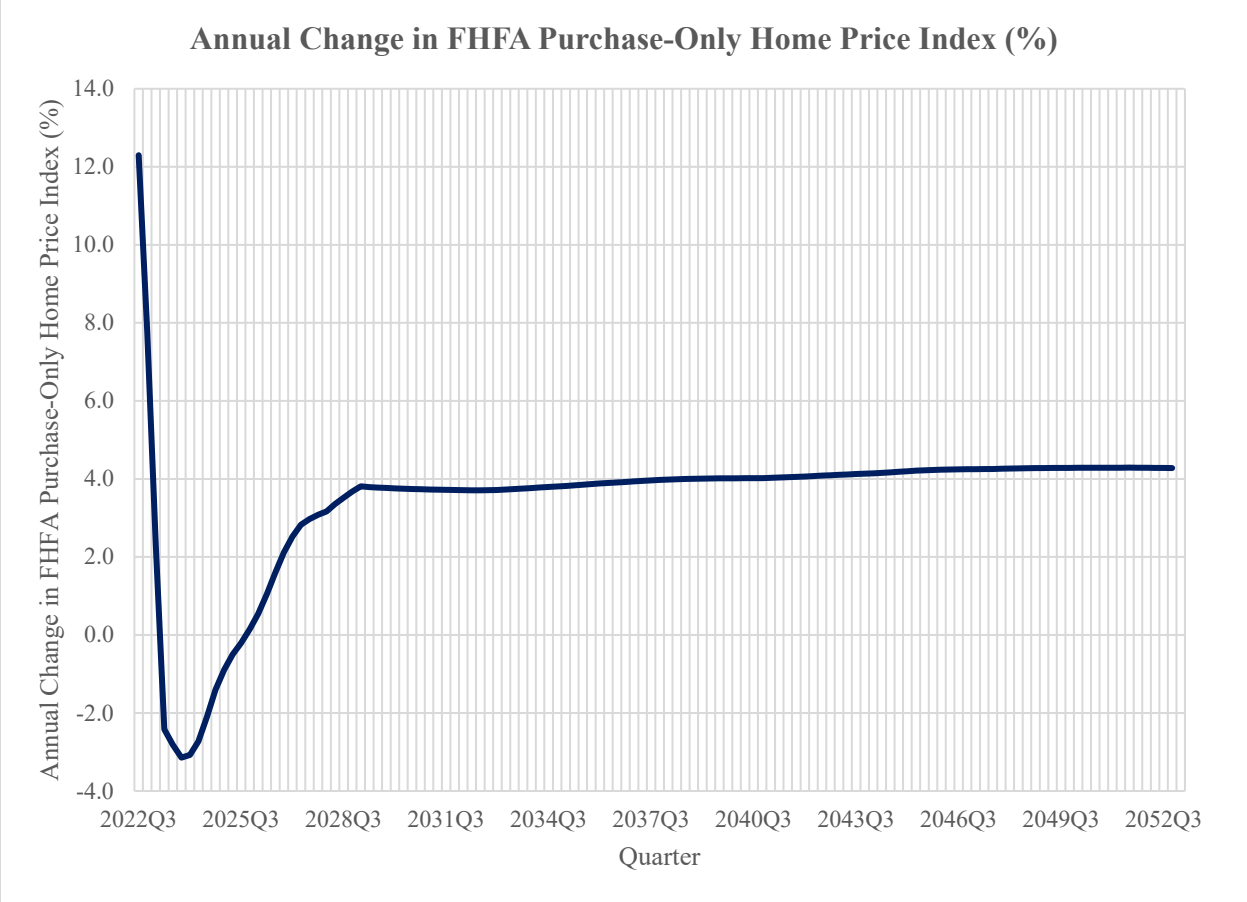
Figure 5: Historical FHFA Purchase Only House Price Index



From 1992 through 2005, the annual rate of change increased to a high of over 10%. During the housing crisis that began in 2006, the annual rate of change decreased significantly, dropping to a low of -10% in 2008, and remained negative through 2011. The trend then increased again, and continued through 2013, and the rate then remained between 5% and 7% through the second quarter of 2020. The rate then began increasing in the third quarter of 2020 due to a significant increase in housing demand and was at a high of 18.9% in the first quarter of 2022. The annual rate of change was at 12.3% in the third quarter of 2022.

Moody's projects the home price index to 2052. Moody's also produces a forecast for local areas, including metropolitan areas and states. The annual percentage change in the countrywide projected FHFA Purchase Only House Price Index by quarter is shown in Figure 6 for Moody's baseline projections.

Figure 6: FHFA Purchase Only House Price Index – Moody's Baseline Projections

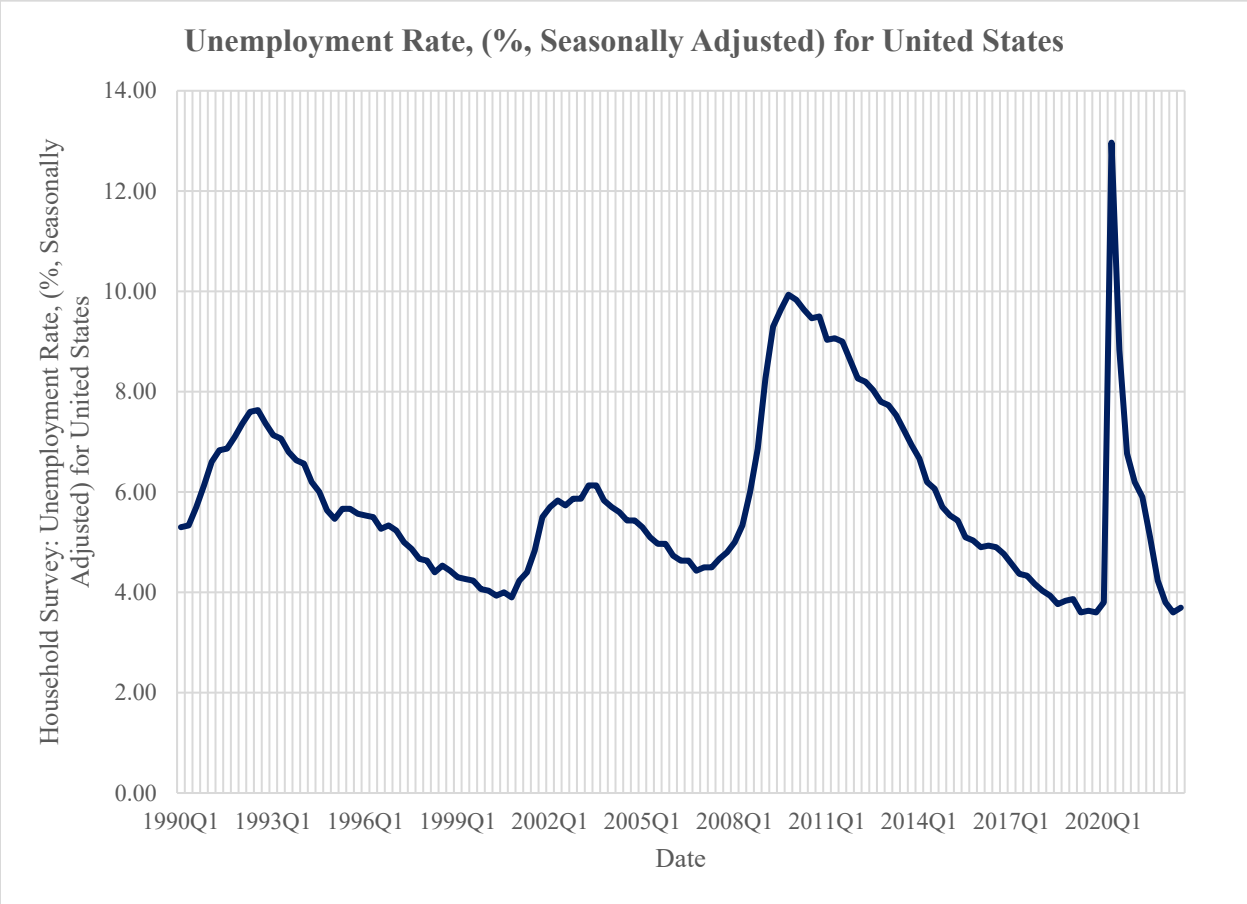


For Moody's Baseline projections, the annual percentage change for the index decreases to -3.1% in 2023. The rate then increases sharply to a long-term average of 4.0% by 2030.

Unemployment Rate

The unemployment rate has an impact on the ability of homeowners to make their mortgage payments. This impacts the default rates and ultimate projections of the MMI. The historical unemployment rate is shown below.

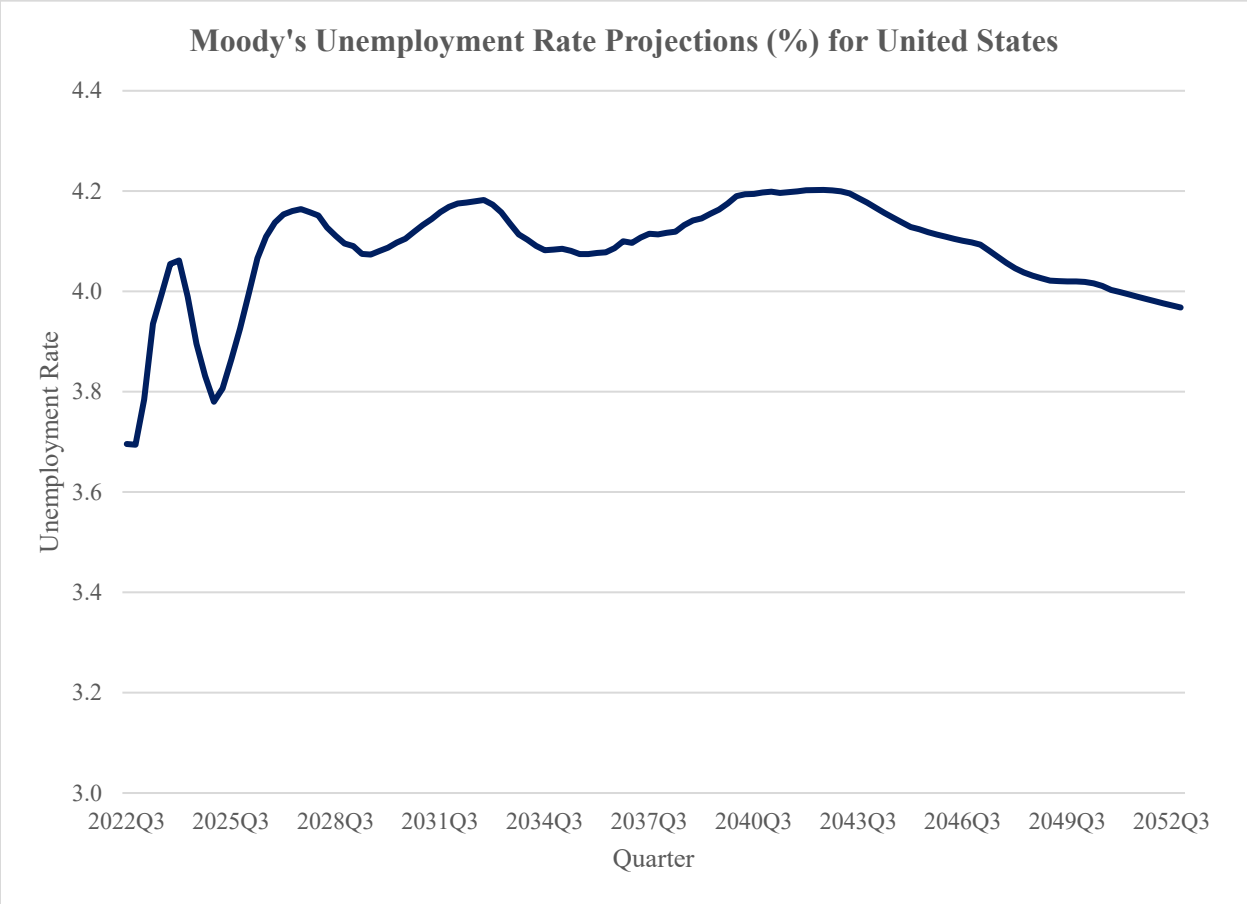
Figure 7: Historical Unemployment Rate



Beginning in 2008, as the economic downturn occurred, the seasonally adjusted unemployment rate nearly doubled from 5% to just under 10% by the end of 2009. Since 2009, the rate had decreased steadily to 3.5% by year-end 2019. In 2020, the economic issues associated with the COVID-19 pandemic resulted in an unemployment rate of 13.0% in the second quarter of 2020. The rate has recovered to 3.7% as of the third quarter of 2022.

The projected unemployment rates from Moody's are shown in Figure 8.

Figure 8: Unemployment Rate Projection



Moody's projections show an increase in unemployment rates through 2024, followed by decreasing rates through 2025. The unemployment rate then continues to increase slowly through 2027 to 4.1%.

Mortgage Volume

The mortgage endorsement volume for FHA and the U.S. home market is shown in Table 5. The health and capacity of the private mortgage insurance market can impact the projected value of the MMI. If the private mortgage insurance market increases capacity and is successful in providing insurance to borrowers who are less likely to default, it could have a negative impact on the Cash Flow NPV of the MMI.

Table 5: FHA Share of Home Sales (in $ billion)

Calendar Year	FHA	Market	FHA Share
2001	89	959	9.2%
2002	82	1,097	7.5%
2003	71	1,274	5.6%
2004	53	1,306	4.1%
2005	37	1,506	2.5%
2006	36	1,402	2.5%
2007	39	1,144	3.5%
2008	129	743	17.4%
2009	185	652	28.3%
2010	167	540	31.0%
2011	129	503	25.7%
2012	127	594	21.3%
2013	119	728	16.4%
2014	107	758	14.1%
2015	154	897	17.1%
2016	176	1,051	16.7%
2017	174	1,139	15.3%
2018	158	1,206	13.1%
2019	170	1,221	13.9%
2020	193	1,484	13.0%
2021	206	1,871	11.0%
2022	135	1,359	9.9%

Sources: FHA Volume from FHA Data Warehouse, September 30, 2022, extract. Market volume from Mortgage Bankers Association.

FHA's share of the volume of home sales has increased significantly from its low of 2.5% in 2005 and 2006. From 2002 to 2006, FHA's share of the number and volume of home sales declined as the subprime mortgage market expanded from 2003 to 2007. The housing and economic crisis that occurred in 2008 decreased the availability of mortgages in general, and significantly impacted the availability of subprime mortgages. Private mortgage insurers were also facing significant losses and decreased the volume of insurance they were providing. As a result, FHA's market share began to increase significantly. The volume of FHA endorsed mortgages increased from 2.5% to 31.0% from 2006 to 2010. As the housing market has recovered, the percentage of loans endorsed by FHA had decreased steadily through 2018 to 13.1%. In 2019, the FHA share increased to 13.9%, but has decreased since then. Through the first three calendar quarters of 2022, the FHA share of mortgage originations has decreased to 9.9%. This may be due to the increased demand in the housing market since 2021, the increased willingness of private mortgage insurers to support this increased demand, and the increase in demand for mortgages above the FHA mortgage limits.

Report Structure

The remainder of this report is divided into the following sections:

Section 2 - Summary of Findings and Comparison with Fiscal Year 2021 Actuarial Review – presents the MMI Economic Net Worth for Fiscal Year 2022 and the projected Cash Flow NPV by cohort and product. This section also provides a reconciliation and explanation of the major differences between the Fiscal Year 2021 and Fiscal Year 2022 reports.

Section 3 - Cash Flow NPV Based on Alternative Scenarios – presents estimates of the MMI Cash Flow NPV using a range of alternative economic assumptions.

Section 4 - Characteristics of the Fiscal Year 2022 Insurance Portfolio – describes the Fiscal Year 2022 insurance portfolio and compares the risk characteristics of the origination books of business across historical fiscal years.

Section 5 – Summary of Methodology – presents an overview of the data processing, transition, loss severity and cash flow models used in the analysis.

Appendix A: Data – Sources, Processing and Reconciliation – provides a description of the data sources used for the analysis, the data processing required to prepare the data for analysis and the data reconciliation performed.

Appendix B – Transition Models – provides a technical description of our predictive models of current and default transitions, the model parameters and model validation results.

Appendix C: Loss Severity Models – provides a technical description of our predictive models of loss severity rates, the model parameters and model validation results.

Appendix D: Economic Scenarios – describes the forecast of future values of economic factors that affect the performance of the MMI and presents the variation in estimated Cash Flow NPV based on the additional economic scenarios. Details of the stochastic analysis are also provided.

Appendix E: Cash Flow Analysis – describes the process used to project future cash flows.

Appendix F: Review of HUD Analysis of Economic Net Worth, Comparison of HUD and RMA Models, and Assessment of Vulnerabilities – high-level review of HUD models developed to project Economic Net Worth, comparison of the models developed by HUD with the models developed by RMA, and assessment of the vulnerabilities of the models developed.

Appendix G: Summary of Historical and Projected Claim Rates, Non-Claim Termination Rates and Loss Severities – historical and projected claim, non-claim termination and loss severity rates.

Section 2 - Summary of Findings and Comparison with Fiscal Year 2021 Actuarial Review

This section presents the Economic Net Worth and the details of the Cash Flow NPV of the MMI Forward Loan portfolio as of the end of Fiscal Year 2022, and shows a comparison of the elements of the Economic Net Worth between the 2021 Actuarial Review and this review.

Economic Net Worth Estimate

The Economic Net Worth is defined as cash available to the Fund plus the Cash Flow NPV of all future cash outflows and inflows that are expected to result from the mortgages currently insured by the MMI. The 2022 Actuarial Review estimates the Cash Flow NPV of the MMI as of the end of Fiscal Year 2022 using data through September 30, 2022. We developed this estimate by analyzing historical loan performance using data provided by FHA, developing predictive models for loan transition and losses, and using these model results along with economic projections from the OMB and Moody's to project future cash flows of the MMI. The NPV of these cash flows along with the MMI's capital resources represent the economic value of the MMI.

The predictive models used in this report are similar structurally to the models developed in the 2021 Actuarial Review. We have developed binomial logistical models by product type to predict each transition type independently. The binomial model results are then combined in the final simulation to reflect the multiple possible transition outcomes.

Transition types are discussed in more detail in Appendix B.

Appendices A through G describe the individual models, the assumptions used and the detailed projection model results. Our main findings are as follows.

The Cash Flow NPV is computed from the projected cash flows occurring after the end of Fiscal Year 2022. It is computed based on economic projections associated with the OMB Economic Assumptions. **As of the end of Fiscal Year 2022, RMA estimates that the MMI Cash Flow NPV is positive $46.764 billion.** The Cash Flow NPV estimate provided by FHA to be used in FHA's Annual Report to Congress is positive $37.089 billion.

The capital resource available to the MMI is positive $89.512 billion, which results in an Economic Net Worth of positive $136.276 billion.

In addition to the overall estimate of the Cash Flow NPV, we have estimated the Cash Flow NPV by cohort. The RMA estimate compared to the FHA estimate by cohort is shown below.

Table 6: Cash Flow NPV by Cohort (in $ billion)

Cohort	RMA	FHA	Dollar Difference
1992	0.0	0.0	0.0
1993	0.0	0.0	0.0
1994	0.0	0.0	0.0
1995	0.0	0.0	0.0
1996	0.0	0.0	0.0
1997	0.0	0.0	0.0
1998	0.0	0.0	0.0
1999	0.0	0.0	0.0
2000	0.0	0.0	0.0
2001	0.0	0.0	0.0
2002	-0.1	0.0	-0.1
2003	-0.1	0.0	-0.1
2004	-0.1	0.0	-0.1
2005	-0.1	0.0	-0.1
2006	-0.1	0.0	-0.1
2007	-0.2	0.0	-0.1
2008	-0.4	-0.1	-0.4
2009	-0.5	-0.1	-0.4
2010	-0.6	-0.1	-0.4
2011	-0.4	-0.1	-0.3
2012	-0.5	-0.1	-0.4
2013	-0.7	0.3	-1.0
2014	1.0	1.0	-0.1
2015	1.8	1.7	0.1
2016	2.5	2.4	0.2
2017	2.9	2.8	0.1
2018	2.3	2.2	0.1
2019	2.6	2.3	0.3
2020	8.9	6.8	2.1
2021	16.6	11.6	5.0
2022	12.3	6.7	5.6
Total	46.8	37.1	9.7

The RMA estimates by cohort are consistent with the FHA estimates for cohorts 1992 – 2012, 2014 – 2019, lower for cohort 2013, and higher for the 2020 – 2022 cohorts. The total RMA Cash Flow NPV estimate is $9.7 billion higher than the FHA estimate, which as a percentage of unamortized IIF is 0.70%. The current unamortized IIF is $1,384 billion. The difference between the RMA and FHA estimate as a percentage of amortized IIF is 0.78%. The current amortized IIF is $1,237 billion. Unamortized IIF is the original mortgage amounts of all active endorsements. The amortized IIF reflects the current outstanding loan balance of all active endorsements.

The housing and economic crisis that occurred in 2008 has resulted in higher claim rates for mortgages originated during Fiscal Years 2005 – 2010. Given that their upfront MIP has already been collected and is included as part of the current capital resources, and due to their large

origination volume, the Fiscal Year 2008 – 2013 cohorts are estimated to experience larger negative Cash Flow NPVs than other cohorts. However, at the end of the housing recession, house prices bottomed out and then started to increase. As a result, mortgages originated in Fiscal Years 2014 – 2021 have positive Cash Flow NPVs. The NPV is also being positively impacted for these more recent cohorts due to MIP now being collected over the life of the mortgage. In addition, the low mortgage interest rates in 2020, 2021 and the first quarter of 2022 resulted in a lower likelihood of termination, thus resulting in projections of MIP being collected for a longer period in the simulation.

Also, the 2020 and 2021 Cash Flow NPV was influenced by a significant increase in new originations. There was a significant increase in refinance activity during this period. While this resulted in a decrease in Cash Flow NPV for older cohorts, it also resulted in an increase in Cash Flow NPV for the 2020 and 2021 cohorts as the older loans refinanced into newer cohorts.

Interest rates through the first half of Fiscal Year 2022 were still at historic lows, and this tends to increase the NPV as the likelihood of refinance decreases. As interest rates have increased in the latter half of Fiscal Year 2022, this likelihood of refinance will tend to be lower for these loans. However, given the projected increase in interest rates, the rate of refinance remains relatively low for loans originated in Fiscal Year 2022.

The table below shows RMA's Cash Flow NPV estimates by cohort and product.

Table 7: Cash Flow NPV by Cohort and Product

Cohort	Fixed Rate 30	Fixed Rate 15	Adjustable-Rate Mortgage	Total
1992	-	-	-	-
1993	(29,527)	-	(26,662)	(56,189)
1994	(265,042)	-	(195,608)	(460,650)
1995	(698,837)	-	(155,729)	(854,566)
1996	(2,003,941)	-	(329,723)	(2,333,664)
1997	(3,456,148)	-	(540,529)	(3,996,677)
1998	(8,955,538)	-	(404,880)	(9,360,418)
1999	(15,319,773)	-	(765,916)	(16,085,689)
2000	(15,446,858)	-	(793,987)	(16,240,845)
2001	(33,182,871)	-	(391,227)	(33,574,098)
2002	(64,046,107)	-	(1,704,535)	(65,750,642)
2003	(90,159,784)	-	(1,197,876)	(91,357,660)
2004	(139,707,069)	-	(4,133,265)	(143,840,334)
2005	(141,902,047)	-	(4,428,985)	(146,331,032)
2006	(134,688,459)	-	(1,470,406)	(136,158,865)
2007	(183,881,097)	-	(1,261,776)	(185,142,873)
2008	(442,371,850)	(22,685)	(2,876,369)	(445,270,904)
2009	(534,265,566)	(167,630)	(3,159,661)	(537,592,857)
2010	(553,192,669)	(229,581)	(6,987,974)	(560,410,224)
2011	(369,990,712)	(369,410)	(8,122,713)	(378,482,835)
2012	(489,637,322)	(869,614)	(2,965,145)	(493,472,081)

Cohort	Fixed Rate 30	Fixed Rate 15	Adjustable-Rate Mortgage	Total
2013	(702,279,254)	(311,889)	95,800	(702,495,343)
2014	944,848,906	3,598,701	10,679,647	959,127,254
2015	1,756,482,008	6,210,549	8,030,614	1,770,723,171
2016	2,513,157,430	8,115,024	4,170,136	2,525,442,590
2017	2,840,865,632	10,621,837	3,136,972	2,854,624,441
2018	2,258,544,080	6,847,404	2,143,959	2,267,535,443
2019	2,597,431,745	5,719,016	1,286,872	2,604,437,633
2020	8,859,760,255	8,567,328	836,366	8,869,163,949
2021	16,561,769,449	19,241,009	1,028,205	16,582,038,663
2022	12,281,449,987	14,319,539	4,476,202	12,300,245,728
Total	46,688,829,021	81,269,598	(6,028,193)	46,764,070,426

The value of the overall Cash Flow NPV is influenced primarily by the fixed rate 30-year mortgage (FRM30) product, which has the largest volume of mortgages. The total Cash Flow NPV is positive for the FRM30 and Fixed Rate 15-year (FRM15) products and is negative for the ARM products.

Change in the Economic Net Worth

Table 8 shows the comparison of our estimate of the MMI's Cash Flow NPV and IIF as of the end of Fiscal Year 2022 to the Cash Flow NPV estimate in the 2021 Review.

Table 8: Estimate of Cash Flow NPV as of the end of Fiscal Year 2022 (in $ million)

Item	2021	2022	Dollar Difference	Percent Change
Cash Flow NPV	25,696	46,764	21,068	82.0%
Capital Resources	78,500	89,512	11,012	14.0%
Economic Net Worth	104,196	136,276	32,080	30.8%
Unamortized Insurance-In-Force	1,323,092	1,383,596	60,504	4.6%

As seen in Table 8, the estimated Fiscal Year 2022 Cash Flow NPV of the MMI has increased by $21.068 billion from the level estimated in Fiscal Year 2021, from $25.696 billion to positive $46.764 billion. The capital resources available to the MMI have increased by 14.0%, from $78.500 billion to positive $89.512 billion. The unamortized IIF increased by 4.6% from $1,323 billion to $1,384 billion. The change in the Cash Flow NPV represents the net impact of several significant factors, which are described in the next section.

Sources of Change in the Cash Flow NPV from the Fiscal Year 2021 Review

Table 9 provides a summary of the decomposition of changes in the Cash Flow NPV of the MMI as of the end of Fiscal Year 2022 as compared to the Cash Flow NPV in the Fiscal Year 2021 report. The overall net change in the Cash Flow NPV is positive.

Table 9: Changes in Projected Cash Flow NPV

	Change in NPV	Cash Flow NPV - 9/30/22
Baseline FY1992-FY2021		25,695,952,625
Impact of assumption change	-3,361,690,976	22,334,261,649
Impact of model change	17,187,352,672	39,521,614,321
Impact of book change	-5,057,789,619	34,463,824,702
FY1992-FY2021	8,767,872,077	
FY2022	12,300,245,728	46,764,070,430
Cumulative Change	21,068,117,805	

This section describes the sources of change in estimates of Cash Flow NPV between this year's review and last year's review. Separating out the specific impacts can be done only up to a certain degree of accuracy as the results can vary depending on the order in which the decomposition is done. The interdependency among the various components of the analysis prevents us from identifying and analyzing these as purely independent effects. Given this limitation, this section presents a description of the approximate differences in the Cash Flow NPV from that presented in the Fiscal Year 2021 Review by source of change.

Updated Economic Scenario Forecast

For this decomposition step, we updated the forecasts for the purchase-only HPI and the interest and unemployment rates from 2022 PEA forecast to the 2023 PEA forecast. This step also replaces the projection used in 2021 Actuarial Review with the actual economic experience for the fourth quarter of 2021 and the first three quarters of 2022.

The cumulative result of these economic assumption changes is a decrease of $3.362 billion in the projected Cash Flow NPV.

Updated Predictive Models

With this analysis, we have continued to refine the predictive models to capture better the termination behavior and projected claim amounts of loans in the MMI. We re-estimated the models using updated data and revised variable specifications, and the model assumptions have been adjusted to better reflect the expected ultimate projected claim rates. We have also adjusted our models for the impact of changes to forbearance rules and the economic impacts of COVID-19. For details about these model updates and refinements, refer to Appendices B, C, and E.

These model changes led to an increase in estimated economic value in the Cash Flow NPV of $17.187 billion.

Actual Performance of Cohorts 2021 and Prior in Fiscal Year 2022

The actual performance of the MMI 2021 and prior cohorts realized during Fiscal Year 2022 affects the Cash Flow NPV of the MMI estimate of the in-force portfolio. The actual experience

for this period was $5.058 billion worse than expected. This is driven in part by rising mortgage and interest rates.

Fiscal Year 2022 Origination Volume

The addition of the origination volume for the Fiscal Year 2022 book of business had a positive impact on the NPV. This additional origination volume increased the Cash Flow NPV projection by $12.300 billion.

Section 3 – Cash Flow NPV Based on Alternative Scenarios

The Cash Flow NPV of the MMI will vary from our estimates if the actual economic drivers of mortgage performance deviate from the baseline projections associated with the OMB Economic Assumptions. In this section, we develop additional estimates of the Cash Flow NPV based on the following approaches:

1. Moody's economic scenarios
2. Stochastic simulation of key economic variables
3. Sensitivity testing of key economic variables

We use these additional estimates of the Cash Flow NPV to develop a range of estimates. These alternative estimates are compared to the Cash Flow NPV resulting from the OMB Economic Assumptions to determine the sensitivity of the Cash Flow NPV estimate to alternative assumptions.

Each Moody's scenario produces an estimate of the Cash Flow NPV using future interest, unemployment and HPI rates as a deterministic path. We are including 10 Moody's scenarios in the analysis. These scenarios are consistent with the scenarios used in the 2021 Actuarial Review.

The Moody's scenarios are:

- Baseline
- Alternative 0 – Upside (4th Percentile)
- Alternative 1 – Upside (10th Percentile)
- Alternative 2 – Downside (75th Percentile)
- Alternative 3 – Downside (90th Percentile)
- Alternative 4 – Downside (96th Percentile)
- Slower Trend Growth
- Stagflation
- Next-Cycle Recession
- Low Oil Price

The resulting Cash Flow NPV associated with each alternative scenario is summarized in Table 10. Below, we discuss the characteristics of each Moody's scenario.

Baseline Scenario

In the Baseline scenario, the HPI increases throughout the entire projection period. The rate of increase decreases from 7.8% to -3.1% in the fourth quarter of 2023, and then increases to about 4.0% per year by 2037 and remains at this level for the remainder of the projection period. The mortgage interest rate remains flat through the third quarter of 2024, increases through the third

quarter of 2026, and then stabilizes at 5.6%. The unemployment rate is projected to decrease through 2022 to approximately 3.55%, and then increases to 4.1% by the first quarter of 2024. The rate then decreases to 3.8% by the first quarter of 2025, and then increases to 4.1% by 2027. The rate then remains around 4% for the remainder of the projection period.

Alternative Scenario 0 – Upside (4th Percentile)

In the Alternative Scenario 0 – Upside (4th Percentile), the HPI increases throughout most of the projection period. The rate of increase decreases from 10.7% to -0.3% by 2025, and then increases to about 4.0% per year for the remainder of the projection period. The mortgage interest rate remains flat through the third quarter of 2024, increases through the third quarter of 2026, and then levels off at 5.6%. The unemployment rate is projected to decrease in the fourth quarter of 2022, remain steady through the fourth quarter of 2025, and then increase gradually until it stabilizes at approximately 3.8%.

Alternative Scenario 1 – Upside (10th Percentile)

In Alternative Scenario 1 – Upside (10th Percentile), the HPI is projected to increase most of the projection period. The rate of increase drops sharply from 9.4% per year in the fourth quarter of 2021 to -0.9% per year by the first quarter of 2025. The rate then increases to about 4.0% per year for the remainder of the projection period. The mortgage interest rate remains flat through the third quarter of 2024, increases through the third quarter of 2026, and then levels off at 5.6%. The unemployment rate is projected to decrease in the fourth quarter of 2022, remain steady through the fourth quarter of 2025, and then increase gradually until it stabilizes at approximately 3.9%.

Alternative Scenario 2 – Downside (75th Percentile)

In the Alternative Scenario 2 – Downside (75th Percentile), the HPI increases through the fourth quarter of 2022, decreases through the first quarter of 2026, and then increases for the remainder of the projection period. The rate of increase increases to approximately 4.0% by 2033. Mortgage interest rates are projected to decrease through the second quarter of 2023, then increase through third quarter of 2026, and then level off for the remainder of the projection period at approximately 5.6%. The unemployment rate is projected to increase to 6.4% by the third quarter of 2023 then decrease to 4.0% by 2024.

Alternative Scenario 3 – Downside (90th Percentile)

In the Alternative Scenario 3 – Downside (90th Percentile), the HPI increases through the fourth quarter of 2022, decreases through the first quarter of 2024, and then begins to increase. Mortgage interest rates are projected to decrease through the third quarter of 2023, increase through the third quarter of 2026, and then level off for the remainder of the projection period at approximately

5.6%. The unemployment rate increases to 7.8% in the fourth quarter of 2023, then decreases to 4.1% by 2027.

Alternative Scenario 4 – Downside (96th Percentile)

In Alternative Scenario 4 – Downside (96th Percentile), the HPI decreases from the fourth quarter of 2023, through the second quarter of 2024, and then begins to increase. Mortgage interest rates are projected to decrease through the third quarter of 2024, then increase through first quarter of 2027, and then level off for the remainder of the projection period at approximately 5.6%. The unemployment rate spikes to 8.9% by 2024, and then decreases to 4.2% by 2032.

Slower Trend Growth

In the Slower Trend Growth scenario, the HPI increases through the first quarter of 2024, decreases through the first quarter of 2026, and then begins to increase. Mortgage interest rates decrease through the third quarter of 2024, increase through the second quarter of 2027 before leveling off at about 5.5%. The unemployment rate increases to 5.2% by the end of 2023, then decreases slowly to 4.1% by the end of 2028.

Stagflation

In the Stagflation scenario, the HPI increases through the first quarter of 2023, decreases through the fourth quarter of 2025, and then begins to increase. Mortgage interest rates increase in the fourth quarter of 2022, then decrease through the second quarter of 2025. Mortgage rates then increase through the fourth quarter of 2026, and level off at 5.6%. The unemployment rate increases to 9.1% by the end of 2024, and then decreases to a long-term average of 4.1% by 2028.

Next-Cycle Recession

In the Next-Cycle Recession scenario, the HPI increases through the first quarter of 2023, and then decreases through the fourth quarter of 2024. The HPI then increases for the remainder of the projection period. Mortgage interest rates increase in the fourth quarter of 2022, then decrease through the fourth quarter of 2023. Mortgage rates then increase through the third quarter of 2026, and level off at 5.6%. The unemployment rate increases to 6.2% by the fourth quarter of 2023. The rate then decreases to 4.1% by 2026, where it remains for the remainder of the projection period.

Low Oil Price

In the Low Oil Price scenario, the HPI increases through the first quarter of 2023, then decreases through the first quarter of 2026. The HPI then increases for the remainder of the projection period. Mortgage interest rates are projected to decrease through the first quarter of 2024, then increase through third quarter of 2026, and then level off for the remainder of the projection period at approximately 5.5%. The unemployment rate decreases through the fourth quarter of 2022, then

increases through the first quarter of 2024. The unemployment rate then decreases again through the second quarter of 2025, and then increases gradually to a long-term average of 4.1%.

Summary of Alternative Scenarios

Table 10 shows the projected Cash Flow NPV from the 11 deterministic scenarios. The range of projected results is between positive $27.873 billion and positive $49.025 billion.

Table 10: Cash Flow NPV Summaries from Alternative Scenarios

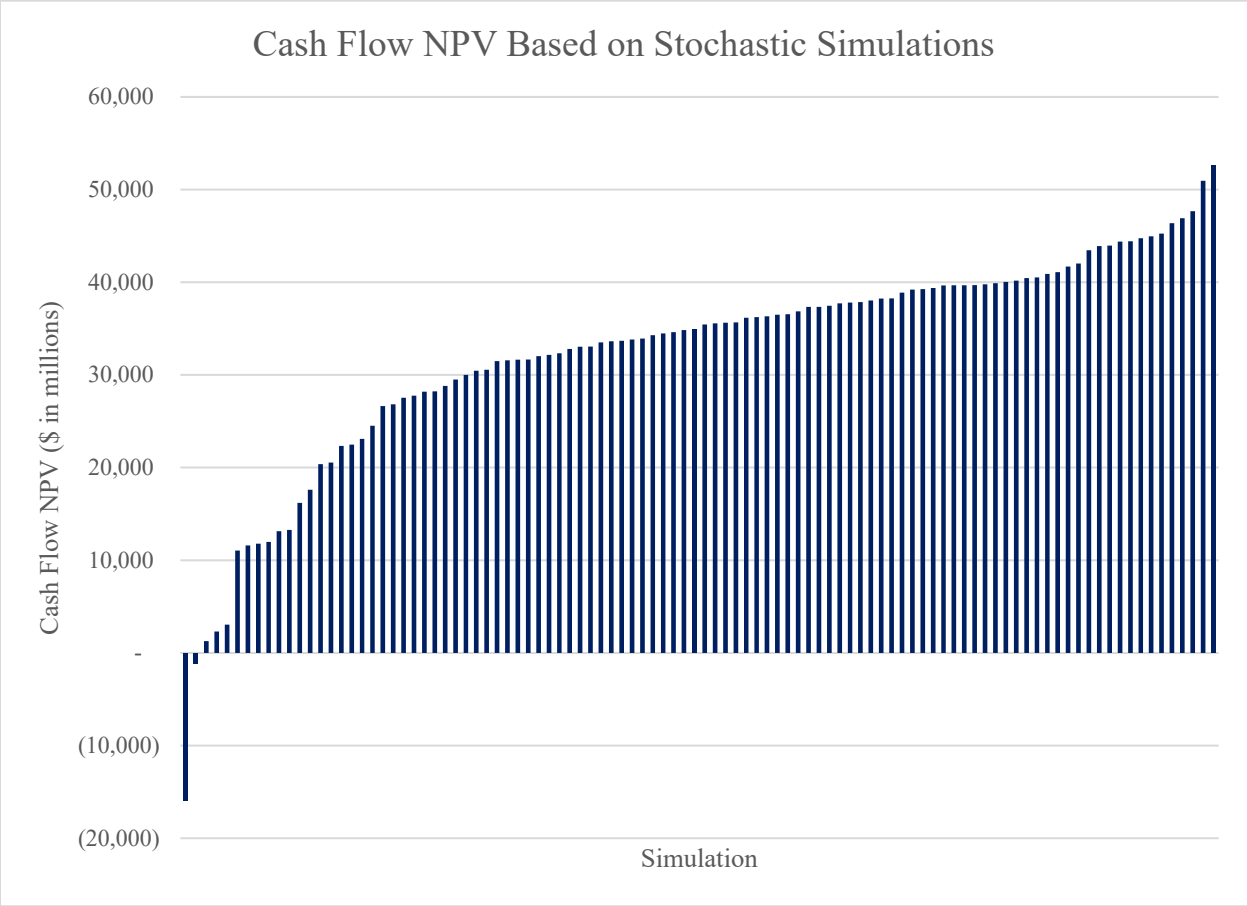
Cohort	RMA ACE	Baseline	Alternative 0 – Upside (4th Percentile)	Alternative 1 – Upside (10th Percentile)	Alternative 2 – Downside (75th Percentile)	Alternative 3 – Downside (90th Percentile)	Alternative 4 – Downside (96th Percentile)	Slower-Trend Growth	Stagflation	Next-Cycle Recession	Low Oil Price
1992	0	-658	0	0	0	0	0	0	0	0	0
1993	-56,189	-95,594	-46,280	-55,508	-31,993	-92,488	-118,500	-47,230	-51,277	-50,832	-98,091
1994	-460,650	-539,442	-332,657	-387,612	-540,346	-737,092	-907,254	-503,117	-516,184	-512,454	-367,970
1995	-854,566	-1,185,971	-817,174	-1,011,380	-1,365,981	-1,621,784	-1,712,040	-1,203,007	-1,258,444	-1,256,170	-889,201
1996	-2,333,664	-2,991,365	-2,214,823	-2,425,699	-4,083,681	-4,612,766	-5,644,029	-3,211,051	-4,358,691	-4,567,582	-2,264,517
1997	-3,996,677	-5,407,378	-4,293,113	-4,241,166	-6,013,873	-8,043,763	-9,149,667	-5,680,999	-7,589,128	-7,050,103	-4,117,540
1998	-9,360,418	-12,992,915	-8,456,210	-10,169,864	-13,770,712	-17,327,769	-21,025,878	-14,483,947	-18,197,049	-14,833,305	-10,359,453
1999	-16,085,689	-20,777,845	-16,523,496	-16,952,834	-23,967,666	-31,209,074	-36,291,727	-24,393,348	-29,702,419	-26,685,798	-17,939,115
2000	-16,240,845	-19,658,237	-15,442,166	-16,102,506	-23,778,760	-25,123,307	-31,016,431	-22,726,572	-26,655,249	-24,184,063	-16,102,061
2001	-33,574,098	-44,015,730	-35,836,484	-39,686,836	-48,714,972	-55,899,210	-71,539,949	-48,221,451	-59,496,870	-54,463,571	-38,185,942
2002	-65,750,642	-82,025,479	-69,150,421	-71,891,538	-84,803,001	-98,683,784	-115,686,298	-86,272,439	-105,631,012	-95,044,609	-68,288,651
2003	-91,357,660	-118,655,560	-98,964,660	-102,745,428	-117,222,910	-142,725,382	-168,173,521	-122,346,184	-160,048,200	-133,045,054	-95,900,228
2004	-143,840,333	-182,936,537	-151,356,579	-159,753,439	-183,038,727	-209,798,923	-246,710,357	-185,443,706	-227,412,046	-202,133,761	-152,504,226
2005	-146,331,032	-170,837,328	-151,480,990	-155,122,950	-177,808,935	-209,447,702	-232,559,718	-179,540,730	-223,021,906	-188,845,668	-154,282,930
2006	-136,158,864	-164,007,135	-142,902,383	-143,864,831	-174,219,792	-195,560,341	-234,722,598	-176,809,720	-214,321,920	-184,216,671	-143,789,936
2007	-185,142,873	-219,717,814	-187,610,694	-191,838,475	-222,435,595	-263,915,851	-299,056,086	-230,643,714	-282,050,680	-245,553,116	-196,325,591
2008	-445,270,904	-560,442,352	-484,310,344	-504,152,298	-557,432,279	-616,629,976	-721,910,153	-586,086,410	-661,043,341	-635,281,048	-483,714,575
2009	-537,592,857	-672,476,483	-559,173,644	-555,021,036	-715,962,450	-804,070,640	-909,753,819	-703,750,662	-808,906,958	-775,854,055	-556,858,577
2010	-560,410,224	-689,169,835	-583,124,397	-606,932,876	-746,933,667	-810,744,581	-901,485,162	-728,941,564	-838,555,333	-782,037,125	-569,349,093
2011	-378,482,835	-454,654,061	-380,991,857	-396,844,291	-528,922,626	-576,149,882	-637,510,325	-508,902,202	-603,972,079	-540,676,095	-361,642,890
2012	-493,472,081	-640,102,115	-509,616,846	-552,567,934	-677,327,980	-817,092,588	-932,515,019	-687,040,198	-845,250,395	-727,092,737	-524,695,462
2013	-702,495,342	-912,891,430	-659,122,904	-733,842,075	-1,060,441,091	-1,355,317,053	-1,631,609,726	-1,074,838,371	-1,414,488,108	-1,098,207,542	-695,606,483
2014	959,127,254	1,004,058,967	1,015,204,545	1,022,551,756	942,505,813	851,773,328	767,312,125	935,197,031	789,357,200	898,100,913	1,030,401,521
2015	1,770,723,171	1,716,505,008	1,776,680,327	1,785,921,738	1,676,857,005	1,470,514,536	1,219,437,744	1,614,339,928	1,265,868,338	1,547,727,406	1,772,788,381
2016	2,525,442,590	2,473,550,044	2,549,601,255	2,542,047,381	2,309,523,880	2,026,602,967	1,539,726,927	2,274,178,600	1,733,936,993	2,239,890,863	2,539,559,540
2017	2,854,624,441	2,752,744,503	2,844,224,370	2,895,238,692	2,626,527,839	2,269,228,987	1,707,582,059	2,542,213,615	1,776,329,136	2,396,344,947	2,888,420,342
2018	2,267,535,443	2,320,117,337	2,412,309,202	2,438,086,188	2,123,879,858	1,825,148,602	1,400,508,278	1,965,614,817	1,326,466,638	1,898,304,111	2,367,702,250
2019	2,604,437,633	2,505,450,388	2,744,219,126	2,686,926,330	2,341,283,693	1,945,453,006	1,456,079,657	2,250,505,533	1,300,704,916	2,122,988,891	2,575,778,196
2020	8,869,163,950	8,890,678,537	9,286,032,691	9,322,589,218	8,532,733,812	7,596,775,799	6,597,824,713	8,232,118,567	6,800,539,108	8,122,243,320	8,949,078,294
2021	16,582,038,663	16,354,723,160	17,260,665,595	17,117,707,285	15,661,885,920	13,721,932,901	11,595,902,388	15,195,539,868	12,182,504,692	15,189,109,958	16,678,152,926
2022	12,300,245,728	12,427,449,225	13,197,918,173	13,082,851,192	11,963,394,264	10,577,754,774	8,797,763,195	11,517,010,558	8,274,655,118	11,149,541,747	12,590,934,062
Total	46,764,070,430	45,469,695,907	49,025,087,162	48,628,309,202	42,809,775,044	36,040,380,940	27,873,038,828	41,135,631,895	28,917,834,850	39,822,660,799	47,299,532,979

Stochastic Simulation

The stochastic simulation approach provides information about the probability distribution of the Cash Flow NPV of the MMI based on 100 different possible future economic conditions and the corresponding prepayments, claims and loss rates. The simulation provides the Cash Flow NPV associated with each one of the 100 future economic paths. The distribution of Cash Flow NPV based on these scenarios allows us to gain insights into the sensitivity of the MMI's Cash Flow NPV to different economic conditions.

Figure 9 below shows the range of Cash Flow NPV resulting from the 100 simulated scenarios.

Figure 9: Stochastic Simulation Results



Based on the stochastic simulation results, the range of Cash Flow NPV estimates is negative $15.899 billion to positive $52.604 billion.

The range of Cash Flow NPV estimates may not include all conceivable outcomes. For example, it would not include extreme events where the contribution of such events to an expected value is not reliably estimable.

The Cash Flow NPV estimate provided by FHA to be used in the FHA Annual Report to Congress is positive $37.089 billion. Based on RMA's ACE and range estimates, we conclude that the FHA estimate of Cash Flow NPV is reasonable.

Sensitivity Tests of Economic Variables

The scenario analyses described above were conducted to estimate the distribution of the Cash Flow NPV of the MMI with different possible combinations of the interest rate and housing price movements in the future. It is also useful to understand the marginal impact of a change in each single economic factor on the Cash Flow NPV. Below, we show the sensitivity of the Cash Flow

NPV with respect to the change of a single economic factor at a time. This sensitivity test is conducted for:

- Interest rates, including:
  - 10-year CMT rate
  - One-year CMT rate
  - Commitment rate on 30-year fixed-rate mortgages
- Unemployment rate
- HPA

The marginal impact is measured by the change in Cash Flow NPV from the OMB Economic Assumption scenario result. These simulations change each of these variables one at a time from the Baseline scenario. The changes are parallel shifts in the path of each variable in the OMB Economic Assumption scenario, where all three interest rates are shifted together and at the same magnitudes but are kept from going negative.

Figure 10 shows the sensitivity of the Cash Flow NPV with respect to changes in future interest rates. Specifically, we applied parallel shift to the one-year CMT rate, 10-year CMT rate and the mortgage rates up and down from the Baseline scenario by 20, 50, 100 and 200 basis points. Interest rates are not allowed to be negative. The results show a positive slope through the negative 50 basis point change. Higher future interest rates benefit the MMI in two ways. First, a higher future interest rate means lower refinance incentive for existing borrowers. Thus, there would be fewer prepayments, which lead to a longer stream of annual MIP revenue. Second, higher future interest rates imply that the mortgage payments of existing borrowers would be lower than that of a new mortgage with the market interest rate. The below-market mortgage payment serves as an incentive for borrowers to keep their mortgages longer and thus is a disincentive to default to continue to benefit from their below-market payments.

Conversely, an increase in interest rates also results in an increase in loss mitigation expenses. This may be because if a customer has a low mortgage rate and rates increase, they have more of an incentive to keep their home, and thus will take advantage of options to stay in the home. This has an offsetting effect to the lower likelihood of refinance.

A 100-basis point fall in interest rates will result in an increase in Cash Flow NPV of $741 million, and a positive 100 basis point change in interest rates will result in a decrease in Cash Flow NPV of $2.879 billion. For the interest rate sensitivity, the range of Cash Flow NPV impacts across all basis point sensitivities are -0.28% to +0.07% of IIF, as shown in Figure 11.

Figure 10 also reports the sensitivity of the Cash Flow NPV with respect to the unemployment rate. The results show a negative slope, indicating that the Cash Flow NPV of the MMI is negatively related to future unemployment rates. A negative 100 basis point change in the unemployment rates will produce an increase in Cash Flow NPV of $3.638 billion, and a positive

100 basis point change in the unemployment rate will result in a decrease in Cash Flow NPV of $5.152 billion. This results from the fact that as unemployment increases, the likelihood of defaults and claims increase, and the average net loss increases as well. For the unemployment rate sensitivity, the range of Cash Flow NPV impacts across all basis point sensitivities are -0.70% to +0.26% of IIF, as shown in Figure 11.

Figure 10 also reports the sensitivity of the Cash Flow NPV with respect to changes in the HPA forecast. Specifically, we applied a parallel shift to the annualized HPA rates from the Baseline scenario up and down by 20, 50, 100 and 200 basis points. The results show a downward trend. Generally, a large negative HPA shift results in lower recoveries on homes sold by HUD, and thus a lower Cash Flow NPV is realized. Conversely, the large positive HPA shift causes HPA recovery rates to increase on HUD disposed properties, and thus results in a higher Cash Flow NPV for the MMIF. This trend is present in our sensitivity analysis as losses decrease with an increase in the HPA.

However, there is a trend that runs counter to the decreasing loss trend, and it is due in part to the recent significant increases in home values. As HPA turns negative, the percentages of mortgages that prepay decreases, and the decrease in home value is an incentive for homeowners to remain in the homes longer. Conversely, an increase in the home value increases the prepay percentage, as there is an incentive for homeowners to either sell the home or refinance to remove some of the equity in cash. The decrease in MIP as HPA increases is larger than the decrease in losses, thus resulting in a downward trend.

As the rate of home appreciation has slowed in 2022, the impact on the Fiscal Year 2022 cohort is a combination of both trends described above, which results in a sensitivity graph that is not as smooth and consistent as it has been in the past.

A negative 100 basis point change in the HPA will produce an increase in Cash Flow NPV of $1.941 billion, and a positive 100 basis point change in the HPA rate will result in an increase in Cash Flow NPV of $221 million. The range of Cash Flow NPV impacts across all basis point sensitivities are -0.07% to +0.28% of IIF, as shown in Figure 11.

These sensitivity analyses show that Cash Flow NPV of the MMI portfolio would be significantly affected by small changes in unemployment and interest rates, while a small change in HPA has a smaller impact.

Figure 10: Sensitivity Test of Selected Economic Variables

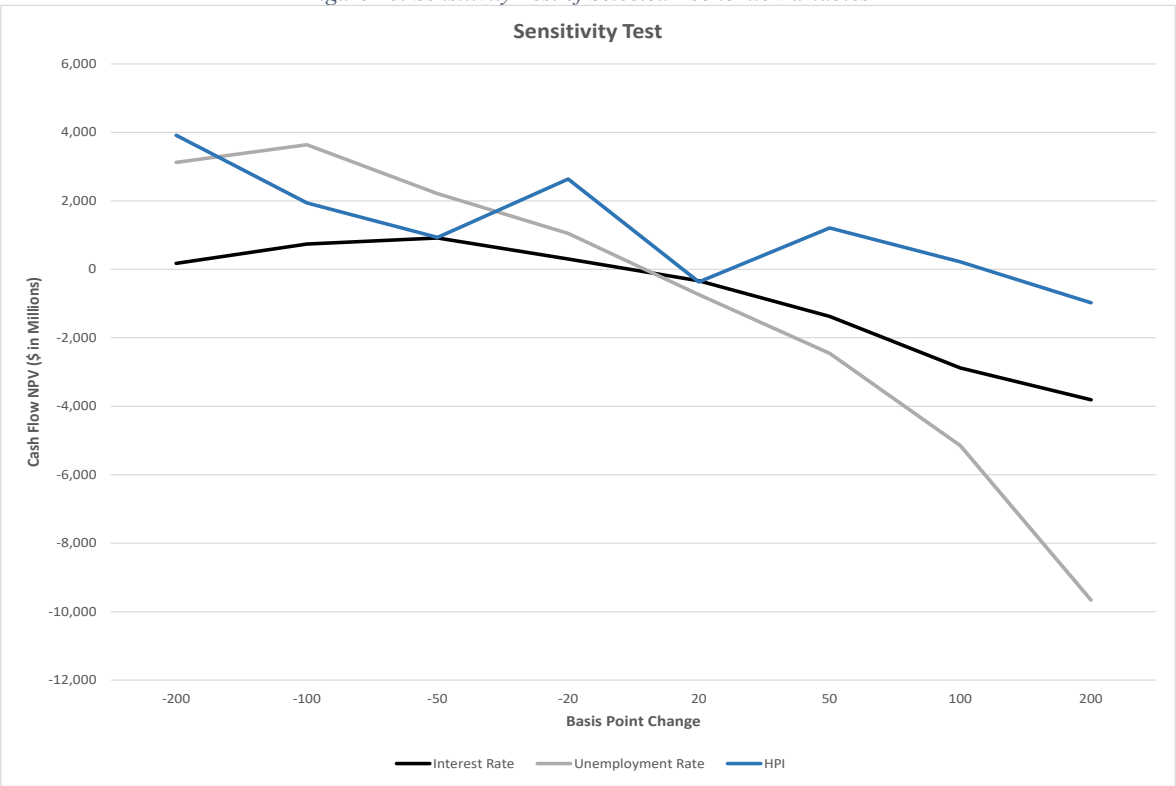
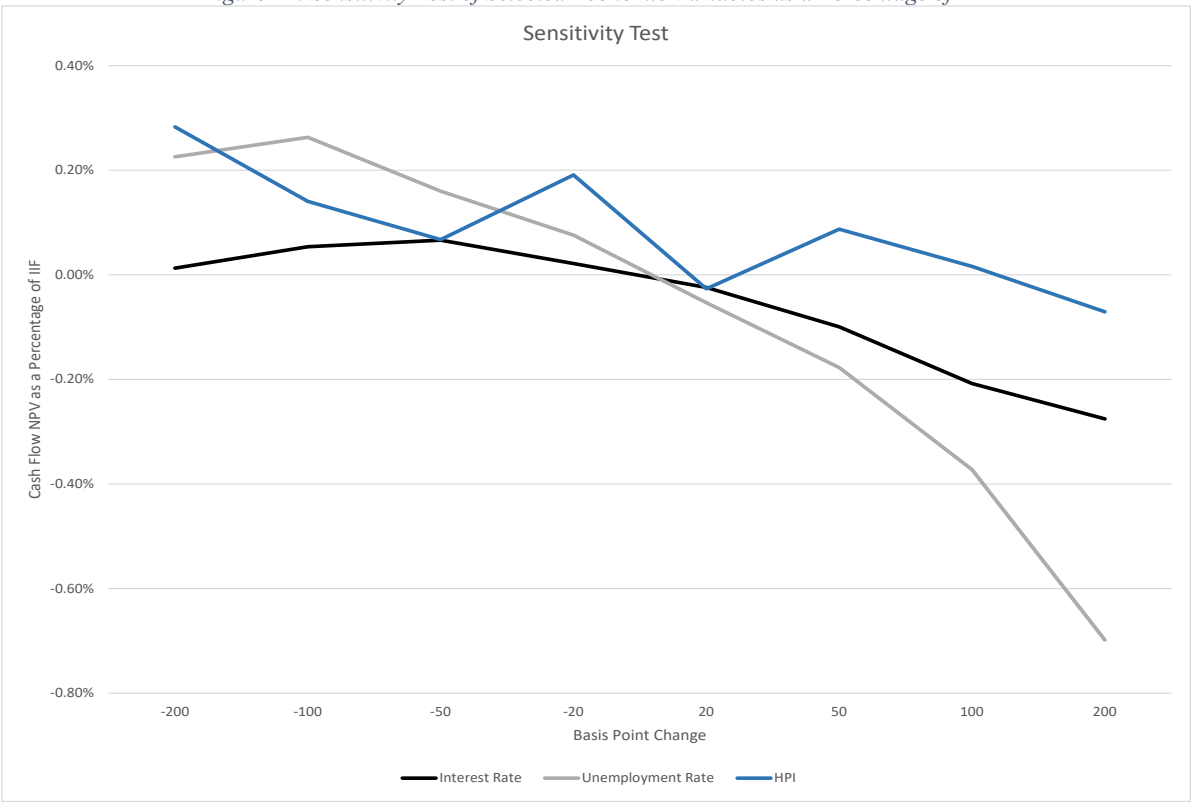


Figure 11: Sensitivity Test of Selected Economic Variables as a Percentage of IIF



Section 4 - Characteristics of the Fiscal Year 2022 Insurance Portfolio

This section analyzes the characteristics of the loan portfolio insured by the MMI as of Fiscal Year 2022. This discussion covers the following three areas:

1. analysis of the volume and composition of loan types,
2. comparison of new purchase loans versus refinances and
3. the distribution of loans by loan characteristics.

This section also examines and compares the 2022 cohort with previous cohorts to determine how the 2022 cohort is likely to influence the future performance of the MMI.

Volume and Share of Mortgage Originations

FHA insured $250 billion in single-family forward mortgages in Fiscal Year 2022, bringing the MMI's total unamortized IIF to $1,384 billion. This represents a decrease of 27.1% relative to the volume insured in Fiscal Year 2021.

Table 11 shows FHA's origination count and volume by cohort. The new purchase count dropped significantly from Fiscal Year 2002 to Fiscal Year 2007, increased dramatically through Fiscal Year 2010, then returned to levels similar to those in Fiscal Years 2000 - 2002. The decline and subsequent rise were due to the Government Sponsored Enterprise (GSE)[78] and non-conforming lenders aggressive marketing strategies during the subprime era and their capital limitations when the housing market crashed. The capital impairment of the private mortgage insurance companies also contributed to FHA's rising volume after the crash. As the private mortgage insurance industry faced severe capital constraints, the GSEs had been unable to purchase or guarantee loans with less than a 20% down payment. FHA became the primary source of high LTV loans after Fiscal Year 2008. Private mortgage insurance companies have begun underwriting more policies during the past eight years.

The new purchase volumes show a similar pattern, for the same reasons cited above, but the volumes after the housing crisis were much higher than volumes in the early 2000s. The loan size limits were increased due to the levels of the GSEs, making more loans eligible for FHA insurance. The private mortgage insurers and non-conforming lenders faced capital constraints, making FHA the only feasible channel for high LTV loans.

In Fiscal Year 2022, new purchase counts decreased by 17.2%, fully underwritten refinances increased by 3.3%, and streamline refinances decreased by 73.6%. The new purchase volume decreased by 1.7%, the fully underwritten refinance volume increased by 7.4% and the streamline

[78] Fannie Mae, Freddie Mac and the Federal Home Loan Banks

refinance volume decreased by 76.8%. The drop in interest rates due to the economic crisis led in part to a substantial increase in refinance activity in 2020 and 2021. Also, the implementation of shelter-in-place orders and the closing of physical offices led to a dramatic increase in the volume of streamline refinance activity in 2020 and 2021. In 2022, the increase in interest rates has led to a significant decrease in refinance activity.

Table 11: Total Count and Volume of FHA-Insured Originations

Cohort	Count of Originations			Volume of Originations (in $ billion)		
	New Purchase	Fully Underwritten Refinance	Streamline Refinance	New Purchase	Fully Underwritten Refinance	Streamline Refinance
1985	340,286	7	45	20.19	0.00	0.00
1986	737,217	18	7,023	45.56	0.00	0.43
1987	1,119,343	21	143,403	69.83	0.00	9.08
1988	670,354	2	42,198	40.95	0.00	2.60
1989	557,895	3	16,287	34.85	0.00	0.97
1990	689,946	127	27,516	45.25	0.01	1.69
1991	629,189	464	27,063	42.87	0.03	1.74
1992	524,680	1,889	72,353	37.19	0.13	4.88
1993	537,869	12,250	300,984	39.99	0.89	21.78
1994	652,711	16,968	549,688	51.84	1.21	38.70
1995	476,712	4,298	41,917	38.08	0.32	2.83
1996	590,486	27,110	91,107	49.85	2.22	7.44
1997	629,615	28,624	43,590	54.82	2.44	3.82
1998	742,465	54,577	174,645	68.04	5.02	17.41
1999	831,805	73,511	258,376	80.86	7.17	25.14
2000	763,063	36,640	31,843	79.40	3.83	3.04
2001	730,105	59,782	172,664	79.71	6.85	20.99
2002	787,093	87,444	293,642	91.02	10.64	34.47
2003	602,451	94,268	522,214	73.03	12.12	62.17
2004	540,314	77,985	274,123	66.84	10.28	30.51
2005	328,543	42,858	106,952	40.20	5.87	11.91
2006	293,257	72,064	34,585	37.10	10.65	3.98
2007	261,166	120,291	20,887	35.00	18.51	3.00
2008	591,326	376,522	63,733	95.37	65.78	10.65
2009	995,101	506,822	329,395	171.67	92.90	65.82
2010	1,109,164	344,877	212,871	191.60	62.61	43.29
2011	777,100	239,344	180,227	134.36	44.36	38.92
2012	733,700	176,767	274,033	124.45	31.83	56.99
2013	702,415	130,588	511,842	124.93	24.07	91.11
2014	594,998	76,315	115,038	105.72	13.19	16.31
2015	753,387	130,032	232,811	140.26	24.75	48.11
2016	879,511	165,506	213,030	171.63	32.14	41.64
2017	882,076	200,258	164,099	178.62	40.54	31.79
2018	776,275	185,816	52,510	160.89	38.10	10.06
2019	743,278	189,213	57,934	159.37	40.54	14.72
2020	817,834	193,326	321,988	188.21	43.46	78.64
2021	846,240	182,962	403,659	209.99	41.04	91.80
2022	677,157	199,737	84,990	185.07	46.66	18.22

Table 12 shows FHA's origination volume and market share in home purchase mortgages from Calendar Year 2001 through the third quarter of Calendar Year 2022.

Table 12: FHA's Market Share in the Home Purchase Mortgage Market (in $ billion)

Calendar Year	FHA	Market	FHA Share
2001	89	959	9.2%
2002	82	1,097	7.5%
2003	71	1,274	5.6%
2004	53	1,306	4.1%
2005	37	1,506	2.5%
2006	36	1,402	2.5%
2007	39	1,144	3.5%
2008	129	743	17.4%
2009	185	652	28.3%
2010	167	540	31.0%
2011	129	503	25.7%
2012	127	594	21.3%
2013	119	728	16.4%
2014	107	758	14.1%
2015	154	897	17.1%
2016	176	1,051	16.7%
2017	174	1,139	15.3%
2018	158	1,206	13.1%
2019	170	1,221	13.9%
2020	193	1,484	13.0%
2021	206	1,871	11.0%
2022	135	1,359	9.9%

Sources: FHA Volume from FHA Data Warehouse, September 30, 2022 extract. Market volume from Mortgage Bankers Association. Calendar year 2022 includes data through September 30, 2022.

FHA's market share declined to a low of 2.5% in 2005. This trend reversed during the next several years and by Fiscal Year 2010, FHA's market share was up to 31.0%. Subsequently, the market share decreased through 2018. The FHA share increased in 2019 and has decreased since then. As of the third quarter of 2022, the FHA share is 9.9%.

Originations by Location

FHA insures loans in all regions of the United States, but over half of FHA's total dollar volume is concentrated in ten states. Table 13 shows the percentage of FHA's total dollar volume originated in these ten states from Fiscal Year 2015 through Fiscal Year 2022. The states are ordered based on the dollar volume endorsed during Fiscal Year 2022.

Table 13: Percentage of Mortgage Origination Volume in the Top 10 States

Top 10 States	Fiscal Year							
	2015	2016	2017	2018	2019	2020	2021	2022
California	18.8%	17.5%	16.8%	14.7%	14.3%	14.4%	12.4%	11.4%
Texas	7.3%	7.5%	7.6%	8.0%	8.3%	9.4%	9.6%	9.1%
Florida	6.0%	6.8%	7.5%	8.5%	8.9%	8.9%	9.1%	9.0%
Georgia	3.2%	3.7%	3.7%	4.0%	4.0%	4.1%	4.2%	4.5%
New Jersey	3.5%	3.4%	3.5%	3.5%	3.5%	3.7%	4.0%	3.8%
Maryland	3.6%	3.6%	3.5%	3.3%	3.3%	3.5%	3.8%	3.4%
New York	3.5%	3.5%	3.7%	3.7%	3.5%	2.9%	3.0%	3.3%
Illinois	3.1%	3.1%	3.2%	3.2%	3.0%	3.0%	3.3%	3.3%
Arizona	3.7%	3.4%	3.2%	3.1%	3.2%	3.4%	3.2%	3.1%
Virginia	3.6%	3.5%	3.3%	3.1%	2.9%	3.0%	3.3%	3.1%

Currently, loans in California comprise the largest percentage of all FHA loans based on dollar volume, making up 11.4% of the portfolio in 2022. The percentage of loan volume in California had been decreasing from 2015 – 2019, increased slightly in 2020, but has decreased again since 2020. Texas is still the second largest state in 2022, after taking over second place from Florida in 2020. Florida remains the third largest state.

Originations by Product

Table 14 shows that the fully underwritten 30-year FRM has comprised the majority of FHA's single-family business, representing a dollar-weighted average share of approximately 76.1% of the business over Fiscal Years 1986 – 2022. The share of total mortgages represented by 30-year FRMs began to change in the early 1990s when FHA started insuring ARMs and streamline refinancing mortgages (SRs). For the next few years, ARM and SR mortgages gradually assumed a larger share of annual loan originations and the 30-year FRM share decreased. The 1993 and 1994 cohorts recorded the lowest shares of 30-year FRMs. An opposite trend emerged from Fiscal Year 2003 through Fiscal Year 2007, in which 30-year FRM endorsements increased from 52.4% to 92.1%, while 30-year SR endorsements dropped from 36.0% to 5.1%. However, the share of 30-year FRMs in Fiscal Year 2009 through Fiscal Year 2013 dropped from 77.1% to 58.3%. From this point, the percentage increased to 93.6% in Fiscal Year 2018. By Fiscal Year 2021, the percentage of 30-year FRMs dropped to 72.8% but has increased in Fiscal Year 2022 to 92.1%.

The ARM share of the portfolio, including SR ARMs, shrank dramatically from 12.0% in Fiscal Year 2005 to 1.1% in Fiscal Year 2009. It subsequently rose to 6.0% in Fiscal Year 2011, and then has decreased since then. ARMs accounted for only approximately 0.02% of the endorsements in the 2021 cohort and increased to approximately 0.15% in the 2022 cohort. The drop in the ARM share and the virtual non-existence since 2021 was related to the low mortgage interest rates. The 15-year FRMs increased from 1.2% in Fiscal Year 2007 to 6.4% in Fiscal Year 2012 but have declined in the last seven years and are at 0.5% in Fiscal Year 2022. The 15-year SR continues to be a minor product type in the MMI.

Table 14: Percentage of Origination Volume by Mortgage Product

Fiscal Year	Fully Underwritten Mortgages			Streamline Refinance		
	30-Year FRM	15-Year FRM	ARMs	30-Year SRs	15-Year SRs	ARMs SRs
1986	89.88	8.30	0.88	0.80	0.15	0.00
1987	81.83	5.52	1.15	9.85	1.61	0.05
1988	85.55	3.99	4.50	5.27	0.66	0.03
1989	92.82	2.70	1.76	2.55	0.17	0.00
1990	92.91	2.79	0.70	3.33	0.26	0.00
1991	89.52	3.13	3.45	3.37	0.50	0.02
1992	70.24	2.62	15.57	8.75	1.71	1.11
1993	49.91	2.21	13.11	26.43	6.46	1.87
1994	40.92	1.83	15.07	30.66	8.75	2.77
1995	62.66	1.54	28.93	4.43	1.62	0.82
1996	62.29	1.32	23.89	8.98	1.74	1.77
1997	61.57	1.19	30.98	3.64	0.81	1.80
1998	60.20	1.09	19.46	15.35	1.21	2.68
1999	73.04	1.14	3.61	19.48	1.79	0.95
2000	84.29	0.73	11.45	2.50	0.35	0.67
2001	77.30	0.90	2.28	18.37	0.58	0.57
2002	68.13	1.19	5.36	21.11	1.48	2.73
2003	52.38	1.31	4.11	35.97	2.92	3.32
2004	62.19	1.37	8.10	21.49	2.60	4.26
2005	69.14	1.26	9.06	16.17	1.41	2.96
2006	88.10	1.36	2.85	6.96	0.48	0.25
2007	92.13	1.22	1.33	5.12	0.11	0.07
2008	90.78	1.61	1.42	5.91	0.14	0.15
2009	77.11	2.18	0.79	19.26	0.37	0.29
2010	78.99	3.63	2.83	13.16	0.36	1.02
2011	72.29	5.64	4.19	15.46	0.62	1.80
2012	65.41	6.38	1.49	24.54	1.18	1.00
2013	58.28	3.08	0.69	36.59	0.96	0.39
2014	82.47	2.51	2.96	11.01	0.37	0.68
2015	74.46	1.67	1.30	21.93	0.19	0.45
2016	81.14	1.34	0.55	16.66	0.25	0.06
2017	85.65	1.27	0.40	12.30	0.36	0.00
2018	93.58	1.13	0.48	4.66	0.14	0.01
2019	91.81	0.90	0.44	6.78	0.07	0.00
2020	74.18	0.44	0.04	25.21	0.13	0.00
2021	72.78	0.43	0.02	26.53	0.25	0.00
2022	92.11	0.45	0.15	7.2	0.08	0.00
1986-2022	76.09	2.03	3.47	16.80	0.85	0.76

Initial Loan to Value Distributions

Based on studies of mortgage behavior, a borrower's equity position in the mortgaged house is one of the most important drivers of default behavior. The larger the equity position a borrower has, the greater the incentive to avoid default on the loan. The original LTV is the complement of

the borrower's equity at origination. Table 15 shows the distribution of mortgage originations by original LTV categories.

Table 15: Percentage of Origination Volume by Original LTV Category

Cohort	Unknown	≤ 80%	> 80% ≤ 90%	> 90% ≤ 95%	> 95% < 97%	≥ 97%
1986	0.42%	73.16%	10.07%	8.33%	6.65%	1.38%
1987	0.12%	84.23%	5.75%	5.35%	3.93%	0.63%
1988	0.06%	86.33%	3.41%	5.14%	4.27%	0.79%
1989	0.38%	85.50%	2.97%	5.49%	4.83%	0.83%
1990	1.40%	25.25%	14.77%	28.85%	25.64%	4.08%
1991	3.30%	6.12%	16.06%	30.32%	29.59%	14.61%
1992	10.79%	4.65%	13.29%	24.87%	33.23%	13.17%
1993	27.22%	3.75%	11.22%	19.57%	23.24%	15.00%
1994	34.39%	3.56%	9.67%	16.38%	19.79%	16.21%
1995	5.62%	3.16%	10.39%	22.94%	31.68%	26.22%
1996	9.47%	2.97%	10.55%	23.07%	30.84%	23.09%
1997	4.55%	3.42%	11.29%	24.94%	32.49%	23.31%
1998	13.33%	3.63%	11.76%	23.29%	29.09%	18.89%
1999	12.89%	4.00%	10.94%	14.77%	25.17%	32.23%
2000	1.43%	2.66%	6.86%	7.26%	31.89%	49.89%
2001	9.52%	3.61%	8.77%	8.63%	22.75%	46.71%
2002	0.27%	4.67%	11.08%	9.99%	23.74%	50.25%
2003	0.00%	6.03%	12.57%	11.73%	23.67%	45.99%
2004	0.00%	6.57%	11.70%	10.33%	22.46%	48.94%
2005	0.00%	6.39%	10.72%	9.06%	22.17%	51.65%
2006	0.00%	7.13%	10.72%	14.35%	19.89%	47.91%
2007	0.00%	7.39%	11.68%	21.24%	18.20%	41.50%
2008	0.13%	6.20%	12.18%	24.03%	14.11%	43.35%
2009	0.00%	5.00%	13.33%	18.82%	35.68%	27.17%
2010	0.00%	4.82%	14.53%	12.63%	58.79%	9.24%
2011	0.00%	4.87%	14.80%	14.07%	59.89%	6.37%
2012	0.00%	5.52%	13.45%	20.00%	57.17%	3.87%
2013	0.00%	5.67%	16.15%	27.25%	48.60%	2.34%
2014	0.00%	6.08%	14.09%	12.92%	65.04%	1.86%
2015	0.00%	6.07%	14.84%	12.95%	63.83%	2.30%
2016	0.00%	6.87%	16.11%	11.14%	64.12%	1.75%
2017	0.00%	7.85%	17.19%	10.08%	63.65%	1.23%
2018	0.00%	7.82%	16.81%	8.10%	66.16%	1.11%
2019	0.00%	7.59%	17.45%	7.77%	65.45%	1.74%
2020	0.00%	10.47%	12.12%	12.28%	62.66%	2.46%
2021	0.00%	12.45%	11.22%	14.53%	60.83%	0.96%
2022	0.00%	20.64%	7.48%	10.88%	60.77%	0.23%

The distribution among original LTV categories shifted significantly after Fiscal Year 1998. Almost half of the loans insured from Fiscal Year 2000 to Fiscal Year 2006 had LTVs greater than or equal to 97%. This concentration in the highest risk category gradually declined during the next

few years. In 2008, MMI placed a limit of 96.5% on original LTV, with no additional allowance for the financing of closing costs. During Fiscal Year 2009, 27.2% of mortgages had LTV ratios of 97% or more. In Fiscal Years 2010 - 2018, this concentration continued to decline, but increased in Fiscal Year 2020 to 2.5%. This percentage has decreased in Fiscal Year 2022 to 0.2%. Since Fiscal Year 2014, over 60% of mortgages have LTV ratios between 95 to 97%.

Since Fiscal Year 2018, the percentage of mortgages with an initial LTV of less than 95% increased by almost seven percentage points from 32.7% to 39.4%. In Fiscal Year 2022, over 20% of mortgages has an initial LTV of 80% or less. This is due in part to the significant increase in home values over the last three years.

The original LTV concentration of individual books of business affects the predictive models in two ways. First, it serves as the starting position for updating the current LTV. Holding everything else constant, loans with higher original LTVs will experience a higher current LTV in future years. Second, the original LTV itself is also included in the models to capture potential behavioral differences among borrowers who self-select into different original LTV categories. For SR loans, we use the original LTV of the prior fully underwritten mortgage, updated for the local house price index and amortization, as a proxy for this variable.

The LTV position of cash-out refinances has also been an issue of concern for HUD. The share of cash-out refinances had increased significantly through the mid-2000's. However, as the housing market weakened in the late 2000's, this was shown to have contributed to an increase in the number of foreclosures. In response, FHA decreased the LTV requirement for cash-out refinances from 95% to 85% in 2009. FHA data showed that the number of cash-out refinances were increasing significantly, and as a result in 2019 decreased the LTV requirement again from 85% to 80% effective September 1, 2019.[79]

Borrower Credit History Distribution

Credit score data has been collected from two different sources. The first source includes credit scores collected for a sample of FHA applications from Fiscal Years 1992, 1994, and 1996, and subsequently extended to loan applications during Fiscal Years 1997 - 2004. This credit score data is particularly useful because these loans have existed for many years and provide valuable historical delinquency, claim and prepayment performance information. The limitation of this data source is that it covers only a limited sample of FHA loans. In addition, the sample was originally

[79] Mortgagee Letter 2019-11, August 1, 2019: Maximum Loan-To-Value and Combined Loan-To-Value Percentages for
Cash-out Refinance Mortgages.

collected for policy research purposes and represents a choice-based sample. For example, there was over-sampling of loans that defaulted early among applications over Fiscal Years 1997 - 2004.

Since May 2004, all lenders originating loans for FHA insurance have been required to report borrower credit scores directly to HUD if any credit scores were ordered as part of the underwriting process. All loans going through the FHA TOTAL scorecard have credit scores obtained electronically by the affiliated automated underwriting systems. This is the second source of credit score data. As there are no exceptions to this requirement, the credit scores collected from this source are comprehensive and unbiased. These loans have grown to be the dominant source of credit score information for our analysis.

Table 16 shows the distribution of fully underwritten FHA mortgage loans by borrower credit score categories and cohort. The distribution among credit score categories remained relatively stable for the 2005 - 2008 cohorts. For loans originated after Fiscal Year 2008, the credit score distribution showed significant improvement over the previous years. Approximately 31% of the Fiscal Year 2022 loans have credit scores above 680. Loans with credit scores below 600 are 4.5% of the loans originated in Fiscal Year 2022, which is substantially lower than in the Fiscal Year 2007 book, where 32.8% of the loans had credit scores below 600. However, despite the distributions having improved since 2007, the trend in credit scores from 2012 through 2019 was concerning. The proportion of loans with credit scores below 600 had been increasing slowly from 2012 through 2019, rising from 0.6% to 5.2%. Also, the proportion of loans with credit scores above 680 had decreased from 2016 through 2019 from 46.0% to 34.5%. In Fiscal Year 2020, the percentage of loans with credit scores below 600 decreased to 3.4%, and the percentage with scores of 680 or higher increased to 38.6%. However, in Fiscal Years 2021 and 2022, the trend has reversed, and credit appears to be deteriorating. If the deterioration in credit scores continues, it could result in worse default and loss experience, and thus would contribute negatively to the economic value of the MMI for the more recent cohorts. HUD should continue to monitor this trend and consider action to mitigate the impacts of deteriorating credit scores if this materializes.

In the predictive models, we also controlled for missing and uncollected credit scores. In Table 16, the category “Missing” refers to loans with insufficient borrower credit history to generate a credit score, and the category “Not Collected” refers to loans where no attempt was made to obtain the credit score for some of the Fiscal Year 2004 and earlier loans. These categories have been combined in the table. Since credit scores became a requirement for fully underwritten loans, the Missing/Not Collected category has been a negligible percentage of the overall book.

Table 16: Percentage of Origination Volume by Credit Score for Fully Underwritten Loans

Year	Missing / Not Collected	Tiered Credit Scores		Stratified Credit Scores					
		< 600	≥ 600	300-499	500-559	560-599	600-639	640-679	680-850
1997	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1998	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1999	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2000	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2001	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2002	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2003	99.96%	0.01%	0.03%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%
2004	75.76%	6.59%	17.65%	0.20%	2.20%	4.19%	6.21%	5.23%	6.22%
2005	6.87%	26.84%	66.29%	0.90%	9.24%	16.70%	24.18%	19.88%	22.22%
2006	4.80%	26.30%	68.90%	0.94%	8.75%	16.61%	24.50%	20.71%	23.69%
2007	4.17%	32.76%	63.07%	1.53%	11.76%	19.47%	25.09%	18.94%	19.04%
2008	2.21%	21.84%	75.94%	0.83%	6.93%	14.09%	24.21%	22.71%	29.03%
2009	1.04%	6.27%	92.69%	0.05%	1.13%	5.10%	18.01%	24.83%	49.86%
2010	1.07%	1.02%	97.91%	0.01%	0.16%	0.86%	12.39%	25.01%	60.51%
2011	0.90%	0.55%	98.55%	0.00%	0.07%	0.48%	8.40%	27.10%	63.05%
2012	0.54%	0.62%	98.84%	0.00%	0.09%	0.52%	8.23%	30.76%	59.86%
2013	0.46%	0.51%	99.03%	0.00%	0.08%	0.43%	6.50%	36.41%	56.13%
2014	0.28%	1.04%	98.68%	0.00%	0.08%	0.96%	11.27%	41.52%	45.89%
2015	0.26%	1.69%	98.05%	0.00%	0.11%	1.58%	14.55%	37.87%	45.63%
2016	0.22%	1.93%	97.85%	0.00%	0.11%	1.81%	15.48%	36.41%	45.96%
2017	0.20%	2.71%	97.09%	0.00%	0.19%	2.52%	17.67%	36.10%	43.31%
2018	0.17%	4.30%	95.53%	0.00%	0.40%	3.90%	20.96%	36.87%	37.69%
2019	0.13%	5.24%	94.63%	0.00%	0.53%	4.72%	22.54%	37.64%	34.45%
2020	0.09%	3.40%	96.51%	0.00%	0.30%	3.09%	18.75%	39.20%	38.57%
2021	0.06%	2.01%	97.93%	0.00%	0.15%	1.86%	18.61%	42.42%	36.90%
2022	0.07%	4.53%	95.38%	0.00%	0.46%	4.07%	23.33%	40.60%	31.46%

Initial Relative Loan Size Distribution

The relative loan size variable is computed by comparing the mortgage origination amount with the average loan size of all FHA-insured loans originated within the same period and in the same state. Empirical results show that this variable is very significant in predicting prepayments.

FHA experience indicates that larger loans tend to perform better compared with smaller loans in the same geographical area, all else being equal. Larger loans incur claims at a lower probability and in those cases where a claim occurs, loss severity tends to be lower. Prior to the increase in FHA's loan limits in Fiscal Year 2008, houses securing larger FHA loans tended to fall into the average house price range within their surrounding areas. Since this market is relatively liquid and there are a relatively large number of similar-quality homes in the area, the house price volatility of these houses tends to be relatively low in comparison to the house price volatility of extremely

low- and high-priced houses. With the increased FHA loan size limit, FHA started endorsements of higher-priced houses after Fiscal Year 2008.

Table 17 shows the percentage of new fully underwritten mortgage originations within each relative loan size category. The distribution has been reasonably stable over time with the largest share in the 75-100% and 100-125% of area average loan size categories. However, since Fiscal Year 2000, there has been a steady increase in the dispersion among loan size categories. The proportion in the highest loan size category increased from 11.1% in Fiscal Year 2001 to 26.2% in Fiscal Year 2013 but had decreased since then to 16.2% in 2020. The proportion in the highest loan size category has increased to 19.1% in 2022. On the other hand, the share in lowest loan size category also increased from 1.8% in Fiscal Year 2004 to 5.2% in Fiscal Year 2012 and has since decreased to 2.8% in Fiscal Year 2022. The increase in both the highest and lowest loan size categories demonstrated the penetration of FHA products into high-balance loans and the resurgence of the low-balance loan, but this penetration has decreased since 2011. The increase in the highest category since 2021 is due in part to the significant increase in home values in the last two years. This significant increase may impact the availability of MMIF mortgage insurance coverage to a smaller percentage of overall homes, which may require HUD to evaluate loan limits.

Table 17: Percentage of Origination Count by Relative Loan Size

Cohort	0-50% of Average Loan Size	50-75% of Average Loan Size	75-100% of Average Loan Size	100-125% of Average Loan Size	125-150% of Average Loan Size	>150% of Average Loan Size
1985	1.75%	10.64%	26.03%	34.72%	21.12%	5.75%
1986	1.37%	10.11%	27.00%	38.76%	18.86%	3.91%
1987	1.17%	9.80%	26.62%	38.84%	19.89%	3.67%
1988	1.49%	10.72%	25.59%	35.52%	20.45%	6.22%
1989	1.73%	11.18%	25.34%	32.46%	21.16%	8.12%
1990	1.76%	11.33%	25.08%	31.18%	21.08%	9.58%
1991	1.84%	11.42%	25.14%	30.04%	21.63%	9.93%
1992	1.72%	11.09%	25.35%	31.30%	21.60%	8.95%
1993	1.50%	10.62%	25.57%	31.92%	22.03%	8.37%
1994	1.19%	9.26%	22.81%	30.13%	24.62%	11.98%
1995	1.61%	11.45%	24.67%	30.38%	22.47%	9.41%
1996	1.61%	11.32%	24.71%	31.28%	22.93%	8.15%
1997	1.75%	11.89%	24.98%	31.66%	21.94%	7.78%
1998	1.64%	11.15%	24.54%	32.83%	22.18%	7.66%
1999	1.80%	11.37%	24.47%	30.74%	20.80%	10.83%
2000	2.02%	11.73%	24.44%	29.27%	20.36%	12.18%
2001	2.22%	12.12%	25.69%	29.52%	19.34%	11.10%
2002	2.06%	11.14%	24.59%	29.61%	19.97%	12.64%
2003	1.81%	10.35%	23.49%	29.85%	20.81%	13.69%
2004	1.79%	10.06%	22.41%	28.83%	21.57%	15.34%
2005	1.92%	10.94%	22.92%	28.28%	21.07%	14.89%
2006	2.17%	11.94%	23.10%	28.04%	20.11%	14.64%
2007	2.49%	12.58%	23.37%	27.55%	19.48%	14.52%
2008	2.80%	12.99%	24.33%	25.44%	17.01%	17.42%
2009	3.94%	14.58%	23.42%	21.70%	15.10%	21.25%
2010	4.39%	15.01%	22.50%	20.33%	14.25%	23.52%
2011	5.06%	15.39%	21.34%	19.31%	13.78%	25.12%
2012	5.18%	15.63%	21.81%	19.71%	13.85%	23.83%
2013	4.10%	13.80%	21.06%	20.10%	14.72%	26.23%
2014	3.59%	13.18%	21.48%	20.91%	15.50%	25.34%
2015	3.85%	13.88%	23.01%	21.74%	15.65%	21.87%
2016	3.39%	12.93%	22.76%	22.41%	16.66%	21.86%
2017	3.14%	12.46%	22.90%	23.32%	17.44%	20.74%
2018	3.11%	12.53%	23.33%	24.34%	17.10%	19.59%
2019	3.19%	12.75%	24.23%	24.97%	16.91%	17.94%
2020	2.83%	12.33%	24.90%	25.97%	17.74%	16.23%
2021	2.47%	10.86%	23.19%	26.31%	18.72%	18.45%
2022	2.76%	11.41%	22.39%	25.45%	18.88%	19.11%

Initial Contract Interest Rate

Table 18 shows the average mortgage contract rate by mortgage type since Fiscal Year 1997. Prior to Fiscal Year 2020, average contract rates in Fiscal Year 2013 were the lowest of this entire period. Rates had been increasing since 2013 but decreased significantly in Fiscal Years 2020 and

2021. Interest rates for 30-year SRs were at the lowest level in Fiscal Year 2021 since 1997, which is one of the reasons for the significant surge in refinance activity in 2020 and 2021. Interest rates have increased in Fiscal Year 2022 by almost a full percentage point.

In general, an FRM with a lower initial contract rate tends to prepay at a slower speed. As interest rates are projected to rise, the prepayment rates of the recent originations are likely to remain low. As these loans will have longer durations, as reflected in our predictive models, more insurance premium income will be generated, thus tending to improve the economic value of these recent books with historically low contract rates.

Also, a mortgage with a contract rate lower than the market rate tends to experience a lower probability of default because the borrower has the incentive to keep the below-market rate mortgage longer even when experiencing some negative equity. This tendency is reflected in our predictive models. As mortgage rates rise in the future, the recent low-interest-rate books are projected to incur fewer defaults and claims. This also tends to improve the economic value.

Table 18: Average Contract Interest Rate by Loan Type (Percent)

Fiscal Year	30-Year FRM	15-Year FRM	ARM	30-Year SR	15-Year SR	ARM SR	Book of Business
1997	8.01	7.77	6.60	8.30	8.04	6.86	7.62
1998	7.42	7.23	6.25	7.62	7.24	6.54	7.22
1999	7.21	6.94	5.96	7.20	6.91	6.11	7.15
2000	8.22	7.95	6.87	8.07	7.81	6.15	8.07
2001	7.69	7.25	6.57	7.44	6.89	6.22	7.61
2002	7.07	6.60	5.37	7.02	6.46	5.38	6.92
2003	6.21	5.62	4.59	6.07	5.55	4.56	6.02
2004	6.08	5.52	4.41	5.92	5.46	4.34	5.84
2005	5.94	5.64	4.78	5.85	5.65	4.67	5.80
2006	6.29	6.14	5.36	6.10	6.02	5.03	6.25
2007	6.51	6.40	5.62	6.38	6.22	5.59	6.49
2008	6.33	5.95	5.39	6.09	5.64	5.33	6.30
2009	5.62	5.14	5.05	5.26	4.81	4.54	5.53
2010	5.14	4.62	3.98	5.13	4.65	4.28	5.08
2011	4.65	4.16	3.51	4.63	4.16	3.69	4.57
2012	3.98	3.46	3.14	3.98	3.53	3.38	3.93
2013	3.62	3.16	2.82	3.71	3.36	2.86	3.63
2014	4.30	3.71	3.31	4.51	3.91	3.39	4.28
2015	4.03	3.47	3.26	3.99	3.69	3.36	4.00
2016	3.91	3.40	3.23	3.87	3.53	3.35	3.89
2017	4.03	3.50	3.18	3.75	3.59	3.02	3.98
2018	4.54	3.87	3.51	4.08	4.03	3.49	4.50
2019	4.68	4.15	4.00	4.23	4.44	4.02	4.64
2020	3.63	3.49	3.47	3.50	3.42	3.50	3.60
2021	3.04	2.67	2.65	2.88	2.82	2.33	2.99
2022	4.03	3.14	3.08	3.08	2.99	2.52	3.94

Source of Down Payment Assistance

Table 19 shows the distribution of annual loan endorsements by source of down payment assistance. Secondary loans provided by governments were included in the category of down payment assistance, and typically these were local government units.

Starting from Fiscal Year 2000 there was a rapid increase in the share of loans with gift letters from non-profit, religious, or community institutions. Home sellers contributed a large share of these funds to the non-profit organizations, which subsequently provided the gift to the buyers of the same properties to fulfill the down payment requirements. This concentration increased to over 20% in the 2005 - 2007 cohorts. FHA effectively terminated seller-financed down payment assistance on October 1, 2008, because of the high losses associated with these loans. The share of loans with this type of assistance declined to negligible amounts after Fiscal Year 2008.

From 2008 to 2018, the percentage of loans with down payment assistance from a relative had increased from 6.8% to 21.7%. From 2019 - 2021, this percentage decreased to 16.0%, but has increased in 2022 to 20.7%. Also, the share of loans with government down payment assistance increased from 2013 to 2016 but has decreased since then.

Table 19: Percentage of Down Payment Assist Loan Counts by Source

Cohort	No Gift	Relative	Non-Profit, Religious or Community	Government
1998	76.81%	22.76%	0.20%	0.23%
1999	81.69%	17.11%	0.53%	0.68%
2000	77.56%	18.97%	1.69%	1.78%
2001	83.35%	11.72%	3.75%	1.17%
2002	83.21%	9.32%	6.29%	1.18%
2003	81.92%	7.61%	9.33%	1.13%
2004	71.69%	9.75%	16.95%	1.61%
2005	64.64%	9.91%	22.96%	2.48%
2006	64.13%	9.44%	23.04%	3.39%
2007	68.25%	7.66%	21.27%	2.81%
2008	74.46%	6.82%	17.38%	1.33%
2009	86.54%	10.34%	2.70%	0.42%
2010	83.99%	15.42%	0.09%	0.51%
2011	85.25%	13.91%	0.12%	0.72%
2012	85.76%	13.44%	0.13%	0.68%
2013	86.89%	12.33%	0.09%	0.70%
2014	77.73%	20.66%	0.29%	1.32%
2015	79.44%	17.88%	0.72%	1.95%
2016	77.31%	19.26%	0.91%	2.53%
2017	77.40%	19.70%	0.74%	2.16%
2018	76.34%	21.71%	0.41%	1.54%
2019	78.19%	20.58%	0.22%	1.01%
2020	82.91%	15.81%	0.19%	1.10%
2021	82.62%	16.02%	0.20%	1.16%
2022	78.28%	20.74%	0.18%	0.80%

Section 5 – Summary of Methodology

This section provides an overview of the analytical approach used in this analysis.

Data Sources

In our analysis, we have relied on data from FHA, Moody's, and the OMB.

From FHA, we have received the following data:

1. Claims_601_Case_Data: used for the cash entry from note sales
2. IDB: core case data; this table is derived based on fields from IDB_1, IDB_2, and the Decision_FICO_Score (one file each for 1975 – 2022)
3. Lossmit_Costs: derived table based on the Loss Mitigation table and IDB_1, used to obtain mitigation claim amounts
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5. SFDW_Default_History: used to create period information related to default histories
6. Fannie_FICO_pre2004: used for supplemental credit data
7. Current_Status: table displaying the current status of each loan
8. SFDW Dictionary for RMA: data dictionary for the tables provided by FHA

From Moody's, we have received the following data elements:

1. Historical Economic Data
2. Baseline Economic Scenario Projections
3. Modified Economic Scenario Projections

From OMB, we have received the Economic Assumptions for the 2023 Budget. The economic data that is included in the analysis is shown below:

1. HPI
2. Mortgage rates
3. Treasury rates
4. Unemployment rates
5. GDP
6. Consumer Confidence Index (CCI)
7. Small Business Optimism Index (SBOI)

Data Processing – Mortgage Level Modeling (Appendix A)

Starting with the raw data, RMA processed the data to create datasets for developing the mortgage level transition and loss severity models. The first step in preparing the data for analysis was processing the economic data. Historical economic data was imported by quarter, additional data elements were derived, and data was joined to the FHA mortgage data.

Once the economic data was prepared, the core data processing occurred. We used mortgage-level data to reconstruct quarterly mortgage-event histories by relating mortgage origination information to other data reflecting events that occurred over the history of the mortgage. In the process of creating quarterly event histories, each mortgage contributed an observed transition for every quarter from origination up to and including the period of mortgage termination, or until September 30, 2022, if the mortgage remained active.

Data Reconciliation

To reconcile the data processed by RMA with the data provided by FHA, RMA compared summaries of key data elements with summaries provided by FHA. The summaries for the number of active mortgages, IIF, number of 90-day delinquencies, and the number of claims to date are shown in the following tables. RMA reconciles with FHA on all data items within +/- 1%.

The following tables are based on data as of September 30, 2022.

Table 20: Data Reconciliation for Number of Active Loans

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	1,245	279	(966)	-78%
1993	10,081	9,907	(174)	-2%
1994	17,955	17,855	(100)	-1%
1995	9,914	9,883	(31)	0%
1996	16,747	16,708	(39)	0%
1997	18,640	18,596	(44)	0%
1998	29,197	29,115	(82)	0%
1999	37,317	37,168	(149)	0%
2000	21,479	21,345	(134)	-1%
2001	36,565	36,190	(375)	-1%
2002	52,303	51,567	(736)	-1%
2003	73,381	72,699	(682)	-1%
2004	92,100	91,165	(935)	-1%
2005	66,881	66,268	(613)	-1%
2006	53,354	52,839	(515)	-1%
2007	51,450	51,015	(435)	-1%
2008	117,549	117,461	(88)	0%
2009	238,105	238,092	(13)	0%
2010	287,661	287,651	(10)	0%
2011	229,908	229,900	(8)	0%
2012	292,844	292,840	(4)	0%
2013	411,547	411,547	0	0%
2014	176,897	176,897	0	0%
2015	296,826	296,826	0	0%
2016	416,764	416,764	0	0%
2017	459,664	459,664	0	0%
2018	374,891	374,891	0	0%

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
2019	376,883	376,883	0	0%
2020	749,562	749,562	0	0%
2021	1,237,627	1,237,627	0	0%
2022	948,633	948,633	0	0%
Total	7,203,970	7,197,837	(6,133)	0%

Table 21: Data Reconciliation for Insurance in Force

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	80,242,139	18,853,462	(61,388,677)	-77%
1993	690,128,120	678,461,206	(11,666,914)	-2%
1994	1,230,779,039	1,223,583,787	(7,195,252)	-1%
1995	634,049,238	632,220,613	(1,828,625)	0%
1996	1,113,455,471	1,111,058,326	(2,397,145)	0%
1997	1,265,515,199	1,262,781,986	(2,733,213)	0%
1998	2,141,195,453	2,135,659,342	(5,536,111)	0%
1999	2,867,090,699	2,856,886,793	(10,203,906)	0%
2000	1,630,421,172	1,620,203,229	(10,217,943)	-1%
2001	3,124,536,203	3,093,858,452	(30,677,751)	-1%
2002	4,846,995,058	4,783,410,286	(63,584,772)	-1%
2003	7,656,385,973	7,594,947,507	(61,438,466)	-1%
2004	9,622,729,367	9,543,722,187	(79,007,180)	-1%
2005	7,145,532,288	7,094,119,160	(51,413,128)	-1%
2006	6,011,646,816	5,961,988,071	(49,658,745)	-1%
2007	6,262,003,100	6,217,476,031	(44,527,069)	-1%
2008	16,294,317,515	16,284,948,410	(9,369,105)	0%
2009	35,552,387,870	35,551,019,369	(1,368,501)	0%
2010	41,388,752,953	41,387,823,793	(929,160)	0%
2011	33,746,485,903	33,745,900,314	(585,589)	0%
2012	44,433,112,767	44,432,710,024	(402,743)	0%
2013	64,476,063,746	64,476,063,746	0	0%
2014	23,559,768,668	23,559,768,668	0	0%
2015	46,107,501,651	46,107,501,651	0	0%
2016	69,430,024,601	69,430,024,601	0	0%
2017	80,518,308,831	80,518,308,831	0	0%
2018	66,531,262,482	66,531,262,482	0	0%
2019	70,567,445,566	70,567,445,566	0	0%
2020	162,716,598,993	162,716,598,993	0	0%
2021	293,847,804,971	293,847,804,971	0	0%
2022	246,812,239,975	246,812,239,975	0	0%
Total	1,352,304,781,827	1,351,798,651,832	(506,129,995)	0%

Table 22: Data Reconciliation for Number of 90 Day Delinquencies

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	109	110	1	1%
1993	399	403	4	1%
1994	659	665	6	1%
1995	515	519	4	1%
1996	892	904	12	1%
1997	952	956	4	0%
1998	1,465	1,484	19	1%
1999	1,980	1,996	16	1%
2000	1,381	1,395	14	1%
2001	2,099	2,119	20	1%
2002	2,718	2,751	33	1%
2003	3,236	3,286	50	2%
2004	4,575	4,662	87	2%
2005	3,885	3,939	54	1%
2006	3,580	3,640	60	2%
2007	3,874	3,942	68	2%
2008	9,035	9,182	147	2%
2009	13,345	13,533	188	1%
2010	12,665	12,858	193	2%
2011	8,811	8,932	121	1%
2012	9,043	9,159	116	1%
2013	10,882	11,006	124	1%
2014	9,334	9,425	91	1%
2015	15,473	15,621	148	1%
2016	21,334	21,495	161	1%
2017	25,455	25,639	184	1%
2018	28,287	28,501	214	1%
2019	29,623	29,815	192	1%
2020	35,540	35,661	121	0%
2021	45,464	45,532	68	0%
2022	15,548	15,554	6	0%
Total	322,158	324,684	2,526	1%

Note: Outstanding Delinquencies = Reported Delinquencies - Submitted Claims - Cured Delinquencies
Data on a cumulative basis as of September 30, 2022.

Table 23: Data Reconciliation for Number of Claims to Date

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary -FHA)	Percent Difference (Actuary - FHA) / FHA
1992	36,794	36,792	(2)	0%
1993	52,317	52,314	(3)	0%
1994	65,965	65,964	(1)	0%
1995	44,716	44,716	0	0%
1996	63,544	63,537	(7)	0%
1997	59,964	59,955	(9)	0%
1998	67,655	67,643	(12)	0%

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary -FHA)	Percent Difference (Actuary - FHA) / FHA
1999	84,444	84,429	(15)	0%
2000	71,493	71,484	(9)	0%
2001	85,632	85,620	(12)	0%
2002	90,855	90,830	(25)	0%
2003	91,630	91,615	(15)	0%
2004	116,481	116,454	(27)	0%
2005	92,693	92,676	(17)	0%
2006	94,969	94,967	(2)	0%
2007	107,152	107,152	0	0%
2008	225,783	225,782	(1)	0%
2009	228,289	228,289	0	0%
2010	117,290	117,290	0	0%
2011	48,516	48,515	(1)	0%
2012	30,451	30,451	0	0%
2013	28,423	28,423	0	0%
2014	16,759	16,759	0	0%
2015	16,695	16,695	0	0%
2016	14,785	14,785	0	0%
2017	11,203	11,203	0	0%
2018	6,583	6,583	0	0%
2019	2,221	2,221	0	0%
2020	440	440	0	0%
2021	86	86	0	0%
2022	0	0	0	0%
Total	1,973,828	1,973,670	(158)	0%

Specification of Mortgage Transition Models (Appendix B)

The purpose of the transition predictive models is to estimate the likelihood of future occurrences of claim and prepayment terminations for FHA forward mortgages in the MMI portfolio. The models are used to project future outstanding balances, cash flows, and ultimately the Cash Flow NPV.

The predictive models reflect the fact that mortgage borrowers possess two mutually exclusive options to terminate the mortgage: one to prepay the mortgage and the other to default by permanently ceasing payment. From FHA's perspective prepayment and claim events are the corresponding outcomes of "competing risks" because they are mutually exclusive, and realization of one of these events precludes the other. Prepayment means cessation of cash inflows from MIP, but at the same time eliminates any chance of incurring claim losses. Conversely, termination through foreclosure means claim costs are incurred and MIP inflows cease, but uncertainty about the possibility and timing of prepayment is eliminated.

The models developed for this analysis also include additional transitions. These include the transition from current to 90 days or more delinquent (Default), cures from Default separated into cures by mortgage modification, and self-cures with no modification or with "light" modifications.

We track the post-cure behavior of modified mortgages and self-cured mortgages separately with modification-related variables, namely a modification flag and the payment reduction ratio. We also track the status of mortgages post-default by including a prior default flag and the time since the most recent default.

We model five possible transitions from a mortgage in current status: remain current, default (become 90 or more days delinquent), prepay by SR, other prepayments or self-cure. (There is also one additional transition possible – cure with a modification. This transition rarely occurs for a mortgage in current status, but most often occurs with a mortgage in default status. Therefore, we have included these transitions in the default transition model development.) Given that these are mutually exclusive outcomes, the sum of the probabilities for all possible transitions is 100%. For a mortgage in default status at the beginning of a particular period, the five possible transitions are that it may be prepaid, transition into a claim, self-cure, cure with a mortgage modification, or remain in default.

For this Actuarial Review, we have separately identified claims in default and in COVID-19 forbearance. Borrowers who experienced an adverse impact on their ability to make on-time mortgage payments due to the COVID-19 pandemic were eligible for forbearance for an initial period of six months, and this initial period could be extended by up to six additional months. All borrowers were eligible for COVID-19 forbearance; therefore, if a borrower was granted this forbearance, it would likely delay the transition of the mortgage in default to a subsequent status. Therefore, we developed additional transition assumptions for COVID-19 forbearances to reflect the potential slow-down in resolution. For loans in COVID-19 forbearance, RMA projects that a portion of the loans eligible for loss mitigation will exit forbearance as either a loss mitigation claim, a loan still in default or a payoff. For loans that are in COVID-19 forbearance but not eligible for loss mitigation, RMA projects that a portion of these loans will exit forbearance as a default loan.

In the 2017 and 2018 Actuarial Reviews, multinomial logistic models were used to estimate the probability of transition for current and default mortgages. In the 2019 and subsequent Actuarial Reviews, we used binomial logistic models to predict each transition separately, and once all the binomial models were completed, we adjusted the binomial probabilities to reflect the multinomial nature of the transitions. The primary reason for making this change was that it allowed us to better model each transition using the independent variables that were significant for that transition. The multinomial structure used in the 2017 and 2018 Actuarial Reviews did not allow for the use of variables just for individual transitions (i.e., if a variable was included in the model, it applied to all transitions). This resulted in over-specification of the transition models, as there are some independent variables that were not significant for some transitions. To address this, RMA used binomial models for each transition and applied an adjustment to reflect the multinomial nature of the process. RMA has continued the use of binomial models for this Actuarial Review.

RMA investigated the use of Multinomial Discrete Choice (MDC) models for this analysis process. MDC models allow all transitions to be modeled simultaneously and allow for the use of independent variables only for specific transitions. RMA compared the MDC approach to the binomial logistic approach and concluded that the two approaches produce identical results. We also observed that the MDC approach took significantly longer to complete as it was more computationally intensive. Because the results of the two methods were identical and the binomial logistic models ran more efficiently, we decided to continue with the binomial logistic approach with the multinomial adjustment.

There are several benefits to using a multinomial logistic model structure. First, it ensures that the event probabilities sum to unity. This means that, at any point in time, a mortgage must experience only one of the possible transitions over the next period. Second, the possible values of each probability are constrained to be between zero and one. Third, as the probability of one transition type increases, the probabilities of the others are automatically reduced, reflecting the competing-risk nature among the transition events. Finally, it allows the conditional termination rates using mortgage-level data to be estimated. With mortgage-level observations, the possible outcomes at each point in time are either 0 (the event did not happen) or 1 (the event happened).

We developed the transition models with the initial condition of C for the FRM30 non-SR product using a random sample of 50% of the data. For all other products, we used 100% of the data in the model development. For Default transition models, we used 100% of the data in the model development for all products.

Loss Severity Model (Appendix C)

FHA incurs a loss from a mortgage claim event. This loss amount depends on many factors, including the property disposition channel. In practice, foreclosed properties generally have higher severity compared to pre-foreclosure-sales (PFS). Foreclosure mortgages can be further separated into REO and Claims Without Conveyance of Title (CWCOT). We have developed multiple models to predict loss severity: models to predict whether the property is disposed by PFS, REO or CWCOT, and separate loss severity models for PFS, REO and CWCOT cases. The loss severity models capture characteristics of the mortgage, the collateral, the borrower, and the housing market environment when a claim occurs. The claim disposition selection model was estimated using multinomial logistic regression, while Generalized Linear Models (GLM) were developed for loss severity models.

In addition to the loss severity models, we developed separate models to project the frequency of loss mitigation claims and the severity associated with these claims.

All loans granted a COVID-19 forbearance must be evaluated for eligibility for a partial claim and/or loan modification. When the COVID-19 forbearance program began, borrowers who were current or less than 30 days past due as of March 1, 2020, were to be evaluated for COVID-19 loss

mitigation options. In 2021, eligibility for COVID-19 forbearance was extended to loans that were 30 or more days past due as of March 31, 2020. Once a loan is projected to exit COVID-19 forbearance, RMA estimated the transition path of the loan based on the percentages estimated from forbearance exits that have occurred since the forbearance program began. If the loan is projected to be a COVID-19 loss mitigation claim, the severity will be estimated based on the loss mitigation severity model.

Cash Flow Projections (Appendix E)

After developing the transition and severity predictive models, we use this information to project future cash flows. The cash flow model includes the calculation of five types of cash flows:

1. Upfront MIP
2. Annual MIP
3. Claim payments
4. Loss mitigation related expenses
5. Premium refunds

The federal credit subsidy present value conversion factors provided by OMB are used to discount future cash flows to determine their present value as of the end of Fiscal Year 2022.

FHA executed note sales in November 2015, September 2016, and April 2021. Based on information provided by HUD, there are no current planned or pending note sales. Therefore, we have not projected any future note sales in our analysis.

We have calculated the Cash Flow NPV based on multiple deterministic economic scenario paths. The ACE projection is based on the OMB Economic Assumptions, and the variation in the estimate is calculated in part by using 10 alternative economic projection scenarios from Moody's. These scenarios include both more favorable than expected and less favorable than expected economic assumptions. The resulting Cash Flow NPV is then calculated based on these varying assumptions. The following are the economic variables that drive the variation in the MMI Cash Flow NPV:

- One-year CMT rates
- Three-year CMT rates
- Five-year CMT rates
- 10-year CMT rates
- 30-year CMT rates
- 30-year FRM rates
- FHFA national purchase-only HPI
- Unemployment rates by state
- Change in unemployment rate
- One-year GDP ratio
- CCI
- SBOI

Appendices

Appendix A: Data – Sources, Processing and Reconciliation

Appendix B: Transition Models

Appendix C: Loss Severity Models

Appendix D: Economic Scenarios

Appendix E: Cash Flow Analysis

Appendix F: Review of HUD Analysis of Economic Net Worth, Comparison of HUD and RMA Models, and Assessment of Vulnerabilities

Appendix G: Summary of Historical and Projected Claim Rates, Non-Claim Termination Rates and Loss Severities

Appendix A: Data – Sources, Processing and Reconciliation

Data Sources

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The following tables are based on data as of September 30, 2022.

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Total	7,203,970	7,197,837	(6,133)	0%

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1994	1,230,779,039	1,223,583,787	(7,195,252)	-1%
1995	634,049,238	632,220,613	(1,828,625)	0%
1996	1,113,455,471	1,111,058,326	(2,397,145)	0%
1997	1,265,515,199	1,262,781,986	(2,733,213)	0%
1998	2,141,195,453	2,135,659,342	(5,536,111)	0%
1999	2,867,090,699	2,856,886,793	(10,203,906)	0%
2000	1,630,421,172	1,620,203,229	(10,217,943)	-1%
2001	3,124,536,203	3,093,858,452	(30,677,751)	-1%
2002	4,846,995,058	4,783,410,286	(63,584,772)	-1%
2003	7,656,385,973	7,594,947,507	(61,438,466)	-1%
2004	9,622,729,367	9,543,722,187	(79,007,180)	-1%
2005	7,145,532,288	7,094,119,160	(51,413,128)	-1%
2006	6,011,646,816	5,961,988,071	(49,658,745)	-1%
2007	6,262,003,100	6,217,476,031	(44,527,069)	-1%
2008	16,294,317,515	16,284,948,410	(9,369,105)	0%
2009	35,552,387,870	35,551,019,369	(1,368,501)	0%
2010	41,388,752,953	41,387,823,793	(929,160)	0%
2011	33,746,485,903	33,745,900,314	(585,589)	0%
2012	44,433,112,767	44,432,710,024	(402,743)	0%
2013	64,476,063,746	64,476,063,746	0	0%
2014	23,559,768,668	23,559,768,668	0	0%
2015	46,107,501,651	46,107,501,651	0	0%
2016	69,430,024,601	69,430,024,601	0	0%
2017	80,518,308,831	80,518,308,831	0	0%
2018	66,531,262,482	66,531,262,482	0	0%
2019	70,567,445,566	70,567,445,566	0	0%
2020	162,716,598,993	162,716,598,993	0	0%
2021	293,847,804,971	293,847,804,971	0	0%
2022	246,812,239,975	246,812,239,975	0	0%
Total	1,352,304,781,827	1,351,798,651,832	(506,129,995)	0%

Table 26: Data Reconciliation for Number of 90 Day Delinquencies

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	109	110	1	1%
1993	399	403	4	1%
1994	659	665	6	1%
1995	515	519	4	1%
1996	892	904	12	1%
1997	952	956	4	0%
1998	1,465	1,484	19	1%
1999	1,980	1,996	16	1%
2000	1,381	1,395	14	1%
2001	2,099	2,119	20	1%
2002	2,718	2,751	33	1%
2003	3,236	3,286	50	2%
2004	4,575	4,662	87	2%
2005	3,885	3,939	54	1%
2006	3,580	3,640	60	2%
2007	3,874	3,942	68	2%
2008	9,035	9,182	147	2%
2009	13,345	13,533	188	1%
2010	12,665	12,858	193	2%
2011	8,811	8,932	121	1%
2012	9,043	9,159	116	1%
2013	10,882	11,006	124	1%
2014	9,334	9,425	91	1%
2015	15,473	15,621	148	1%
2016	21,334	21,495	161	1%
2017	25,455	25,639	184	1%
2018	28,287	28,501	214	1%
2019	29,623	29,815	192	1%
2020	35,540	35,661	121	0%
2021	45,464	45,532	68	0%
2022	15,548	15,554	6	0%
Total	322,158	324,684	2,526	1%

Note: Outstanding Delinquencies = Reported Delinquencies - Submitted Claims - Cured Delinquencies
Data on a cumulative basis as of September 30, 2022.

Table 27: Data Reconciliation for Number of Claims to Date

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Difference (Actuary -FHA)	Percent Difference (Actuary - FHA) / FHA
1992	36,794	36,792	(2)	0%
1993	52,317	52,314	(3)	0%
1994	65,965	65,964	(1)	0%
1995	44,716	44,716	0	0%
1996	63,544	63,537	(7)	0%
1997	59,964	59,955	(9)	0%
1998	67,655	67,643	(12)	0%
1999	84,444	84,429	(15)	0%
2000	71,493	71,484	(9)	0%
2001	85,632	85,620	(12)	0%
2002	90,855	90,830	(25)	0%
2003	91,630	91,615	(15)	0%
2004	116,481	116,454	(27)	0%
2005	92,693	92,676	(17)	0%
2006	94,969	94,967	(2)	0%
2007	107,152	107,152	0	0%
2008	225,783	225,782	(1)	0%
2009	228,289	228,289	0	0%
2010	117,290	117,290	0	0%
2011	48,516	48,515	(1)	0%
2012	30,451	30,451	0	0%
2013	28,423	28,423	0	0%
2014	16,759	16,759	0	0%
2015	16,695	16,695	0	0%
2016	14,785	14,785	0	0%
2017	11,203	11,203	0	0%
2018	6,583	6,583	0	0%
2019	2,221	2,221	0	0%
2020	440	440	0	0%
2021	86	86	0	0%
2022	0	0	0	0%
Total	1,973,828	1,973,670	(158)	0%

Appendix B: Transition Models

This appendix describes the technical details of the predictive models used to estimate the transition behavior of forward mortgages.

Section 1 summarizes the model specifications used to analyze FHA mortgage status transitions and the subsequent ultimate claim and prepayment rates. This section also presents the statistical theory behind multinomial logistic models.

Section 2 describes the explanatory variables used in the models.

Section 3 shows the model parameters.

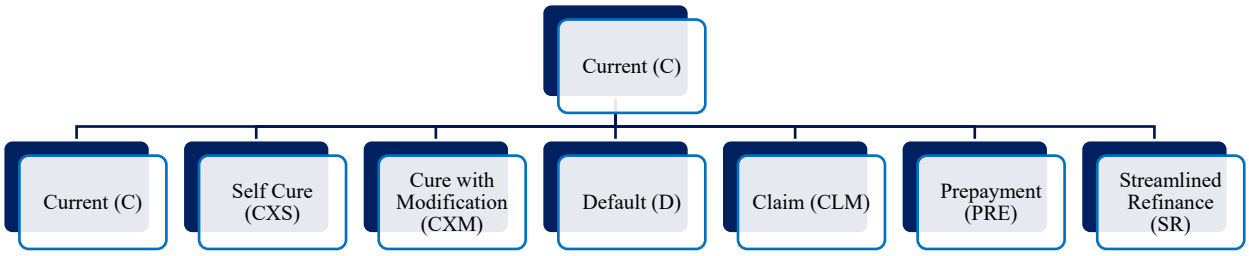
Section 4 shows the model validation of the binomial logistic models.

Section 1: Model Specification

Models are specified by a competing-risk framework based on multinomial logistic models for quarterly conditional probabilities of prepayment, claim terminations and 90-day delinquency (or default). The date from which a mortgage is first reported to be 90 or more days late is used to identify the start of a default episode, and this episode continues until ended by cure or the mortgage terminates through claim or prepayment. Active mortgages that are not in a 90-day default episode at the beginning of the quarter are classified as current.

Figure 12 shows the possible "current" status transitions that have been modeled using the multinomial framework.

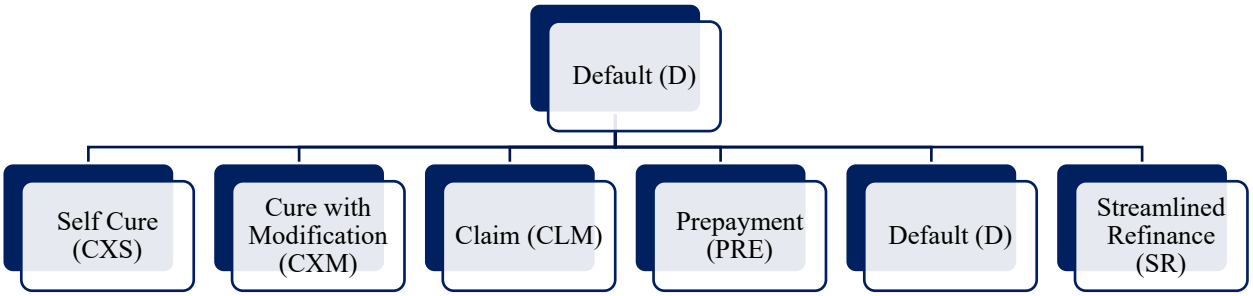
Figure 12: Transition Models – Initial Current Status



Mortgages in current status (C) at the beginning of the quarter can default and cure in the same quarter (CXS and CXM), transition to default status (D) at the start of the next quarter, result in a claim (CLM) or terminate as a prepayment due to an FHA Streamlined Refinance (SR) or as a prepayment (PRE) for any reason other than SR. There are two types of cures, a self-cure (CXS) and a cure that includes a mortgage modification (CXM). Also, due to the very low likelihood of a current mortgage transitioning into to a CLM in one quarter, we have combined D and CLM into one category (DCLM).

Figure 13 shows the possible default status transitions that have been modeled using the multinomial framework.

Figure 13: Transition Models – Initial Default Status



For mortgages that begin the quarter in default, they can cure either by the borrower becoming current on their own (CXS), or they can cure with a modification in the terms of the mortgage (CXM). The mortgage can also terminate as a prepayment due to an SR or as a prepayment (PRE) for any reason other than SR, turn into a claim (CLM) or remain in default (D). For the development of the transition models, we have combined PRE and SR into one category (END).

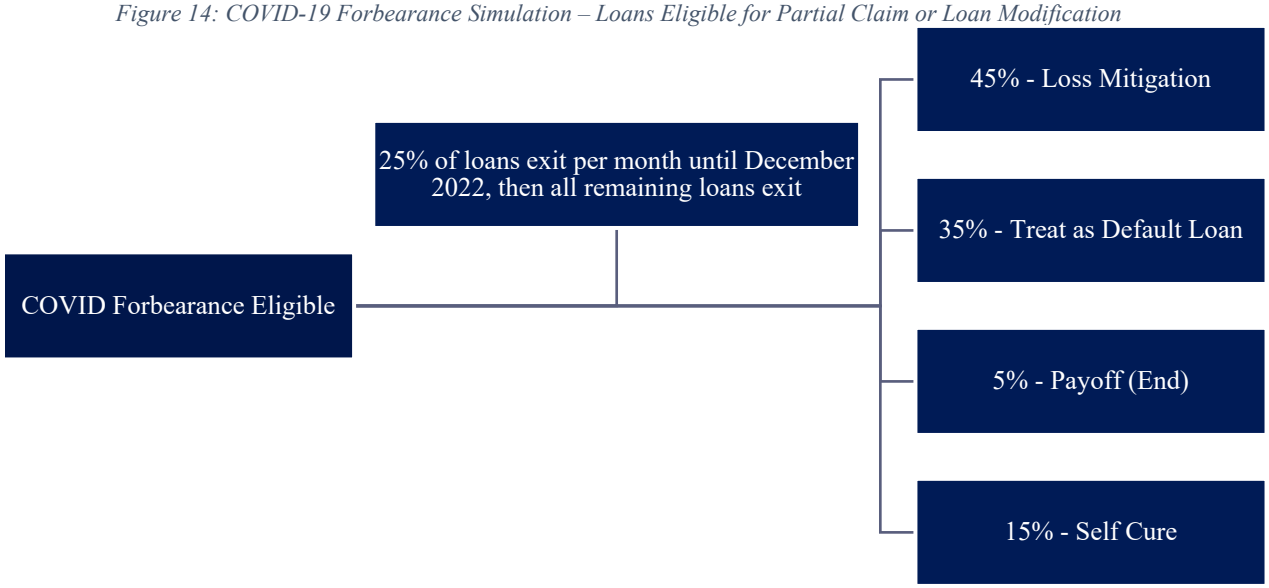
As the mortgage transitions through multiple stages, the historical status of the mortgage is retained. At any point in the life of the mortgage, we track both the number of prior times the mortgage was either in default or modified as well as the length of time since the mortgage was in the prior stage.

As a result of the COVID-19 pandemic, borrowers who experienced an adverse impact on their ability to make on-time mortgage payments are eligible for forbearance for an initial period of six months, and this initial period can be extended by up to six additional months. Borrowers were eligible to apply for COVID-19 forbearance through June 30, 2022. For loans that entered forbearance through June 30, 2021, they are eligible for up to one year of forbearance, while loans that entered between July 1, 2021 and June 30, 2022 are eligible for six months of forbearance. This may result in loans being in forbearance through December 31, 2022.

While a loan is in forbearance, the borrower does not have to make mortgage payments, which technically means the loan is in default. As no action can be taken on these loans by the lender while the loan is in forbearance, the path of these loans cannot be projected by the normal default models.

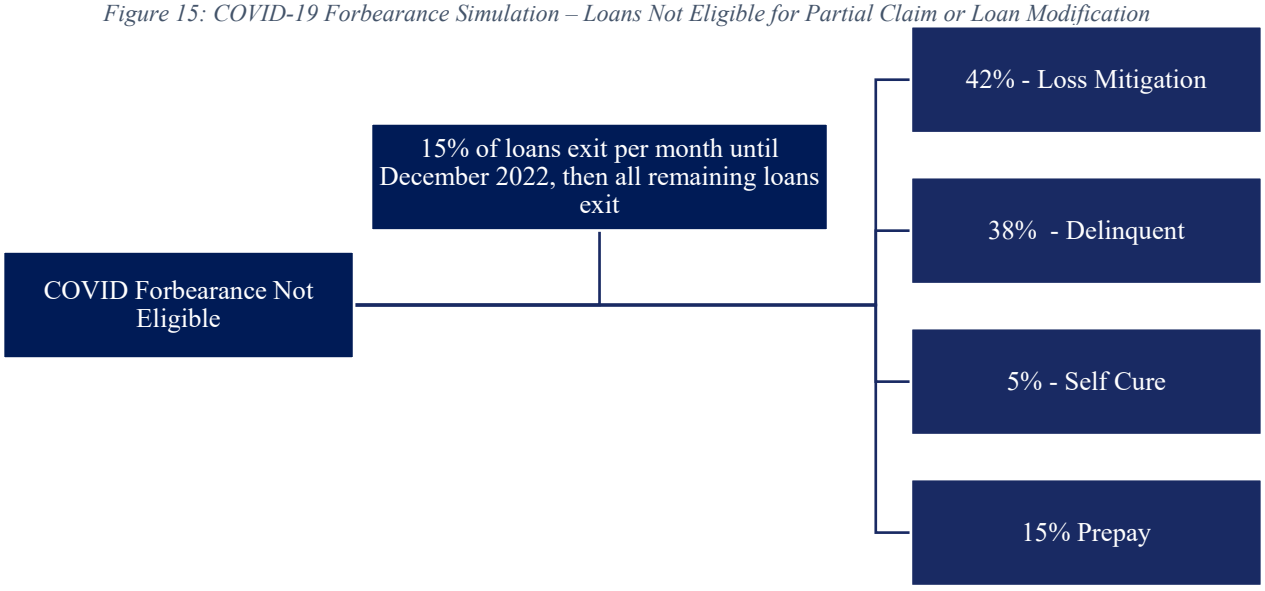
For loans in forbearance, some may be eligible for a partial claim or loan modification if they meet certain criteria. Based on the forbearance criteria, RMA has developed an adjustment to the simulation process to handle these COVID-19 forbearance loans. Loans in COVID-19 forbearance as of September 30, 2022 that are eligible for a loan modification or partial claim were simulated as follows:

Figure 14: COVID-19 Forbearance Simulation – Loans Eligible for Partial Claim or Loan Modification



Loans in COVID-19 forbearance as of September 30, 2022, that are not eligible for a loan modification or partial claim will be simulated as follows:

Figure 15: COVID-19 Forbearance Simulation – Loans Not Eligible for Partial Claim or Loan Modification



These projections were developed based on data from HUD and Black Knight. The projections have not been updated since last year. The indicated numbers did not change significantly, and any changes would not have had a material impact because all loans in COVID forbearance are scheduled to exit forbearance by the end of 2022.

Multinomial Logistic Regression Theory and Model Specification

Multinomial logistic regression is used to model the relationship between a collection of predictor variables and the distributional behavior of a polytomous response variable. It is a likelihood-based

methodology and may be viewed as the generalization of logistic regression for a response variable with more than two levels.

To formalize its description, let the response variable Y take m possible levels, denoted for simplicity as 1,…,m, and assume there is a collection of g predictors $X_1,\ldots,X_g$, that are used to model Y's distribution. We assume that Y and $X_1,\ldots,X_g$ are jointly observed n times with the i^{th} random observation being labeled as

$$Y_i, X_{1i},\ldots,X_{gi} \text{ and its realized value } y_i, x_{1i},\ldots,x_{gi}.$$

In a multinomial logistic regression, the mathematical structure of the model is set by the following two assumptions:

1. The g+1 length random vectors $<Y_i, X_{1i},\ldots,X_{gi}>$ are jointly independent across all i
2. Given that $X_{1i},\ldots,X_{gi}$ have been observed at $x_{1i},\ldots,x_{gi}$, Y_i's distribution is assumed to be multinomial with

$$P(Y_i = l) = \exp(\mu^l+\sum_{k=1}^{g}\beta_k^l\cdot x_{ki})/(\sum_{j=1}^{m}\exp(\mu^j+\sum_{k=1}^{g}\beta_k^j\cdot x_{ki})),$$

where the β_k^j are unknown regression parameters and the μ^j are unknown intercept parameters. [Note: To prevent over-specification of the model due to the constraint that the above probabilities sum to 1 over l=1,…,m, a base level j is chosen such that β_k^j and μ^j are set equal to zero.] Thus, if j = 1, then

$$P(Y_i=1) = 1/(1+\sum_{j=2}^{g}\exp(\mu^j+\sum_{k=1}^{g}\beta_k^j\cdot x_{ki})).$$

It now follows the likelihood equation for this model is given by

$$\prod_{i=1}^{n} P(Y_i=y_i) = \prod_{i=1}^{n} \exp(\mu^{y_i}+\sum_{k=1}^{g}\beta_k^{y_i}\cdot x_{ki})/(\sum_{j=1}^{m}\exp(\mu^j+\sum_{k=1}^{g}\beta_k^j\cdot x_{ki})).$$

The multinomial logistic regression procedure optimizes the above likelihood over the unknown parameters to find those parameters that are most likely to have given rise to the data.

In the 2017 and 2018 Actuarial Reviews, multinomial logistic models were used to estimate the probability of transition for current and default mortgages. Following the change that occurred in Actuarial Reviews in 2019, we continued using binomial logistic models to predict each transition separately. Once all the binomial models are completed, we compute multinomial probabilities from the binomial models. The primary reason for this change was that it allows better modeling of each transition with the variables that impact that transition, whereas the multinomial model structure requires us to include a variable for all transitions, even if it is only predictive of one of the transitions.

The multinomial structure used in the 2017 and 2018 reports did not allow for the use of variables just for individual transitions, if a variable was included in the model it applied to all transitions. This can result in model over-specification, as there are some independent variables that are not significant for some transitions. To address this, RMA used binomial models for each transition and applied an adjustment to reflect the multinomial nature of the process.

RMA investigated the use of Multinomial Discrete Choice (MDC) models for this analysis. MDC models allow all transitions to be modeled simultaneously and allows for the use of independent variables only for specific transitions. RMA compared the MDC approach to the binomial logistic approach and concluded that the two approaches produce identical model results. We also observed that the MDC approach took significantly longer to complete as it was more computationally intensive. Because the results of the two methods were identical and the binomial logistic models ran more efficiently, we decided to continue with the binomial logistic approach with the multinomial adjustment.

The target variables for the current and default transition models are shown in Figure 12 and Figure 13. The independent variables used in the models are described in the following section. 31 models were built, 15 for the current (C) transitions and 16 for the Default (D) transitions. Four product groups are modeled: non-SR fixed rate 30-year term (FRM30NSR), SR fixed rate 30-year term (FRM30SR), fixed rate 15-year term (FRM15) and adjustable-rate mortgages (ARM). The model development was completed using a train/validate approach. A random sample of the data is used to train the model, to determine inclusion and exclusion of explanatory variables, and to calculate model parameters. The remaining sample, the validation, is used as a final validation step to confirm the predictive power of the final model.

To generate the random sample, random numbers were added to the dataset at the case level using a random number generator. The random numbers were drawn from a uniform distribution between 0 and 1. Based on these random numbers, 60% of the cases were assigned to the train dataset and 40% were assigned to the validation dataset.

There have been over 39 million single-family mortgages insured by FHA originated between the first quarter of Fiscal Year 1975 and the end of Fiscal Year 2022. For the transition models with the initial condition of C for the FRM30NSR, we used a random sample of 50% of the data. For all other products, we used 100% of the data in the model development.

For transition models with the initial condition of D we used 100% of the data for all ending condition models for all products.

Computation of Multinomial Logistic Probabilities from Binomial Models

As stated above, we compute multinomial probabilities from the binomial models described developed. To arrive at the multinomial logit model for K possible outcomes, K-1 independent

binary logistic regression models are run and the *Kth* outcome is derived from the *K-1* models. The linear predictor (*lp*) is formulated by a binomial logistic regression for all transitions except for the transition representing remaining in the same state (C_C or D_D), which is the *Kth* outcome. This is consistent with the approach developed by Begg and Gray (1984)[80], in which separate binomial logistic models for each possible transition type are developed, and then the estimates are recombined to derive the multinomial logistic probabilities.

For the C transitions:

$$lp(C\_D) = e^{\alpha^{C\_D} + X^{C\_D}(t)\beta^{C\_D}}$$
$$lp(C\_CXS) = e^{\alpha^{C\_CXS} + X^{C\_CXS}(t)\beta^{C\_CXS}}$$
$$lp(C\_SR) = e^{\alpha^{C\_SR} + X^{C\_SR}(t)\beta^{C\_SR}}$$
$$lp(C\_PRE) = e^{\alpha^{C\_PRE} + X^{C\_PRE}(t)\beta^{C\_PRE}}$$

The probabilities can then be derived for each of the *K-1* transitions:

$$Prob(C\_D) = lp(C\_D) / [1+lp(C\_D)+lp(C\_CXS)+lp(C\_SR)+lp(C\_PRE)]$$
$$Prob(C\_CXS) = lp(C\_CXS) / [1+lp(C\_D)+lp(C\_CXS)+lp(C\_SR)+lp(C\_PRE)]$$
$$Prob(C\_SR) = lp(C\_D) / [1+lp(C\_D)+lp(C\_CXS)+lp(C\_SR)+lp(C\_PRE)]$$
$$Prob(C\_PRE) = lp(C\_D) / [1+lp(C\_D)+lp(C\_CXS)+lp(C\_SR)+lp(C\_PRE)]$$

The *Kth* probability is

$$Prob(C\_C) = 1- Prob(C\_D)- Prob(C\_CXS)- Prob(C\_SR)- Prob(C\_PRE)$$

For the D transitions:

$$lp(D\_CLM) = e^{\alpha^{D\_CLM} + X^{D\_CLM}(t)\beta^{D\_CLM}}$$
$$lp(D\_CXS) = e^{\alpha^{D\_CXS} + X^{D\_CXS}(t)\beta^{D\_CXS}}$$
$$lp(D\_CXM) = e^{\alpha^{D\_CXM} + X^{D\_CXM}(t)\beta^{D\_CXM}}$$
$$lp(D\_END) = e^{\alpha^{D\_END} + X^{D\_END}(t)\beta^{D\_END}}$$

The probabilities can then be derived for each of the K-1 transitions:

$$Prob(D\_CLM)= lp(D\_CLM) / [1+lp(D\_CLM)+lp(D\_CXS)+lp(D\_CXM)+lp(D\_END)]$$
$$Prob(D\_CXS) = lp(D\_CXS) / [1+lp(D\_CLM)+lp(D\_CXS)+lp(D\_CXM)+lp(D\_END)]$$
$$Prob(D\_CXM)\ l=p(D\_CXM) / [1+lp(D\_CLM)+lp(D\_CXS)+lp(D\_CXM)+lp(D\_END)]$$

[80] Begg, C.B. and R. Gray, "Calculation of Polychotomous Logistic Regression Parameters Using Individualized Regressions," Biometrika, 71(1):11-18, 1984.

$$Prob(D\_END) = lp(D\_END) / [1+lp(D\_CLM)+lp(D\_CXS)+lp(D\_CXM)+lp(D\_END)]$$

The *Kth* probability is

$$Prob(D\_D) = 1- Prob(D\_CLM)- Prob(D\_CXS)- Prob(D\_CXM)- Prob(D\_END)$$

Finally, a check is built into the simulation to assure the sum of all transition probabilities does not exceed 1.0.

Section 2: Transition Model Explanatory Variables

Multiple categories of explanatory variables were considered in development of the transition models.

- Fixed initial mortgage characteristics: market rate, initial mortgage size, spread at origination, refinance indicator
- Fixed initial borrower characteristics: down payment assistance, first-time home buyer, credit score, cohort year
- Property characteristics: the number of living units, initial home values
- Dynamic variables based on mortgage information: prior default indicator, number of prior default episodes, prior mortgage modification, number of prior modifications, LTV ratio, interest rate spread, TEI (expense to income ratio), mortgage period, duration of default episode, time since last default episode
- Dynamic variables derived by combining mortgage information and external economic data: spread, season
- Dynamic macroeconomic variables: average unemployment rate over multiple time periods, change in the unemployment rate, HPI, change in HPI, treasury rates, GDP measures, slope of yield curve. Consumer Confidence Index, Small Business Confidence Index
- Geographic variables: judicial state, collateral state

The following explanatory variables are used in the transition models. A general description of the variable is provided below, and more specific detail is included in the Model Parameters section.

- **Periodnbr**: the number of quarters since the inception of the mortgage. This variable is incorporated as a piecewise variate and a grouped categorical variable.

- **Refiincent**: refinance incentive - the ratio of the difference in the initial mortgage rate to the current market mortgage rate. This variable is calculated as *(100*mortgage interest rate)/(market FRM30 rate)*. This variable is incorporated as a piecewise variate.

- **Priordef**: number of prior default episodes. This variable is incorporated as a grouped categorical variable and a piecewise variate.

- **Timesinced**: time since most recent default. This variable is incorporated as a grouped categorical variable.

- **Credit**: credit score. This variable is incorporated as a piecewise variate.

- **Ratiotmptei**: front end ratio, the portion of an individual's income allocated to mortgage payments. This variable is incorporated as a piecewise variate.

- **Deltaue**: change in unemployment rate from mortgage inception to current. This variable is incorporated as a piecewise variate.

- **Deltauepr3**: change in unemployment rate from three quarters prior to current. This variable is incorporated as a piecewise variate.

- **Hpa2yb**: house price appreciation over the past two years. This variable is calculated as (*current hpi_index /hpi_index 8 quarters prior)*. This variable is incorporated as a piecewise variate.

- **LTV**: ratio of the amortized loan balance to the current home value. This variable is incorporated as a piecewise variate.

- **Loanraw**: the initial mortgage amount. This variable is incorporated as a piecewise variate.

- **Frst_tm_by**: first time home buyer. This variable is incorporated as a categorical variable.

- **Season**: the quarter of the year. Possible values are 1 – January through March, 2 – April through June, 3 – July through September, and 4 – October through December. This variable is incorporated as a grouped categorical variable.

- **Rfnc_ind**: an indicator of whether the mortgage was a refinance. This variable is incorporated as a categorical variable.

- **Dpa**: down payment assistance. This variable is incorporated as a categorical variable.

- **Ueblend**: current unemployment rate. This variable is incorporated as a piecewise variate.

- **Ycslope**: yield curve. This variable is incorporated as a grouped categorical variable.
- **Sato**: spread at origination. This variable is calculated as the difference between the prevailing interest rate and the mortgage interest rate at time of origination. This variable is incorporated as a piecewise variate.
- **Calperiod**: calendar year and quarter. This variable is incorporated as a grouped categorical variable.
- **Judicial**: whether the property is in a judicial state. This variable is incorporated as a categorical variable.
- **Cred_subs_coht**: credit subsidy cohort. This variable is incorporated as a grouped categorical variable.
- **Treasury_yr30**: 30-year CMT rate. This variable is incorporated as a grouped categorical variable.
- **Deltaty1**: change in one-year CMT rate from policy inception to current. This variable is incorporated as a piecewise variate.
- **Deltaty10init**: 10-year CMT rate at policy inception. This variable is incorporated as a grouped categorical variable.
- **Durdefep**: duration of default episode. This variable is incorporated as a grouped categorical variable.

For variables that are incorporated as a piecewise variate, further information is provided on how these variates are specified in the Model Parameter section.

The overall percentage of records in each final condition category for the initial condition of Current is shown in Table 28.

Table 28: Distribution of Final Condition for Current Transition Models

Final Condition	Percentage
CXS	0.47%
DCLM	2.54%
CXM	0.01%
SR	0.80%
PRE	2.40%
C	93.73%

The overall percentage of records in each final condition category for the initial condition of Default is shown in Table 29.

Table 29: Distribution of Final Condition for Default Transition Models

Final Condition	Percentage
CLM	3.26%
CXM	3.28%
CXS	18.49%
END	1.73%
D	73.10%

Section 3: Binomial Model Results[81, 82]

Current Transition Model Parameters – FRM30NSR C_SR

The model parameters for the FRM30NSR current to streamlined refinance transition are shown in Table 30.

Table 30: Current to Streamlined Refinance Transition FRM30NSR Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-6.8943	0.0403	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	Categorical of judicial (judicial state)	-0.1591	0.0014	<.0001
mperiodnbr_CSR	**L03**		Categorical of period_number	period_number <= 3	-0.5135	0.0032	<.0001
mperiodnbr_CSR	**L04**		Categorical of period_number	period_number = 4	0.3374	0.0029	<.0001
mperiodnbr_CSR	**L05**		Categorical of period_number	period_number = 5	0.3525	0.0028	<.0001
mperiodnbr_CSR	**L06**		Categorical of period_number	period_number = 6	0.2513	0.0028	<.0001
mperiodnbr_CSR	**L07**		Categorical of period_number	period_number = 7	0.1198	0.0029	<.0001
vperiodnbr_CSR_pw1			Variate piecewise of period_number	median(0,period_number-8,22-8)	-0.0566	0.0002	<.0001
vperiodnbr_CSR_pw2			Variate piecewise of period_number	median(0,period_number-22,39-22)	-0.0702	0.0003	<.0001
vperiodnbr_CSR_pw3			Variate piecewise of period_number	median(0,period_number-39,56-39)	-0.0512	0.0006	<.0001
vperiodnbr_CSR_pw4			Variate piecewise of period_number	median(0,period_number-56,70-56)	-0.0389	0.0015	<.0001
vperiodnbr_CSR_pw5			Variate piecewise of period_number	median(0,period_number-70,88-70)	-0.0589	0.0023	<.0001
vrefiincent_CSR_pw1			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-0,93-0)	-0.0095	0.0003	<.0001
vrefiincent_CSR_pw2			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-93,113-93)	0.1051	0.0002	<.0001

[81] For categorical variables, only non-base levels are listed.
[82] The tables' footnotes are consistent among the tables. They are listed at the end of the section.

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vrefiincent_CSR_pw3			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-113,130-113)	0.0631	0.0001	<.0001
vrefiincent_CSR_pw4			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-130,180-130)	0.0166	0.0001	<.0001
vrefiincent_CSR_pw5			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-180,250-180)	-0.0036	0.0003	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	-1.0923	0.0077	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	-0.8148	0.0079	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	-0.5527	0.0081	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	-0.1723	0.0079	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	-0.1117	0.0087	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	-0.1632	0.0099	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; 7 <= cx_time <= 9	-0.1313	0.0068	<.0001
mpriordef_csr*mtimesinceD_CSR	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time > 9	-0.0016	0.0065	0.8037
mpriordef_csr*mtimesinceD_CSR	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	-1.5485	0.0144	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	-1.1814	0.0149	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	-0.7623	0.0145	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	-0.1720	0.0128	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	-0.0730	0.0138	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	-0.1320	0.0160	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_csr*mtimesinceD_CSR	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; 7 <= cx_time <= 9	-0.0882	0.0111	<.0001
mpriordef_csr*mtimesinceD_CSR	**L02**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time > 9	-0.0081	0.0095	0.389
mpriordef_csr*mtimesinceD_CSR	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	-1.7642	0.0133	<.0001
mpriordef_csr*mtimesinceD_CSR	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	-1.2800	0.0133	<.0001
mpriordef_csr*mtimesinceD_CSR	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	-0.7889	0.0128	<.0001
mpriordef_csr*mtimesinceD_CSR	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	-0.0530	0.0108	<.0001
mpriordef_csr*mtimesinceD_CSR	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	0.0904	0.0114	<.0001
mpriordef_csr*mtimesinceD_CSR	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	0.0262	0.0132	0.0468
mpriordef_csr*mtimesinceD_CSR	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; 7 <= cx_time <= 9	0.0079	0.0099	0.4225
mpriordef_csr*mtimesinceD_CSR	**L03**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time > 9	-0.0466	0.0093	<.0001
vpriordef_CSR_pw1			Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.0877	0.0019	<.0001
vcredit_CSR_pw1			Variate piecewise of credit_score	median(0,credit_score-500,650-500)	-0.0037	0.0000	<.0001
vcredit_CSR_pw2			Variate piecewise of credit_score	median(0,credit_score-650,680-650)	0.0012	0.0001	<.0001
vcredit_CSR_pw3			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	-0.0028	0.0001	<.0001
vcredit_CSR_pw4			Variate piecewise of credit_score	median(0,credit_score-720,800-720)	-0.0019	0.0001	<.0001
mRatioTmpTei_CSR	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	1.0166	0.0050	<.0001
vratiotmptei_CSR_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-11,18-11)	0.0215	0.0006	<.0001
vratiotmptei_CSR_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-18,22-18)	0.0098	0.0007	<.0001
vratiotmptei_CSR_pw3			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-22,29-22)	0.0015	0.0004	<.0001
vratiotmptei_CSR_pw4			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-29,37-29)	-0.0045	0.0003	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vtimesinced_CSR_pw1			Variate piecwise of cx_time1	median(0,cx_time-9,40-9)	0.0023	0.0006	0.0002
vdeltaUEinit_CSR_pw1			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,60-0)	-0.0076	0.0003	<.0001
vdeltaUEinit_CSR_pw2			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-60,77-60)	0.0185	0.0002	<.0001
vdeltaUEinit_CSR_pw3			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-77,100-77)	-0.0010	0.0002	<.0001
vdeltaUEinit_CSR_pw4			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-100,105-100)	0.0681	0.0006	<.0001
vdeltaUEinit_CSR_pw5			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-105,145-105)	0.0062	0.0001	<.0001
vdeltaUEinit_CSR_pw6			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-145,225-145)	-0.0005	0.0001	<.0001
vhpa2yb_CSR_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-0,85-0)	0.0134	0.0001	<.0001
vhpa2yb_CSR_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,100-85)	-0.0142	0.0003	<.0001
vhpa2yb_CSR_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-100,106-100)	0.1115	0.0005	<.0001
vhpa2yb_CSR_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-106,111-106)	-0.0072	0.0005	<.0001
vhpa2yb_CSR_pw5			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-111,122-111)	-0.0047	0.0003	<.0001
vhpa2yb_CSR_pw6			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-122,160-122)	-0.0091	0.0002	<.0001
vltv_CSR_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	-0.0016	0.0003	<.0001
vltv_CSR_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,80-70)	0.0274	0.0004	<.0001
vltv_CSR_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-89,93-89)	-0.0312	0.0006	<.0001
vltv_CSR_pw5			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-93,95-93)	0.0398	0.0013	<.0001
vltv_CSR_pw6			Variate piecewise of loansize_raw	median(0,ltv_i_r-95,97-95)	0.1000	0.0020	<.0001
vltv_CSR_pw7			Variate piecewise of loansize_raw	median(0,ltv_i_r-97,100-97)	0.2000	0.0050	<.0001
vloanraw_CSR_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-47000,74000-47000)	5.E-05	2.E-07	<.0001
vloanraw_CSR_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-74000,159000-74000)	1.E-05	3.E-08	<.0001
vloanraw_CSR_pw3			Variate piecewise of loansize_raw	median(0,loansize_raw-159000,345000-159000)	0.0000	0.0000	<.0001
vloanraw_CSR_pw4			Variate piecewise of loansize_raw	median(0,loansize_raw-345000,600000-345000)	0.0000	0.0000	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mfrst_tm_by	**1**		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.2245	0.0014	<.0001
mDeltaTY1Init_CSR	**L01**		Categorical of DeltaTy1Init (Change in 1 yr Treasury policy inception to current)	DeltaTY1Init > 1.15	0.3226	0.0021	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.6305	0.0033	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.4902	0.0028	<.0001
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.4234	0.0025	<.0001
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	3.4852	0.0398	<.0001
v_CCI_growthQ_CSR_pw1			Variate piecewise of CCI quarterly growth	min(CCI_growthQ,0)	-1.5522	0.0128	<.0001
v_CCI_growthQ_CSR_pw2			Variate piecewise of CCI quarterly growth	median(0,CCI_growthQ,0.2)	0.8515	0.0125	<.0001
v_CCI_growthQ_CSR_pw3			Variate piecewise of CCI quarterly growth	max(CCI_growthQ,0.2)	1.5470	0.0120	<.0001

Current Transition Model Parameters – FRM30NSR C_PRE

The model parameters for the FRM30NSR current to prepayment transition are shown in Table 31.

Table 31: Current to Prepayment Transition FRM30NSR Model Parameters

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-6.6505	0.0178	<.0001
mseason	1		Categorical of season	season = "winter"	-0.1607	0.0013	<.0001
mseason	2		Categorical of season	season = "spring"	0.1002	0.0012	<.0001
mseason	3		Categorical of season	season = "summer"	0.0742	0.0012	<.0001
mfrst_tm_by	1		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.1506	0.0011	<.0001
mrfnc_ind	2		Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind = "N"	-0.0624	0.0034	<.0001
mdpa_govt	LGovt		Categorical of dpa (down payment assistance)	dpa = "govt"	-0.0746	0.0036	<.0001
mdpa_rel	LRela		Categorical of dpa (down payment assistance)	dpa = "Relative"	0.0549	0.0012	<.0001
mperiodnbr_CPre	L02		Categorical of period_number	period_number = 2	-2.7835	0.0077	<.0001
mperiodnbr_CPre	L03		Categorical of period_number	period_number = 3	-1.7255	0.0048	<.0001

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mperiodnbr_CPre	L04		Categorical of period_number	period_number = 4	-1.1445	0.0037	<.0001
mperiodnbr_CPre	L05		Categorical of period_number	period_number = 5	-0.6366	0.0031	<.0001
mperiodnbr_CPre	L06		Categorical of period_number	period_number = 6	-0.3825	0.0028	<.0001
mperiodnbr_CPre	L07		Categorical of period_number	period_number = 7	-0.2480	0.0027	<.0001
vperiodnbr_CPre_pw1			Variate piecewise of period_number	median(0,period_number-8,22-8)	0.0148	0.0002	<.0001
vperiodnbr_CPre_pw2			Variate piecewise of period_number	median(0,period_number-22,35-22)	-0.0148	0.0002	<.0001
vperiodnbr_CPre_pw4			Variate piecewise of period_number	median(0,period_number-42, 70-42)	-0.0245	0.0002	<.0001
vperiodnbr_CPre_pw5			Variate piecewise of period_number	median(0,period_number-70, 108-70)	0.0058	0.0003	<.0001
mperiodnbr_CPre*mrfnc_ind	L02	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 2; rfnc_ind = "N"	1.0349	0.0124	<.0001
mperiodnbr_CPre*mrfnc_ind	L03	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 3; rfnc_ind = "N"	1.0027	0.0082	<.0001
mperiodnbr_CPre*mrfnc_ind	L04	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 4; rfnc_ind = "N"	0.8109	0.0070	<.0001
mperiodnbr_CPre*mrfnc_ind	L05	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 5; rfnc_ind = "N"	0.4514	0.0067	<.0001
mperiodnbr_CPre*mrfnc_ind	L06	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 6; rfnc_ind = "N"	0.2775	0.0066	<.0001
mperiodnbr_CPre*mrfnc_ind	L07	2	Interaction of categorical of period_number and categorical of rfnc_ind	period_number = 7; rfnc_ind = "N"	0.1693	0.0067	<.0001
vperiodnbr_CPre_pw1*mrfnc_ind	2		Interaction of variate of period_number and categorical of rfnc_ind	median(0,period_number-8,22-8); rfnc_ind = "N"	-0.0286	0.0004	<.0001
vperiodnbr_CPre_pw2*mrfnc_ind	2		Interaction of variate of period_number and categorical of rfnc_ind	median(0,period_number-22,35-22); rfnc_ind = "N"	-0.0117	0.0005	<.0001
vperiodnbr_CPre_pw3*mrfnc_ind	2		Interaction of variate of period_number and categorical of rfnc_ind	median(0,period_number-35,42-35); rfnc_ind = "N"	0.0186	0.0011	<.0001
vperiodnbr_CPre_pw4*mrfnc_ind	2		Interaction of variate of period_number and categorical of rfnc_ind	median(0,period_number-42, 70-42); rfnc_ind = "N"	0.0151	0.0005	<.0001
vperiodnbr_CPre_pw5*mrfnc_ind	2		Interaction of variate of period_number and categorical of rfnc_ind	median(0,period_number-70, 108-70); rfnc_ind = "N"	-0.0178	0.0015	<.0001
vcredit_CPre_pw1			Variate piecewise of credit_score	median(0,credit_score-450,530-450)	-0.0105	0.0001	<.0001
vcredit_CPre_pw2			Variate piecewise of credit_score	median(0,credit_score-530,630-530)	0.0033	0.0001	<.0001
vcredit_CPre_pw3			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	0.0051	0.0000	<.0001

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vcredit_CPre_pw4			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	0.0030	0.0001	<.0001
vcredit_CPre_pw5			Variate piecewise of credit_score	median(0,credit_score-720,760-720)	0.0010	0.0001	<.0001
vcredit_CPre_pw6			Variate piecewise of credit_score	median(0,credit_score-760,800-760)	-0.0010	0.0001	<.0001
vhpa2yb_CPre_pw1			Variate piecewise of hpa2y_blended_r[6] (2 year house price appreciation)	median(0,hpa2y_blended_r-85,100-85)	0.0376	0.0003	<.0001
vhpa2yb_CPre_pw2			Variate piecewise of hpa2y_blended_r[6] (2 year house price appreciation)	median(0,hpa2y_blended_r-100,106-100)	0.1126	0.0005	<.0001
vhpa2yb_CPre_pw3			Variate piecewise of hpa2y_blended_r[6] (2 year house price appreciation)	median(0,hpa2y_blended_r-106,111-106)	0.0296	0.0003	<.0001
vhpa2yb_CPre_pw4			Variate piecewise of hpa2y_blended_r[6] (2 year house price appreciation)	median(0,hpa2y_blended_r-111,122-111)	0.0390	0.0002	<.0001
vhpa2yb_CPre_pw5			Variate piecewise of hpa2y_blended_r[6] (2 year house price appreciation)	median(0,hpa2y_blended_r-122,150-122)	0.0324	0.0001	<.0001
vpriordef_CPre_pw1			Variate piecewise of prior_default_cnt	meidan(sim_mprior_def_cnt-3,15-3)	0.0184	0.0008	<.0001
vltv_CPRE_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,78-0)	-0.0066	0.0001	<.0001
vltv_CPRE_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-78,85-78)	0.0018	0.0003	<.0001
vltv_CPRE_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-85,87-85)	-0.0147	0.0011	<.0001
vltv_CPRE_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-87,91-87)	-0.0321	0.0005	<.0001
vltv_CPRE_pw5			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-91,94-91)	-0.067	0.0007	<.0001
vltv_CPRE_pw6			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,100-94)	-0.0136	0.0009	<.0001
vueblend_CPre_pw1			Variate piecewise of ue_blended_r[8] (unemployment rate)	(0,ue_blended_r-0,450-0)	-0.0007	0.0000	<.0001
vueblend_CPre_pw2			Variate piecewise of ue_blended_r[8] (unemployment rate)	(0,ue_blended_r-450,700-450)	-0.0002	0.0000	<.0001
vueblend_CPre_pw3			Variate piecewise of ue_blended_r[8] (unemployment rate)	(0,ue_blended_r-700,730-700)	-0.0049	0.0001	<.0001
vueblend_CPre_pw4			Variate piecewise of ue_blended_r[8] (unemployment rate)	(0,ue_blended_r-730, 1000-730)	-0.0008	0.0000	<.0001
vrefiincent_CPre_pw1			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent_r-0,115-0)	0.0247	0.0001	<.0001
vrefiincent_CPre_pw2			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent_r-115,150-115)	0.0078	0.0001	<.0001

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vrefiincent_CPre_pw3			Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent_r-150,200-150)	-0.0034	0.0001	<.0001
vratiotmptei_CPre_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,5-0)	0.0185	0.0007	<.0001
vratiotmptei_CPre_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-5,18-5)	-0.0152	0.0002	<.0001
vratiotmptei_CPre_pw3			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-18,47-18)	-0.0118	0.0001	<.0001
vratiotmptei_CPre_pw4			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-47,100-47)	0.0052	0.0003	<.0001
vdeltaUEinit_CPre_pw1			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,88-0)	0.0024	0.0000	<.0001
vdeltaUEinit_CPre_pw2			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-88,96-88)	0.0107	0.0003	<.0001
vdeltaUEinit_CPre_pw3			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-96,100-96)	0.0079	0.0007	<.0001
vdeltaUEinit_CPre_pw4			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-100,126-100)	0.0067	0.0001	<.0001
vdeltaUEinit_CPre_pw5			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-126,200-126)	0.0028	0.0000	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L01	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	-0.3706	0.0045	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L02	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	-0.3802	0.0050	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L03	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	-0.3682	0.0055	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L04	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	-0.2983	0.0058	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L05	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	-0.2897	0.0062	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L01	L06	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	-0.3003	0.0067	<.0001

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_cpre*mtimesinceD_CPRE	L01	L07	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >= 7	-0.3055	0.0034	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L01	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	-0.5890	0.0068	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L02	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	-0.6130	0.0080	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L03	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	-0.5718	0.0090	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L04	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	-0.4710	0.0096	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L05	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	-0.4289	0.0103	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L06	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	-0.4480	0.0113	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L02	L07	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >= 7	-0.4132	0.0046	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L01	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	-0.7657	0.0054	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L02	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	-0.7897	0.0064	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L03	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	-0.7077	0.0071	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L04	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	-0.5678	0.0075	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L05	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	-0.5126	0.0080	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L06	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	-0.5000	0.0090	<.0001
mpriordef_cpre*mtimesinceD_CPRE	L03	L07	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time >= 7	-0.4000	0.0040	<.0001
vtimesinced_CPre_pw1			Variate piecewise of prior_default_cnt	median(0,cx_time-7,19-7)	0.0070	0.0004	<.0001
vtimesinced_CPre_pw2			Variate piecewise of prior_default_cnt	median(0,cx_time-19,35-19)	0.0080	0.0004	<.0001
vloanraw_CPRE_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-0,57000-0)	0.0000	0.0000	<.0001

Parameters	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vloanraw_CPRE_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-57000,159000-57000)	0.0000	0.0000	<.0001
vloanraw_CPRE_pw3			Variate piecewise of loansize_raw	median(0,loansize_raw-159000,345000-159000)	0.0000	0.0000	<.0001
vloanraw_CPRE_pw4			Variate piecewise of loansize_raw	median(0,loansize_raw-345000,600000-345000)	0.0000	0.0000	<.0001
mDeltaTY1Init_CPRE	L01		Categorical of DeltaTy1Init (Change in 1 yr Treasury policy inception to current)	DeltaTy1Init < 0.17	-0.2053	0.0018	<.0001
mDeltaTY1Init_CPRE	L02		Categorical of DeltaTy1Init (Change in 1 yr Treasury policy inception to current)	DeltaTY1Init > 2.30	0.1710	0.0015	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.1111	0.0020	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.1432	0.0017	<.0001
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.1341	0.0016	<.0001
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-3.2558	0.0270	<.0001
v_MTG_RATE30Y_lag4_CPRE_pw1			Variate piecewise of 30 year mortgate rate with 4Q lag	min(MTG_RATE30Y_lag4,5.5)	0.1091	0.0011	<.0001
v_MTG_RATE30Y_lag4_CPRE_pw2			Variate piecewise of 30 year mortgate rate with 4Q lag	median(0,MTG_RATE30Y_lag4 - 5.5, 6.5-5.5)	0.3747	0.0023	<.0001
v_MTG_RATE30Y_lag4_CPRE_pw3			Variate piecewise of 30 year mortgate rate with 4Q lag	max(MTG_RATE30Y_lag4,6.5)	-0.2149	0.0013	<.0001

Current Transition Model Parameters – FRM30NSR C_CXS

The model parameters for the FRM30NSR current to self-cure transition are shown in Table 32.

Table 32: Current to Self-Cure Transition FRM30NSR Model Parameters

Parameter	Level		DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
Intercept			1			-3.6928	0.0184	40252.73	<.0001
mseason	**1**		1	Categorical of season	season = "winter"	0.3522	0.0022	25459.18	<.0001
mseason	**2**		1	Categorical of season	season = "spring"	-0.2266	0.0025	8536.763	<.0001
mseason	**3**		1	Categorical of season	season = "summer"	-0.0256	0.0024	110.6575	<.0001
mfrst_tm_by	**1**		1	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	0.0593	0.0018	1103.068	<.0001
mdpa_govt	**LGovt**		1	Categorical of dpa (down payment assistance)	dpa = "govt"	0.0733	0.0049	222.5262	<.0001

Parameter	Level		DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
mdpa_rel	**LRela**		1	Categorical of dpa (down payment assistance)	dpa = "Relative"	0.0867	0.0020	1813.348	<.0001
mcalperiod_CCXS	**L200604**		1	Categorical of Calendar Period	if period < 200604 then mcalperiod_CCXS = "L200604"	-2.5929	0.0054	226944.4	<.0001
vpriordef_CCXS_pw1			1	Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.1023	0.0006	34052.94	<.0001
mperiodnbr_cCXS	**L02**		1	Categorical of period_number	period_number = 2	-0.1415	0.0053	700.7124	<.0001
mperiodnbr_cCXS	**L03**		1	Categorical of period_number	period_number = 3	0.1115	0.0048	546.322	<.0001
mperiodnbr_cCXS	**L04**		1	Categorical of period_number	period_number = 4	0.1658	0.0046	1312.72	<.0001
mperiodnbr_cCXS	**L05**		1	Categorical of period_number	period_number = 5	0.1702	0.0045	1405.257	<.0001
mperiodnbr_cCXS	**L06**		1	Categorical of period_number	period_number = 6	0.1873	0.0044	1781.623	<.0001
mperiodnbr_cCXS	**L07**		1	Categorical of period_number	period_number = 7	0.1211	0.0045	723.1037	<.0001
vperiodnbr_CCXS_pw1			1	Variate piecewise of period_number	median(0,period_number-8,36-8)	-0.0250	0.0001	33089.24	<.0001
vperiodnbr_CCXS_pw2			1	Variate piecewise of period_number	median(0,period_number-36,53-36)	-0.0121	0.0003	2021.13	<.0001
vperiodnbr_CCXS_pw3			1	Variate piecewise of period_number	median(0,period_number-53,76-53)	-0.0132	0.0003	1637.932	<.0001
vperiodnbr_CCXS_pw4			1	Variate piecewise of period_number	median(0,period_number-76,86-76)	-0.0154	0.0009	292.9709	<.0001
vcredit_CCXS_pw1			1	Variate piecewise of credit_score	median(0,credit_score-450,500-450)	-0.0003	0.0001	6.153	0.0131
vcredit_CCXS_pw2			1	Variate piecewise of credit_score	median(0,credit_score-500,630-500)	-0.0004	0.0000	65.6745	<.0001
vcredit_CCXS_pw3			1	Variate piecewise of credit_score	median(0,credit_score-630,680-630)	-0.0059	0.0001	10136.27	<.0001
vcredit_CCXS_pw4			1	Variate piecewise of credit_score	median(0,credit_score-680,800-680)	-0.0080	0.0001	25468.8	<.0001
mRatioTmpTei_CCXS	**L00**		1	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.1154	0.0101	130.6992	<.0001
vratiotmptei_CCXS_pw1			1	Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-5,30-5)	0.0078	0.0002	2549.618	<.0001
vratiotmptei_CCXS_pw2			1	Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-30,45-30)	0.0040	0.0003	245.8117	<.0001
vratiotmptei_CCXS_pw3			1	Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio tmp tei-45,57-45)	-0.0108	0.0020	28.6982	<.0001
vhpa2yb_CCXS_pw1			1	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y blended r-90,105-90)	0.0020	0.0003	61.0153	<.0001
vhpa2yb_CCXS_pw2			1	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-105,117-105)	-0.0022	0.0003	73.0525	<.0001
vhpa2yb_CCXS_pw3			1	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,125-117)	-0.0182	0.0005	1595.946	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L01**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	2.3545	0.0034	484079.2	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L02**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	2.0835	0.0043	234885.8	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L03**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	1.8142	0.0055	110718	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L04**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	1.6913	0.0064	70800.89	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L05**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	1.3863	0.0081	28977.41	<.0001

Parameter	Level		DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L06**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	1.2280	0.0095	16699.04	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L07**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	1.2043	0.0105	13273.44	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L01**	**L08**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >= 8	1.1985	0.0067	31790.58	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L01**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	2.8378	0.0039	523394.7	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L02**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	2.5588	0.0052	246527.4	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L03**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	2.2482	0.0068	108810.6	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L04**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	2.1133	0.0082	67168.07	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L05**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	1.7697	0.0107	27200.3	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L06**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	1.6186	0.0126	16505.05	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L07**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	1.5374	0.0143	11532.93	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L02**	**L08**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >=8	1.4134	0.0084	28674.12	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L01**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	3.1622	0.0031	1023187	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L02**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.8019	0.0038	550155.1	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L03**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	2.4463	0.0048	264777.7	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L04**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	2.2801	0.0056	165032.8	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L05**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	1.8805	0.0074	65498.11	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L06**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.6821	0.0087	37197.07	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L07**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	1.5890	0.0099	25645.4	<.0001
mpriordef_ccxs*mtimesinceD_CCXS	**L03**	**L08**	1	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time >=8	1.0000	0.0070	39483.47	<.0001

Parameter	Level		DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
vtimesinced_CCXS_pw1			1	Variate piecwise of cx_time[1]	median(0,cx_time-8,13-8)	-0.0900	0.0020	2741.776	<.0001
vtimesinced_CCXS_pw2			1	Variate piecwise of cx_time[1]	median(0,cx_time-13,40-13)	-0.0225	0.0006	1334.915	<.0001
vloanraw_CCXS_pw1			1	Variate piecewise of loansize_raw	median(0,loansize_raw-0,57000-0)	0.0000	0.0000	2096.823	<.0001
vloanraw_CCXS_pw2			1	Variate piecewise of loansize_raw	median(0,loansize_raw-57000,159000-57000)	0.0000	0.0000	6772.435	<.0001
vloanraw_CCXS_pw3			1	Variate piecewise of loansize_raw	median(0,loansize_raw-159000,345000-159000)	0.0000	0.0000	93.3851	<.0001
vdeltaUEinit_CCXS_pw1			1	Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-45,100-45)	0.0002	0.0001	11.479	0.0007
vdeltaUEinit_CCXS_pw2			1	Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit r-100,200-100)	0.0010	0.0000	685.578	<.0001
vSBOI_CCXS_pw1			1	Variate piecewise of small business optimism index	median(0,mSBOI-85,100-85)	-0.0113	0.0004	1040.94	<.0001
vSBOI_CCXS_pw2			1	Variate piecewise of small business optimism index	median(0,mSBOI-100,108-100)	0.0140	0.0006	547.4538	<.0001
v_UE_CW_growthQ_pw1			1	Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.2395	0.0032	5799.885	<.0001
v_UE_CW_growthQ_lag1_pw1			1	Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.0258	0.0035	55.1555	<.0001
v_UE_CW_growthQ_lag2_pw1			1	Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE CW growthQ lag2)	-0.0579	0.0036	258.4507	<.0001
v_UE_CW_growthQ_lag2_pw2			1	Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	4.6776	0.0609	5891.42	<.0001
v_TR1Q_lag1_CCXS_pw1			1	Variate piecewise of quarterly treature rate with 1Q lag	min(TR1Q_lag1,2.5)	0.0733	0.0014	2654.078	<.0001
v_TR1Q_lag1_CCXS_pw2			1	Variate piecewise of quarterly treature rate with 1Q lag	max(TR1Q_lag1,2.5)	0.1088	0.0021	2759.377	<.0001
v_TR1Q_growthY_lag1_CCXS_pw1			1	Variate piecewise of quarterly treature rate yearly growth with 1Q lag	min(TR1Q_growthY_lag1,5)	0.0040	0.0006	46.1419	<.0001
v_TR1Q_growthY_lag1_CCXS_pw2			1	Variate piecewise of quarterly treature rate yearly growth with 1Q lag	max(TR1Q_growthY_lag1,5)	0.1170	0.0006	33625.31	<.0001

Current Transition Model Parameters – FRM30NSR C_D

The model parameters for the FRM30NSR current to default transition are shown in Table 33.

Table 33: Current to Default Transition FRM30NSR Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-3.3518	0.0115	<.0001
mseason	**1**		Categorical of season	season = "winter"	-0.2192	0.0011	<.0001
mseason	**2**		Categorical of season	season = "spring"	-0.3623	0.0011	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mseason	**3**		Categorical of season	season = "summer"	-0.1946	0.0011	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	judicial = 1 (yes)	0.0372	0.0008	<.0001
mycslope_CD	**L01**		Categorical of ycslope_r9 (Yield Curve Slope)	100<=ycslope_r9<=200	-0.1435	0.0013	<.0001
mfrst_tm_by	**1**		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	0.0601	0.0011	<.0001
mrfnc_ind	**2**		Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind = "N"	0.0608	0.0016	<.0001
mcalperiod_CD	**L200604**		Categorical of Calendar Period	period < 200604	-1.1079	0.0019	<.0001
mperiodnbr_CD	**L02**		Categorical of period_number	period_number = 2	-0.3700	0.0026	<.0001
mperiodnbr_CD	**L03**		Categorical of period_number	period_number = 3	0.0153	0.0023	<.0001
mperiodnbr_CD	**L04**		Categorical of period_number	period_number = 4	0.0921	0.0023	<.0001
mperiodnbr_CD	**L05**		Categorical of period_number	period_number = 5	0.1154	0.0023	<.0001
mperiodnbr_CD	**L06**		Categorical of period_number	period_number = 6	0.1242	0.0024	<.0001
mperiodnbr_CD	**L07**		Categorical of period_number	period_number = 7	0.0810	0.0025	<.0001
vperiodnbr_CD_pw1			Variate piecewise of period_number	median(0,period_number-8,40-8)	-0.0205	0.0001	<.0001
vperiodnbr_CD_pw2			Variate piecewise of period_number	median(0,period_number-40,53-40)	-0.0074	0.0005	<.0001
vperiodnbr_CD_pw3			Variate piecewise of period_number	median(0,period_number-53,68-53)	-0.0271	0.0008	<.0001
vperiodnbr_CD_pw4			Variate piecewise of period_number	median(0,period_number-68,108-68)	-0.0106	0.0007	<.0001
vcredit_CD_pw1			Variate piecewise of credit_score	median(0,credit_score-450,530-450)	0.0026	0.0000	<.0001
vcredit_CD_pw2			Variate piecewise of credit_score	median(0,credit_score-530,630-530)	-0.0029	0.0000	<.0001
vcredit_CD_pw3			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	-0.0083	0.0000	<.0001
vcredit_CD_pw4			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	-0.0092	0.0001	<.0001
vcredit_CD_pw5			Variate piecewise of credit_score	median(0,credit_score-720,760-720)	-0.0079	0.0001	<.0001
vcredit_CD_pw6			Variate piecewise of credit_score	median(0,credit_score-760,800-760)	-0.0105	0.0002	<.0001
vdeltaUEinit_CD_pw1			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-50,100-50)	0.0018	0.0000	<.0001
vdeltaUEinit_CD_pw2			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-100,200-100)	0.0034	0.0000	<.0001
mRatioTmpTei_cd	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.3983	0.0043	<.0001
vratiotmptei_CD_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0170	0.0001	<.0001
vratiotmptei_CD_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	0.0120	0.0001	<.0001
vpriordef_CD_pw1			Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.0618	0.0003	<.0001
mperiodnbr_CD*mpriordef_ind	**L02**	**L01**	Interaction of categorical period number and categorical prior default count	period number =2; prior_default_cnt NE 0	-0.6966	0.1802	0.0001
mperiodnbr_CD*mpriordef_ind	**L03**	**L01**	Interaction of categorical period number and categorical prior default count	period number =3; prior_default_cnt NE 0	-0.4896	0.0109	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mperiodnbr_CD*mpriordef_ind	**L04**	**L01**	Interaction of categorical period number and categorical prior default count	period number =4; prior_default_cnt NE 0	-0.2341	0.0066	<.0001
mperiodnbr_CD*mpriordef_ind	**L05**	**L01**	Interaction of categorical period number and categorical prior default count	period number =5; prior_default_cnt NE 0	-0.1148	0.0053	<.0001
mperiodnbr_CD*mpriordef_ind	**L06**	**L01**	Interaction of categorical period number and categorical prior default count	period number =6; prior_default_cnt NE 0	-0.0551	0.0048	<.0001
mperiodnbr_CD*mpriordef_ind	**L07**	**L01**	Interaction of categorical period number and categorical prior default count	period number =7; prior_default_cnt NE 0	-0.0227	0.0046	<.0001
vperiodnbr_CD_pw1*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	period number piecewise; prior_default_cnt NE 0	0.0066	0.0001	<.0001
vperiodnbr_CD_pw2*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	period number piecewise; prior_default_cnt NE 0	-0.0072	0.0006	<.0001
vperiodnbr_CD_pw3*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	period number piecewise; prior_default_cnt NE 0	0.0217	0.0008	<.0001
vperiodnbr_CD_pw4*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	period number piecewise; prior_default_cnt NE 0	0.0082	0.0007	<.0001
vsato_cd_pw1			Variate piecewise of sato (spread at origination)	median(0,sato-(-2.5),-.1-(-2.5))	0.0184	0.0016	<.0001
vsato_cd_pw2			Variate piecewise of sato (spread at origination)	median(0,sato-(-.1),.7-(-.1))	0.2640	0.0016	<.0001
vsato_cd_pw3			Variate piecewise of sato (spread at origination)	median(0,sato-.7,2.5-.7)	0.2424	0.0027	<.0001
vltv_CD_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-25,70-25)	0.0047	0.0001	<.0001
vltv_CD_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,88-70)	0.0071	0.0001	<.0001
vltv_CD_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-88,97-88)	0.0240	0.0002	<.0001
mhpa2yb_CD	**L00**		Categorical of hpa2y_blended_r6	hpa2y_blended_r = 0	-1.4443	0.0108	<.0001
vhpa2yb_CD_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-50,85-50)	-0.0076	0.0002	<.0001
vhpa2yb_CD_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,100-85)	-0.0096	0.0001	<.0001
vhpa2yb_CD_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-100,125-100)	-0.0050	0.0001	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	2.3810	0.0022	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	2.1359	0.0025	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	1.9136	0.0028	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	1.6122	0.0034	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	1.4279	0.0039	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	1.2845	0.0045	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CD*mtimesinceD_CD	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	1.2210	0.0050	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >=8	1.0604	0.0031	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	2.7986	0.0025	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	2.5366	0.0030	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	2.3203	0.0036	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	1.9927	0.0045	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	1.7767	0.0053	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	1.6130	0.0062	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	1.5081	0.0070	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >=8	1.2445	0.0041	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	3.0728	0.0023	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.7745	0.0026	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	2.5137	0.0029	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	2.1447	0.0035	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	1.8993	0.0040	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.7073	0.0046	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	1.5872	0.0052	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time >=8	1.2339	0.0035	<.0001
vtimesinced_CD_pw1			Variate piecewise of country wide unemployment rate quarterly growth	median(0,cx_time-8,24-8)	-0.0568	0.0003	<.0001
vtimesinced_CD_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	median(0,cx_time-24,40-24)	-0.0071	0.0006	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.4626	0.0014	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.2242	0.0014	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.0032	0.0015	0.0377
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-0.3388	0.0278	<.0001
v_TR1Q_CD_pw1			Variate piecewise quarterly treature rate	min(TR1Q,3)	0.1613	0.0008	<.0001
v_TR1Q_CD_pw2			Variate piecewise quarterly treature rate	max(TR1Q,3)	-0.0566	0.0009	<.0001

Current Transition Model Parameters – FRM30SR C_CXS

The model parameters for the FRM30SR current to self-cure transition are shown in Table 34.

Table 34: Current to Self-Cure Transition FRM30SR Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-5.8806	0.0600	<.0001
mseason	**1**		Categorical of season	season = "winter"	0.2525	0.0052	<.0001
mseason	**2**		Categorical of season	season = "spring"	-0.2192	0.0057	<.0001
mseason	**3**		Categorical of season	season = "summer"	0.0163	0.0056	0.0035
mcalperiod_CCXS	**L199501**		Categorical of Calendar Period	period < 199501	-4.1667	0.0614	<.0001
mcalperiod_CCXS	**L200104**		Categorical of Calendar Period	period < 200104	-3.6204	0.0224	<.0001
mcalperiod_CCXS	**L200604**		Categorical of Calendar Period	period < 200604	-2.0371	0.0148	<.0001
mltv	**L00**		Categorical of ltv i r[7] (loan-to-value)	ltv_i_r=.	0.1789	0.0123	<.0001
mperiodnbr_CCXS	**L03**		Categorical of period_number	period_number = 3	0.0951	0.0109	<.0001
mperiodnbr_CCXS	**L04**		Categorical of period_number	period_number = 4	0.1227	0.0106	<.0001
mperiodnbr_CCXS	**L05**		Categorical of period_number	period_number = 5	0.1040	0.0106	<.0001
mperiodnbr_CCXS	**L06**		Categorical of period_number	period_number = 6	0.0975	0.0106	<.0001
vperiodnbr_CCXS_pw1			Variate piecewise of period_number	median(0,period_number-7,30-7)	-0.0231	0.0004	<.0001
vperiodnbr_CCXS_pw2			Variate piecewise of period_number	median(0,period_number-30,54-30)	-0.0095	0.0005	<.0001
vperiodnbr_CCXS_pw3			Variate piecewise of period_number	median(0,period_number-54,70-54)	-0.0125	0.0010	<.0001
vperiodnbr_CCXS_pw4			Variate piecewise of period_number	median(0,period number-70,100-70)	-0.0102	0.0011	<.0001
mcredit_score_CCXS	**L00**		Categorical of credit_score	credit_score=0	-0.2992	0.0170	<.0001
vcredit_CCXS_pw1			Variate piecewise of credit_score	median(0,credit_score-525,680-525)	-0.0019	0.0001	<.0001
vcredit_CCXS_pw2			Variate piecewise of credit_score	median(0,credit_score-680,745-680)	-0.0083	0.0004	<.0001
vcredit_CCXS_pw3			Variate piecewise of credit_score	median(0,credit score-745,800-745)	-0.0105	0.0010	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	2.3749	0.0080	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior default cnt = 1; cx time = 2	2.0922	0.0102	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	1.8458	0.0129	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	1.7454	0.0149	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	1.4785	0.0186	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	1.3462	0.0211	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	1.3161	0.0233	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 8	1.2017	0.0261	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 9	1.0845	0.0296	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 10	1.0409	0.0320	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 11	1.0881	0.0334	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L12**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 12	0.9788	0.0370	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L13**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >= 13	0.7374	0.0151	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	2.9702	0.0093	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	2.7073	0.0121	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	2.3867	0.0161	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	2.2601	0.0191	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	1.8992	0.0252	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	1.8041	0.0286	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	1.7620	0.0320	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 8	1.6080	0.0371	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 9	1.4223	0.0438	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 10	1.4856	0.0452	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 11	1.4422	0.0494	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L12**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 12	1.2269	0.0579	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L13**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >= 13	0.9977	0.0229	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	3.2579	0.0083	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.8945	0.0097	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	2.5436	0.0119	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	2.3655	0.0140	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	2.0090	0.0177	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.8290	0.0207	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	1.7508	0.0234	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 8	1.6266	0.0266	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 9	1.4764	0.0308	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 10	1.4163	0.0339	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 11	1.2595	0.0392	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L12**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 12	1.1516	0.0437	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L13**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time >= 13	0.8908	0.0192	<.0001
vpriordef_CCXS_pw1			Variate of prior_default_cnt	median(0,prior_default_cnt-2,10-2)	0.1118	0.0018	<.0001
vpriordef_CCXS_pw2			Variate of prior_default_cnt	median(0,prior_default_cnt-10,15-10)	0.0987	0.0049	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vhpa2yb_CCXS_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,130-85)	-0.0065	0.0002	<.0001
vratiotmptei_CCXS_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-5,30-5)	-0.0039	0.0003	<.0001
vratiotmptei_CCXS_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-30,55-30)	0.0036	0.0009	<.0001
vltv_CCXS_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-78,85-78)	0.0055	0.0011	<.0001
vltv_CCXS_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-85,88-85)	0.0109	0.0029	0.0002
vltv_CCXS_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-88,92-88)	-0.0100	0.0020	<.0001
vltv_CCXS_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-92,95-92)	0.0700	0.0030	<.0001
vloanraw_ccxs_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-0,57000-0)	0.0000	0.0000	<.0001
vloanraw_ccxs_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-57000,159000-57000)	0.0000	0.0000	<.0001
vloanraw_ccxs_pw3			Variate piecewise of loansize_raw	median(0,loansize_raw-159000,345000-159000)	0.0000	0.0000	<.0001
vdeltaUEinit_CCXS_pw1			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-20,95-20)	0.0030	0.0001	<.0001
vSBOI_CCXS_pw1			Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	-0.0237	0.0008	<.0001
vSBOI_CCXS_pw2			Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-100,108-100)	0.0337	0.0014	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ)	0.3083	0.0068	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of quarterly treature rate with 1 quarter lag	max(0.4,UE_CW_growthQ_lag1)	0.0457	0.0080	<.0001
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of quarterly treature rate with 1 quarter lag	min(UE_CW_growthQ_lag2, -0.2)	3.0411	0.1457	<.0001
v_TR1Q_lag1_CCXS_pw1			Variate piecewise of quarterly treature rate yearly growth with 1 quarter lag	min(TR1Q_lag1,2.5)	0.0640	0.0036	<.0001
v_TR1Q_lag1_CCXS_pw2			Variate piecewise of quarterly treature rate yearly growth with 1 quarter lag	max(TR1Q_lag1,2.5)	0.3514	0.0052	<.0001
v_TR1Q_growthY_lag1_CCXS_pw1			Variate piecewise of quarterly treature rate with 1Q lag	min(TR1Q_growthY_lag1,5)	-0.0029	0.0014	0.0347
v_TR1Q_growthY_lag1_CCXS_pw2			Variate piecewise of quarterly treature rate with 1Q lag	max(TR1Q_growthY_lag1,5)	0.1592	0.0014	<.0001

Current Transition Model Parameters – FRM30SR C_D

The model parameters for the FRM30SR current to default transition are shown in Table 35.

Table 35: Current to Default Transition FRM30SR Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-5.4733	0.0423	<.0001
mseason	**1**		Categorical of season	season = "winter"	-0.2014	0.0025	<.0001
mseason	**2**		Categorical of season	season = "spring"	-0.3302	0.0026	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mseason	**3**		Categorical of season	season = "summer"	-0.1606	0.0025	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	judicial = 1 (yes)	0.0262	0.0019	<.0001
mycslope_CD	**L01**		Categorical of ycslope_r[9] (yield curve slope)	1<= ycslope <= 2	0.0653	0.0032	<.0001
mcalperiod_CD	**L199504**		Categorical of Calendar Period	period < 199504	-2.3562	0.0118	<.0001
mcalperiod_CD	**L200104**		Categorical of Calendar Period	period < 200104	-1.8591	0.0076	<.0001
mcalperiod_CD	**L200604**		Categorical of Calendar Period	period < 200604	-0.5526	0.0046	<.0001
mperiodnbr_CD	**L02**		Categorical of period_number	period_number = 2	-0.2328	0.0051	<.0001
mperiodnbr_CD	**L03**		Categorical of period_number	period_number = 3	0.0253	0.0046	<.0001
vperiodnbr_CD_pw1			Variate piecewise of period_number	median(0,period_number-3,45-3)	-0.0185	0.0001	<.0001
vperiodnbr_CD_pw2			Variate piecewise of period_number	median(0,period_number-45,70-45)	-0.0061	0.0003	<.0001
vperiodnbr_CD_pw3			Variate piecewise of period_number	median(0,period_number-70,108-70)	-0.0105	0.0005	<.0001
Mcredit_score_CD	**L00**		Categorical of credit_score	credit_score=0	-0.2821	0.0065	<.0001
vcredit_CD_pw1			Variate piecewise of credit_score	median(0,credit_score-600,630-600)	-0.0013	0.0003	<.0001
vcredit_CD_pw2			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	-0.0062	0.0002	<.0001
vcredit_CD_pw3			Variate piecewise of credit_score	median(0,credit_score-680,745-680)	-0.0077	0.0002	<.0001
vcredit_CD_pw4			Variate piecewise of credit_score	median(0,credit_score-745,800-745)	-0.0127	0.0005	<.0001
vratiotmptei_CD_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	-0.0084	0.0001	<.0001
vratiotmptei_CD_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	0.0186	0.0005	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	2.4376	0.0039	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	2.1966	0.0048	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	2.0024	0.0058	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	1.7406	0.0072	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	1.5675	0.0085	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	1.4439	0.0097	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	1.3700	0.0108	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 8	1.2392	0.0123	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 9	1.1518	0.0136	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 10	1.0916	0.0149	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 11	1.0272	0.0164	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L12**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 12	0.9765	0.0179	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CD*mtimesinceD_CD	L01	L13	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >= 13	0.9514	0.0107	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L01	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	2.9844	0.0047	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L02	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	2.7314	0.0060	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L03	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	2.5423	0.0074	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L04	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	2.2344	0.0095	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L05	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	2.0599	0.0113	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L06	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	1.8807	0.0134	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L07	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	1.8273	0.0150	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L08	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 8	1.6534	0.0176	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L09	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 9	1.5340	0.0200	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L10	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 10	1.4677	0.0222	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L11	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 11	1.3712	0.0247	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L12	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 12	1.2936	0.0274	<.0001
mpriordef_CD*mtimesinceD_CD	L02	L13	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >= 13	1.2183	0.0137	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L01	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	3.2285	0.0042	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L02	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.9420	0.0049	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L03	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	2.7113	0.0058	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L04	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	2.3576	0.0071	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L05	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	2.1400	0.0085	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L06	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.9617	0.0099	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L07	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	1.8542	0.0113	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L08	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 8	1.6561	0.0133	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L09	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 9	1.5288	0.0151	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L10	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 10	1.4123	0.0172	<.0001
mpriordef_CD*mtimesinceD_CD	L03	L11	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 11	1.3857	0.0186	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CD*mtimesinceD_CD	**L03**	**L12**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 12	1.2465	0.0213	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L13**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time >= 13	1.1339	0.0122	<.0001
vtimesinced_CD_pw1			Variate piecwise of cx_time[1]	median(0,cx_time-12,24-12)	-0.0261	0.0014	<.0001
vtimesinced_CD_pw2			Variate piecwise of cx_time[1]	median(0,cx_time-24,40-24)	-0.0108	0.0016	<.0001
vpriordef_CD_pw1			Variate of prior_default_cnt	median(0,prior_default_cnt-2,10-2)	0.1196	0.0009	<.0001
vsato_cd_pw1			Variate piecewise of sato (spread at origination)	median(-2,sato,0)	-0.0237	0.0047	<.0001
vsato_cd_pw2			Variate piecewise of sato (spread at origination)	median(sato,0,2)	0.2688	0.0033	<.0001
vdeltaUEinit_CD_pw1			Variate piecewise of DeltaUEInit r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-100,200-100)	0.0033	0.0000	<.0001
vUEblend_CD_pw1			Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue blended r-400,1000-400)	0.0003	0.0000	<.0001
mltv	**L00**		Categorical of ltv i r[7] (loan-to-value)	ltv_i_r = .	0.1091	0.0055	<.0001
vltv_CD_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-62,84-62)	0.0043	0.0002	<.0001
vltv_CD_pw3			Variate piecewise of ltv i r[7] (loan-to-value)	median(0,ltv_i_r-86,92-86)	0.0204	0.0006	<.0001
vltv_CD_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-92,95-92)	0.0821	0.0015	<.0001
vltv_CD_pw5			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-95,97-95)	0.0658	0.0031	<.0001
vltv_CD_pw6			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-97,100-97)	0.0305	0.0052	<.0001
vhpa2yb_CD_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-0,85-0)	0.0036	0.0003	<.0001
vhpa2yb_CD_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,95-85)	-0.0167	0.0005	<.0001
vhpa2yb_CD_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y blended r-95,113-95)	-0.0111	0.0003	<.0001
vhpa2yb_CD_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-113,118-113)	-0.0118	0.0008	<.0001
vhpa2yb_CD_pw5			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-118,130-118)	-0.0073	0.0004	<.0001
vSBOI_CD_pw1			Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	-0.0112	0.0006	<.0001
vSBOI_cd_pw2			Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-100,108-100)	0.0014	0.0007	0.0486
vCCI_CD_pw1			Variate piecewise of CCI (consumer confidence index)	median(0,mCCI-50,100-50)	-0.0023	0.0001	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.4189	0.0038	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag 1)	0.2552	0.0036	<.0001
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag 2)	0.0401	0.0039	<.0001
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-1.1665	0.0666	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_TR1Q_lag2_CD_pw1			Variate piecewise of quarterly treature rate with 2 quarter lag	min(TR1Q_lag2,3)	0.0483	0.0018	<.0001
v_TR1Q_lag2_CD_pw2			Variate piecewise of quarterly treature rate with 2 quarter lag	median(0,TR1Q_lag2 - 3, 4-3)	0.4082	0.0074	<.0001
v_TR1Q_lag2_CD_pw3			Variate piecewise of quarterly treature rate with 2 quarter lag	max(TR1Q_lag2,4)	0.3449	0.0069	<.0001

Current Transition Model Parameters – FRM30SR C_END

The model parameters for the FRM30SR current to end (refinance or payoff) transition are shown in Table 36.

Table 36: Current to End Transition FRM30SR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-7.0765	0.0355	<.0001
mseason	**1**	Categorical of season	season = "winter"	-0.1471	0.0021	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.0580	0.0020	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.0644	0.0020	<.0001
mcalperiod_CEND	**L200104**	Categorical of Calendar Period	period < 200104	0.1210	0.0035	<.0001
mcalperiod_CEND	**L200604**	Categorical of Calendar Period	period < 200604	0.5535	0.0029	<.0001
mycslope_CEND	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope>=9	-0.4779	0.0025	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	0.2016	0.0167	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.1056	0.0016	<.0001
mperiodnbr_cend	**L02**	Categorical of period_number	period_number <= 2	-1.0939	0.0052	<.0001
mperiodnbr_cend	**L03**	Categorical of period_number	period_number = 3	-0.2987	0.0039	<.0001
mperiodnbr_cend	**L04**	Categorical of period_number	period_number = 4	0.1410	0.0035	<.0001
mperiodnbr_cend	**L05**	Categorical of period_number	period_number = 5	0.1489	0.0035	<.0001
mperiodnbr_cend	**L06**	Categorical of period_number	period_number = 6	0.0861	0.0037	<.0001
mperiodnbr_cend	**L07**	Categorical of period_number	period_number = 7	0.0648	0.0038	<.0001
vperiodnbr_cend_pw1		Variate piecewise of period_number	median(0,period_number-8,19-8)	0.0024	0.0003	<.0001
vperiodnbr_cend_pw2		Variate piecewise of period_number	median(0,period_number-19,31-19)	-0.0235	0.0003	<.0001
vperiodnbr_cend_pw3		Variate piecewise of period_number	median(0,period_number-31,40-31)	0.0130	0.0006	<.0001
vperiodnbr_cend_pw4		Variate piecewise of period_number	median(0,period_number-40,49-40)	-0.0578	0.0007	<.0001
vperiodnbr_cend_pw5		Variate piecewise of period_number	median(0,period_number-49,108-49)	-0.0043	0.0003	<.0001
vrefiincent_cend_pw1		Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-0,100-0)	0.0111	0.0001	<.0001
vrefiincent_cend_pw2		Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-100,120-100)	0.0439	0.0001	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vrefiincent_cend_pw3		Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-120,135-120)	0.0088	0.0002	<.0001
vrefiincent_cend_pw4		Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-135,155-135)	0.0067	0.0002	<.0001
vrefiincent_cend_pw5		Variate piecewise of refi_incent2_r[13] (refinance incentive)	median(0,refi_incent2_r-155,200-155)	-0.0016	0.0002	<.0001
mcredit_score_CEND	**L00**	Categorical of credit_score	credit_score=0	0.2538	0.0170	<.0001
vcredit_cend_pw2		Variate piecewise of credit_score	median(0,credit_score-500,630-500)	0.0020	0.0002	<.0001
vcredit_cend_pw3		Variate piecewise of credit_score	median(0,credit_score-630,680-630)	0.0009	0.0002	<.0001
vcredit_cend_pw5		Variate piecewise of credit_score	median(0,credit_score-745,800-745)	-0.0011	0.0002	<.0001
mtimesinceD_CEND	**L00**	Categorical of cx_time[1](time since default)	prior_default_cnt=0	0.2985	0.0076	<.0001
mtimesinceD_CEND	**L01**	Categorical of cx_time[1](time since default)	cx_time <= 1	-0.3786	0.0096	<.0001
mtimesinceD_CEND	**L02**	Categorical of cx_time[1](time since default)	cx_time = 2	-0.2998	0.0101	<.0001
mtimesinceD_CEND	**L03**	Categorical of cx_time[1](time since default)	cx_time = 3	-0.2043	0.0104	<.0001
mtimesinceD_CEND	**L04**	Categorical of cx_time[1](time since default)	cx_time <= 16	0.0081	0.0080	0.311
vtimesinced_cend_pw1		Variate piecewise of cx_time[1](time since default)	median(0,cx_time-16,55-16)	0.0042	0.0006	<.0001
vhpa2yb_cend_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-0,90-0)	-0.0107	0.0001	<.0001
vhpa2yb_cend_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-90,106-90)	0.0341	0.0003	<.0001
vhpa2yb_cend_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-106,111-106)	0.0327	0.0007	<.0001
vhpa2yb_cend_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-111,114-111)	0.0439	0.0011	<.0001
vhpa2yb_cend_pw5		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-114,119-114)	0.0084	0.0007	<.0001
vhpa2yb_cend_pw6		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-119,130-119)	0.0406	0.0003	<.0001
mRatioTmpTei_CEND	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.0680	0.0178	0.0001
vratiotmptei_cend_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,12-0)	-0.0147	0.0016	<.0001
vratiotmptei_cend_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-12,35-12)	-0.0061	0.0003	<.0001
vdeltaUEinit_cend_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-65,78-65)	-0.0038	0.0002	<.0001
vdeltaUEinit_cend_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-78,90-78)	-0.0047	0.0003	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEinit_cend_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-90,97-90)	0.0241	0.0005	<.0001
vdeltaUEinit_cend_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-97,126-97)	0.0070	0.0001	<.0001
vdeltaUEinit_cend_pw5		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-126,150-126)	0.0060	0.0002	<.0001
vloanraw_cend_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,57000-0)	1.E-05	3.E-07	<.0001
vloanraw_cend_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-57000,159000-57000)	0.0000	0.0000	<.0001
vloanraw_cend_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-159000,345000-159000)	0.0000	0.0000	<.0001
vltv_cend_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,78-0)	-0.0035	0.0000	<.0001
vltv_cend_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-78,89-78)	0.0158	0.0003	<.0001
vltv_cend_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-89,92-89)	0.0027	0.0011	0.0131
vltv_cend_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-92,97-92)	0.0234	0.0009	<.0001
vltv_cend_pw5		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-97,100-97)	-0.0572	0.0045	<.0001
vSBOI_CEND_pw1		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	0.0117	0.0004	<.0001
vSBOI_cend_pw2		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-100,108-100)	-0.0120	0.0005	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.1630	0.0033	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.1235	0.0030	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.0648	0.0029	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-6.5648	0.0453	<.0001

Current Transition Model Parameters – FRM15 C_SR

The model parameters for the FRM15 current to streamlined refinance transition are shown in Table 37.

Table 37: Current to Streamlined Refinance Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-6.9064	0.1029	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (judicial state)	0.0277	0.0081	0.0006
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.4404	0.0183	<.0001
mdpa_comb13_CSR	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.7078	0.0383	<.0001
mdpa_comb13_CSR	**3**	Categorical of dpa (down payment assistance)	dpa = "govt" or dpa = "relative"	-0.0957	0.0325	0.0032
mpriordef_CSR	**L01**	Categorical of prior default count	prior_default_cnt = 1	-0.0839	0.0180	<.0001
mpriordef_CSR	**L02**	Categorical of prior default count	prior_default_cnt = 2	-0.1221	0.0326	0.0002
mperiodnbr_CSR	**L02**	Categorical of period_number	period_number = 2	-1.0063	0.0362	<.0001
mperiodnbr_CSR	**L03**	Categorical of period_number	period_number = 3	0.0299	0.0263	0.2566
mperiodnbr_CSR	**L04**	Categorical of period_number	period_number = 4	0.5710	0.0228	<.0001
mperiodnbr_CSR	**L05**	Categorical of period_number	period_number = 5	0.5835	0.0217	<.0001
mperiodnbr_CSR	**L06**	Categorical of period_number	period_number = 6	0.5490	0.0216	<.0001
mperiodnbr_CSR	**L07**	Categorical of period_number	period_number = 7	0.4653	0.0215	<.0001
mperiodnbr_CSR	**L08**	Categorical of period_number	period_number = 8	0.3710	0.0217	<.0001
mperiodnbr_CSR	**L09**	Categorical of period_number	period_number = 9	0.3876	0.0216	<.0001
mperiodnbr_CSR	**L10**	Categorical of period_number	period_number = 10	0.3363	0.0221	<.0001
mperiodnbr_CSR	**L11**	Categorical of period_number	period_number = 11	0.2291	0.0230	<.0001
mperiodnbr_CSR	**L12**	Categorical of period_number	period_number = 12	0.1284	0.0236	<.0001
vperiodnbr_CSR_pw1		Variate piecewise of period_number	median(0,period_number-13,24-13)	-0.0573	0.0021	<.0001
vperiodnbr_CSR_pw2		Variate piecewise of period_number	median(0,period_number-24,43-24)	-0.1107	0.0020	<.0001
mcredit_score_CSR	**L00**	Categorical of credit_score	credit_score = 0	-0.5594	0.0195	<.0001
vcredit_CSR_pw2		Variate piecewise of credit_score	median(0,credit_score-650,770-650)	-0.0027	0.0001	<.0001
vcredit_CSR_pw3		Variate piecewise of credit_score	median(0,credit_score-770,800-770)	-0.0062	0.0009	<.0001
vdeltaUEinit_CSR_pw2		Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-63,91-63)	0.0023	0.0007	0.001
vdeltaUEinit_CSR_pw3		Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-91,99-91)	-0.0272	0.0025	<.0001
vdeltaUEinit_CSR_pw4		Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-99,104-99)	0.0789	0.0039	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEinit_CSR_pw6		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-200,300-200)	-0.0027	0.0006	<.0001
vratiotmptei_CSR_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-11,16-11)	0.0145	0.0031	<.0001
vratiotmptei_CSR_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-16,43-16)	0.0098	0.0007	<.0001
vratiotmptei_CSR_pw4		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-43,50-43)	-0.0638	0.0100	<.0001
vltv_CSR_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,39-0)	-0.0051	0.0009	<.0001
vltv_CSR_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-39,93-39)	0.0055	0.0004	<.0001
vltv_CSR_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-93,100-93)	0.0867	0.0105	<.0001
vloanraw_CSR_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,62400-0)	3.E-05	1.E-06	<.0001
vloanraw_CSR_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-62400,124000-62400)	1.E-05	3.E-07	<.0001
vloanraw_CSR_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-124000,250000-124000)	5.E-06	1.E-07	<.0001
vloanraw_CSR_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-250000,425000-250000)	6.E-07	2.E-07	0.0017
vhpa2yb_CSR_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-88,105-88)	-0.0094	0.0009	<.0001
vsato_csr_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-.4)	0.9084	0.0115	<.0001
vsato_csr_pw2		Variate piecewise of sato (spread at origination)	max(sato-.4,0)	0.1292	0.0379	0.0007
vDeltaTY1_CSR_pw1		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-0,73-0)	-0.0109	0.0003	<.0001
vDeltaTY1_CSR_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-73,150-73)	0.0017	0.0002	<.0001
mdeltaTy10Init_csr	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r >109	-0.8220	0.0131	<.0001
mycslope_CSR	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=218	-0.2980	0.0183	<.0001
vCCI_CSR_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0123	0.0010	<.0001
vCCI_CSR_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	-0.0208	0.0009	<.0001
vCCI_CSR_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0399	0.0018	<.0001
vSBOI_CSR_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	0.0334	0.0034	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vSBOI_CSR_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	0.0409	0.0032	<.0001
m_product	**FRM15SR**	Categorical of product	product = "FRM15SR"	0.1674	0.0163	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.2383	0.0315	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.3552	0.0275	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.1061	0.0234	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-3.3064	0.3417	<.0001
v_CCI_growthQ_CSR_pw3		Variate piecewise of CCI quarterly growth	max(CCI_growthQ,0.2)	1.7678	0.0705	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2002-1999)	0.0512	0.0093	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2002,2014-2002)	-0.0547	0.0027	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	0.0795	0.0060	<.0001

Current Transition Model Parameters – FRM15 C_D

The model parameters for the FRM15 current to default transition are shown in Table 38.

Table 38: Current to Default Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-3.7111	0.0559	<.0001
mdpa	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	0.1460	0.0451	0.0012
mdpa	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.2684	0.0138	<.0001
mdpa	**3**	Categorical of dpa (down payment assistance)	dpa = "relative"	0.1130	0.0116	<.0001
mpriordef_CD	**L01**	Categorical of prior default count	prior_default_cnt = 1	2.0515	0.0060	<.0001
mpriordef_CD	**L02**	Categorical of prior default count	prior_default_cnt = 2	2.7307	0.0073	<.0001
mpriordef_CD	**L03**	Categorical of prior default count	prior_default_cnt >= 3	3.1135	0.0072	<.0001
vpriordef_CD_pw1		Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.1640	0.0018	<.0001
mperiodnbr_CD	**L02**	Categorical of period_number	period_number = 2	-0.6404	0.0184	<.0001
mperiodnbr_CD	**L03**	Categorical of period_number	period_number = 3	-0.3629	0.0163	<.0001
mperiodnbr_CD	**L04**	Categorical of period_number	period_number = 4	-0.2274	0.0152	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vperiodnbr_CD_pw1		Variate piecewise of period_number	median(0,period_number-4,24-4)	-0.0323	0.0011	<.0001
vperiodnbr_CD_pw2		Variate piecewise of period_number	median(0,period_number-24,50-24)	-0.0255	0.0004	<.0001
vperiodnbr_CD_pw3		Variate piecewise of period_number	median(0,period_number-50,57-50)	0.0359	0.0023	<.0001
mcredit_score_CD	**L00**	Categorical of credit_score	credit_score = 0	-0.2702	0.0129	<.0001
vcredit_CD_pw1		Variate piecewise of credit_score	median(0,credit_score-500,650-500)	-0.0030	0.0001	<.0001
vcredit_CD_pw2		Variate piecewise of credit_score	median(0,credit_score-650,800-650)	-0.0094	0.0001	<.0001
vloanraw_CD_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,62400-0)	-6.E-06	3.E-07	<.0001
vloanraw_CD_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-62400,124000-62400)	-2.E-06	1.E-07	<.0001
vloanraw_CD_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-124000,250000-124000)	-1.E-06	8.E-08	<.0001
vdeltaUEinit_CD_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-0,63-0)	0.0063	0.0005	<.0001
vdeltaUEinit_CD_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-63,97-63)	0.0006	0.0003	0.0229
vdeltaUEinit_CD_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-97,200-97)	0.0019	0.0001	<.0001
vdeltaUEinit_CD_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-200,300-200)	0.0007	0.0002	0.0016
mratio_tmp_tei_CD	**L00**	Categorical of ratio_tmp_tei	ratio_tmp_tei = 0	0.3368	0.0112	<.0001
vratiotmptei_CD_pw1		Variate piecewise of ratio_tmp_tei	median(0,ratio_tmp_tei-0,37-0)	0.0135	0.0003	<.0001
vsato_cd_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-.4)	0.0831	0.0054	<.0001
vsato_cd_pw2		Variate piecewise of sato (spread at origination)	max(sato-.4,0)	0.0964	0.0156	<.0001
mltv_CD	**Miss**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	0.5119	0.0207	<.0001
vltv_CD_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,39-0)	0.0084	0.0005	<.0001
vltv_CD_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-39,90-39)	0.0102	0.0002	<.0001
vltv_CD_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-90,100-90)	0.0487	0.0032	<.0001
vhpa2yb_CD_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-88,105-88)	-0.0102	0.0006	<.0001
vhpa2yb_CD_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-105,112-105)	-0.0273	0.0010	<.0001
vhpa2yb_CD_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-123,140-123)	-0.0344	0.0011	<.0001
mseason	**1**	Categorical of season	season = "winter"	-0.2722	0.0059	<.0001
mseason	**2**	Categorical of season	season = "spring"	-0.3678	0.0061	<.0001
mseason	**3**	Categorical of season	season = "summer"	-0.2516	0.0059	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vCCI_CD_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	-0.0075	0.0006	<.0001
vCCI_CD_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0193	0.0003	<.0001
vCCI_CD_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0190	0.0006	<.0001
vSBOI_CD_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0292	0.0021	<.0001
vSBOI_CD_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.1154	0.0021	<.0001
vSBOI_CD_pw3		Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	-0.0582	0.0021	<.0001
m_product	**FRM15SR**	Categorical of product	product = "FRM15SR"	-0.2852	0.0094	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.3827	0.0085	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.5018	0.0094	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.1928	0.0105	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	0.7752	0.1833	<.0001

Current Transition Model Parameters – FRM15 C_CXS

The model parameters for the FRM15 current to self-cure transition are shown in Table 39.

Table 39: Current to Self-Cure Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-3.1235	0.1082	<.0001
mrfnc_ind	**1**	Categorical of rfnc_ind (refinanced loan indicator)	refinanced, non-streamlined	-0.0567	0.0124	<.0001
mrfnc_ind	**2**	Categorical of rfnc_ind (refinanced loan indicator)	streamlined refinanced	-0.1549	0.0203	<.0001
mperiodnbr_CCXS	**L02**	Categorical of period_number	period_number = 2	-0.3131	0.0324	<.0001
mperiodnbr_CCXS	**L03**	Categorical of period_number	period_number = 3	-0.2791	0.0319	<.0001
vperiodnbr_CCXS_pw1		Variate piecewise of period_number	median(0,period_number-3,16-3)	-0.0403	0.0018	<.0001
vperiodnbr_CCXS_pw2		Variate piecewise of period_number	median(0,period_number-16,30-16)	-0.0467	0.0014	<.0001
vperiodnbr_CCXS_pw3		Variate piecewise of period_number	median(0,period_number-30,41-30)	-0.0600	0.0025	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vperiodnbr_CCXS_pw4		Variate piecewise of period_number	median(0,period_number-41,60-41)	-0.0347	0.0023	<.0001
mcredit_score_CCXS	**L00**	Categorical of credit_score	credit_score = 0	-0.1054	0.0166	<.0001
vcredit_CCXS_pw2		Variate piecewise of credit_score	median(0,credit_score-643,800-643)	-0.0072	0.0001	<.0001
vloanraw_CCXS_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,40000-0)	-1.E-05	2.E-06	<.0001
vloanraw_CCXS_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-40000,150000-40000)	-2.E-06	1.E-07	<.0001
mratio_tmp_tei_CCXS	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei = 0	0.1014	0.0238	<.0001
vratiotmptei_CCXS_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-9,16-9)	0.0068	0.0030	0.0252
vratiotmptei_CCXS_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-16,36-16)	0.0084	0.0008	<.0001
mpriordef_CCXS	**L01**	Categorical of prior default count	prior_default_cnt = 1	1.9590	0.0118	<.0001
mpriordef_CCXS	**L02**	Categorical of prior default count	prior_default_cnt = 2	2.6624	0.0142	<.0001
mpriordef_CCXS	**L10**	Categorical of prior default count	prior_default_cnt >= 10	2.9398	0.0434	<.0001
mpriordef_CCXS	**PW1**	Categorical of prior default count	else	2.8007	0.0168	<.0001
vpriordef_CCXS_pw1		Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-2,10-2)	0.2164	0.0044	<.0001
vhpa2yb_CCXS_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-106,115-106)	-0.0139	0.0014	<.0001
mperiod_CCXS	**L01**	Categorical version of period	period < 200604	-2.7063	0.0352	<.0001
mseason_grp_CCXS	**L02**	Categorical of season	season = "spring"	-0.1954	0.0099	<.0001
vCCI_CCXS_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0243	0.0006	<.0001
vCCI_CCXS_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0026	0.0011	0.0149
vSBOI_CCXS_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0339	0.0024	<.0001
vSBOI_CCXS_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.1041	0.0044	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.3455	0.0165	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.2959	0.0212	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	2.1105	0.3825	<.0001
mltv_CCXS	**Miss**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	0.2875	0.0452	<.0001
vltv_CCXS_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,40-0)	0.0064	0.0011	<.0001
vltv_CCXS_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-40,60-40)	0.0019	0.0010	0.044
vltv_CCXS_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-60,88-60)	0.0072	0.0008	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2002-1999)	-0.2633	0.0080	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2002,2014-2002)	-0.0763	0.0021	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	-0.0168	0.0054	0.0019

Current Transition Model Parameters – FRM15 C_PRE

The model parameters for the FRM15 current to prepayment transition are shown in Table 40.

Table 40: Current to Prepayment Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-5.0261	0.0472	<.0001
mdpa_comb13_CPRE	**2**	Categorical of dpa (down payment assistance)	dpa = "nonprof"	-0.2111	0.0304	<.0001
mdpa_comb13_CPRE	**3**	Categorical of dpa (down payment assistance)	dpa = "govt" or dpa = "relative"	0.0826	0.0118	<.0001
mperiodnbr_CPRE	**L02**	Categorical of period_number	period_number = 2	-2.0457	0.0238	<.0001
mperiodnbr_CPRE	**L03**	Categorical of period_number	period_number = 3	-1.2414	0.0166	<.0001
mperiodnbr_CPRE	**L04**	Categorical of period_number	period_number = 4	-0.8276	0.0139	<.0001
mperiodnbr_CPRE	**L05**	Categorical of period_number	period_number = 5	-0.5338	0.0123	<.0001
mperiodnbr_CPRE	**L06**	Categorical of period_number	period_number = 6	-0.3817	0.0115	<.0001
mperiodnbr_CPRE	**L07**	Categorical of period_number	period_number = 7	-0.2904	0.0112	<.0001
mperiodnbr_CPRE	**L08**	Categorical of period_number	period_number = 8	-0.2038	0.0110	<.0001
mperiodnbr_CPRE	**L09**	Categorical of period_number	period_number = 9	-0.1064	0.0107	<.0001
mperiodnbr_CPRE	**L10**	Categorical of period_number	period_number = 10	-0.0952	0.0108	<.0001
mperiodnbr_CPRE	**L11**	Categorical of period_number	period_number = 11	-0.0614	0.0108	<.0001
mperiodnbr_CPRE	**L12**	Categorical of period_number	period_number = 12	-0.0443	0.0109	<.0001
vperiodnbr_CPRE_pw1		Variate piecewise of period_number	median(0,period_number-12,34-12)	0.0061	0.0003	<.0001
vperiodnbr_CPRE_pw3		Variate piecewise of period_number	median(0,period_number-42,56-42)	0.0314	0.0008	<.0001
vperiodnbr_CPRE_pw4		Variate piecewise of period_number	median(0,period_number-56,60-56)	0.3458	0.0038	<.0001
mcredit_score_CPRE	**L00**	Categorical of credit_score	credit_score = 0	0.4961	0.0219	<.0001
vcredit_CPRE_pw1		Variate piecewise of credit_score	median(0,credit_score-500,650-500)	0.0037	0.0002	<.0001
vcredit_CPRE_pw2		Variate piecewise of credit_score	median(0,credit_score-650,800-650)	0.0007	0.0001	<.0001
vloanraw_CPRE_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,62400-0)	3.E-06	2.E-07	<.0001
vloanraw_CPRE_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-62400,124000-62400)	6.E-06	1.E-07	<.0001
vloanraw_CPRE_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-124000,250000-124000)	3.E-06	7.E-08	<.0001
vloanraw_CPRE_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-250000,425000-250000)	1.E-06	1.E-07	<.0001
vdeltaUEinit_CPRE_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-63,97-63)	0.0019	0.0002	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEinit_CPRE_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-97,200-97)	0.0020	0.0001	<.0001
mratio_tmp_tei_CPRE	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei = 0	-0.2543	0.0262	<.0001
vratiotmptei_CPRE_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,11-0)	-0.0134	0.0027	<.0001
vratiotmptei_CPRE_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-11,16-11)	-0.0077	0.0017	<.0001
vratiotmptei_CPRE_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-16,36-16)	-0.0073	0.0004	<.0001
vratiotmptei_CPRE_pw4		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0042	0.0014	0.0022
mpriordef_CPRE	**L01**	Categorical of prior default count	prior_default_cnt = 1	-0.0957	0.0069	<.0001
mpriordef_CPRE	**L02**	Categorical of prior default count	prior_default_cnt = 2	-0.2079	0.0116	<.0001
mpriordef_CPRE	**L03**	Categorical of prior default count	prior_default_cnt = 3	-0.2945	0.0160	<.0001
mpriordef_CPRE	**L04**	Categorical of prior default count	prior_default_cnt >= 4	-0.3407	0.0155	<.0001
vpriordef_CPRE_pw1		Variate piecewise of prior default count	median(0,prior_default_cnt-4,15-4)	0.0114	0.0051	0.0251
vsato_CPre_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-.4)	0.1069	0.0040	<.0001
vsato_CPre_pw2		Variate piecewise of sato (spread at origination)	max(sato-.4,0)	-0.1645	0.0145	<.0001
mltv_CPRE	**Miss**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	-0.2122	0.0130	<.0001
vltv_CPRE_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,39-0)	-0.0108	0.0004	<.0001
vltv_CPRE_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-90,100-90)	-0.0777	0.0044	<.0001
mhpa2yb_CPRE	**L084**	Categorical of hpa2y_blended_r[6]	0<hpa2y_blended_R <= 84	0.2124	0.0197	<.0001
mhpa2yb_CPRE	**L088**	Categorical of hpa2y_blended_r6	hpa2y_blended_R <= 88	0.0939	0.0214	<.0001
vhpa2yb_CPRE_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-88,105-88)	0.0439	0.0009	<.0001
vhpa2yb_CPRE_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-105,112-105)	0.0149	0.0010	<.0001
vhpa2yb_CPRE_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-112,117-112)	0.0209	0.0013	<.0001
vhpa2yb_CPRE_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-117,140-117)	0.0146	0.0004	<.0001
mseason_grp_CPRE	**L02**	Categorical of season	season = "spring"	0.1062	0.0040	<.0001
mseason_grp_CPRE	**L03**	Categorical of season	season = "summer"	0.1159	0.0041	<.0001
vCCI_CPRE_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0032	0.0006	<.0001
vCCI_CPRE_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	-0.0134	0.0002	<.0001
vCCI_CPRE_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	-0.0139	0.0005	<.0001
vSBOI_CPRE_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	0.0175	0.0022	<.0001
vSBOI_CPRE_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	0.0889	0.0016	<.0001
vSBOI_CPRE_pw3		Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	0.0070	0.0013	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.1293	0.0080	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.0511	0.0078	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-2.1088	0.1198	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	0.1041	0.0060	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2002-1999)	-0.0065	0.0023	0.0051
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2002,2014-2002)	-0.0343	0.0009	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	0.1451	0.0022	<.0001

Current Transition Model Parameters – ARM C_SR

The model parameters for the ARM current to streamlined refinance transition are shown in Table 41.

Table 41: Current to Streamlined Refinance Transition ARM Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-8.8310	0.2928	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	judicial = 1 , judicial state	-0.1543	0.0087	<.0001
mdpa_nprof	**LNPro**		Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.5077	0.0170	<.0001
mycslope_CSR	**L01**		Categorical of Yield Curve Slope	1<=ycslope<=2	0.1448	0.0123	<.0001
mfrst_tm_by	**1**		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.0328	0.0119	0.006
mrfnc_ind	**2**		Categorical of rfnc_ind (refinanced loan indicator)	frnc_ind = "Y"	0.2549	0.0162	<.0001
mperiodnbr_CSR	**L02**		Categorical of period_number	period_number = 2	-1.1535	0.0263	<.0001
mperiodnbr_CSR	**L03**		Categorical of period_number	period_number = 3	-0.1502	0.0187	<.0001
mperiodnbr_CSR	**L04**		Categorical of period_number	period_number = 4	0.2464	0.0166	<.0001
mperiodnbr_CSR	**L05**		Categorical of period_number	period_number = 5	0.3158	0.0164	<.0001
mperiodnbr_CSR	**L06**		Categorical of period_number	period_number = 6	0.1202	0.0177	<.0001
mperiodnbr_CSR	**L07**		Categorical of period_number	period_number = 7	-0.1413	0.0198	<.0001
vperiodnbr_CSR_pw1			Variate piecewise of period_number	median(0,period_number-8,33-8)	-0.0559	0.0010	<.0001
vperiodnbr_CSR_pw2			Variate piecewise of period_number	median(0,period_number-33,53-33)	-0.0792	0.0035	<.0001
vperiodnbr_CSR_pw3			Variate piecewise of period_number	median(0,period_number-53,68-53)	0.0496	0.0081	<.0001
vperiodnbr_CSR_pw4			Variate piecewise of period_number	median(0,period_number-68,108-68)	-0.0545	0.0089	<.0001
mperiodnbr_CSR*mdpa_nprof	**L02**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 2; dpa= "nonprof"	-0.3152	0.0714	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mperiodnbr_CSR*mdpa_nprof	**L03**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 3; dpa= "nonprof"	-0.5101	0.0497	<.0001
mperiodnbr_CSR*mdpa_nprof	**L04**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 4; dpa= "nonprof"	-0.7117	0.0464	<.0001
mperiodnbr_CSR*mdpa_nprof	**L05**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 5; dpa= "nonprof"	-0.3863	0.0419	<.0001
mperiodnbr_CSR*mdpa_nprof	**L06**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 6; dpa= "nonprof"	-0.2157	0.0452	<.0001
mperiodnbr_CSR*mdpa_nprof	**L07**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 7; dpa= "nonprof"	-0.1429	0.0512	0.0053
vcredit_CSR_pw1			Variate piecewise of credit_score	0<credit_score<=450	-0.6734	0.2313	0.0036
vcredit_CSR_pw6			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	-0.0070	0.0004	<.0001
vcredit_CSR_pw8			Variate piecewise of credit_score	median(0,credit_score-745,800-745)	-0.0061	0.0007	<.0001
vperiodnbr_CSR_pw2*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-33,53-33); prior_default_cnt ne 0	0.0643	0.0040	<.0001
vperiodnbr_CSR_pw3*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-53,68-53); prior_default_cnt ne 0	-0.0653	0.0098	<.0001
vperiodnbr_CSR_pw4*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-68,108-68); prior_default_cnt ne 0	0.0326	0.0100	0.0011
vdeltaUEinit_CSR_pw1			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,90-0)	-0.0069	0.0005	<.0001
vdeltaUEinit_CSR_pw3			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-97,100-97)	0.0766	0.0043	<.0001
vdeltaUEinit_CSR_pw5			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-110,140-110)	0.0066	0.0006	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEinit_CSR_pw7			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-175,200-175)	-0.0053	0.0011	<.0001
vdeltaUEinit_CSR_pw8			Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-200,300-200)	0.0042	0.0006	<.0001
mRatioTmpTei_CSR	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.8572	0.0326	<.0001
vratiotmptei_CSR_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0193	0.0013	<.0001
vratiotmptei_CSR_pw3			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	0.0090	0.0017	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	-0.6867	0.0443	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	-0.5618	0.0502	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	-0.3215	0.0522	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	-0.8866	0.0750	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	-0.6034	0.0810	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	-0.4543	0.0895	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	-1.1410	0.0738	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	-1.0879	0.0900	<.0001
mpriordef_CSR*mtimesinceD_CSR	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	-0.5633	0.0836	<.0001
vpriordef_CSR_pw1			Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.0668	0.0097	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vsato_csr_pw1			Variate piecewise of sato (spread at origination)	min(0,sato-(-.1))	0.3642	0.0077	<.0001
vsato_csr_pw2			Variate piecewise of sato (spread at origination)	median(sato-(-.1),0,.7-(-.1))	0.8396	0.0458	<.0001
vloanraw_CSR_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-0,64000-0)	4.E-05	3.E-06	<.0001
vloanraw_CSR_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-64000,157000-64000)	8.E-06	2.E-07	<.0001
vloanraw_CSR_pw3			Variate piecewise of loansize_raw	median(0,loansize_raw-157000,425000-157000)	1.E-06	7.E-08	<.0001
vltv_CSR_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	0.0014	0.0007	0.0539
vltv_CSR_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,80-70)	0.0216	0.0028	<.0001
vltv_CSR_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-80,94-80)	0.0099	0.0013	<.0001
vltv_CSR_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,100-94)	0.0157	0.0051	0.0022
vhpa2yb_CSR_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-0,85-0)	0.0083	0.0019	<.0001
vhpa2yb_CSR_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y blended r-85,95-85)	-0.0183	0.0024	<.0001
vhpa2yb_CSR_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-95,117-95)	0.0059	0.0009	<.0001
vhpa2yb_CSR_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,129-117)	-0.0031	0.0015	0.0419
vhpa2yb_CSR_pw5			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y blended r-129,170-129)	-0.0208	0.0016	<.0001
vUEblend_CSR_pw1			Variate piecewise of ue_blended_r8 (change in unemployment rate)	median(0,ue_blended_r-0,420-0)	0.0015	0.0002	<.0001
vUEblend_CSR_pw2			Variate piecewise of ue_blended_r8 (change in unemployment rate)	median(0,ue_blended_r-420,820-420)	-0.0013	0.0000	<.0001
vUEblend_CSR_pw3			Variate piecewise of ue_blended_r8 (change in unemployment rate)	median(0,ue blended r-820,1500-820)	-0.0002	0.0001	0.0094
mcalperiod_CSR	**L200104**		Categorical of Calendar Period	period < 200604	0.2152	0.0176	<.0001
mcalperiod_CSR	**L200604**		Categorical of Calendar Period	period = 200604	0.7645	0.0334	<.0001
mcalperiod_CSR	**L200701**		Categorical of Calendar Period	period = 200701	0.6214	0.0342	<.0001
mcalperiod_CSR	**L200702**		Categorical of Calendar Period	period = 200702	0.9252	0.0325	<.0001
mcalperiod_CSR	**L200703**		Categorical of Calendar Period	period = 200703	0.7871	0.0352	<.0001
vdeltaUEpr3_csr_pw1			Variate piecewise of deltaueper3_r[5] (change in unemployment from 3 quarters prior)	median(deltaueper3_r-(-200),0,(-20)-(-200))	0.0008	0.0002	0.0011

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEpr3_csr_pw2			Variate piecewise of deltaueprr3_r^5 (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-(-20),0,10-(-20))	0.0072	0.0004	<.0001
vdeltaUEpr3_csr_pw3			Variate piecewise of deltaueprr3_r^5 (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-10,0,200-10)	0.0035	0.0001	<.0001
mseason_grp_CSR	**L02**		Categorical of season	season = "spring"	-0.0293	0.0098	0.0028
mseason_grp_CSR	**L03**		Categorical of season	season = "summer"	-0.1515	0.0102	<.0001
vCCI_CSR_pw1			Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0119	0.0012	<.0001
vCCI_CSR_pw2			Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	-0.0063	0.0006	<.0001
vCCI_CSR_pw3			Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0300	0.0016	<.0001
vSBOI_CSR_pw1			Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0504	0.0052	<.0001
vSBOI_CSR_pw3			Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	-0.1719	0.0040	<.0001
m_product	**ARMSR**		Categorical of product	product = "ARMSR"	-0.2128	0.0196	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.1830	0.0397	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.2790	0.0372	<.0001
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.3699	0.0385	<.0001
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-3.9386	0.6627	<.0001
MTG_RATE30Y_growthY_lag1			Variate of 30 year mortage rate yearly growth with 1Q lag	MTG_RATE30Y_growthY_lag1	-1.9877	0.0481	<.0001
vcredit_subsidy_cohort_pw0			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort-1999,2003-1999)	0.0329	0.0058	<.0001

Current Transition Model Parameters – ARM C_CXS

The model parameters for the ARM current to self-cure transition are shown in Table 42.

Table 42: Current to Self-Cure Transition ARM Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-2.7239	0.1507	<.0001
mrfnc_ind	**2**		Categorical of rfnc_ind (refinanced loan indicator)	frnc_ind = "Y"	-0.0638	0.0154	<.0001
mdpa_rel	**LRela**		Categorical of dpa (down payment assistance)	dpa = "relative"	0.0524	0.0135	0.0001
mcalperiod_CCXS	**L200104**		Categorical of Calendar Period	period < 200604	-1.3164	0.0251	<.0001
mcalperiod_CCXS	**L200604**		Categorical of Calendar Period	period = 200604	1.1014	0.0288	<.0001
mcalperiod_CCXS	**L200701**		Categorical of Calendar Period	period = 200701	1.1663	0.0271	<.0001
mcalperiod_CCXS	**L200702**		Categorical of Calendar Period	period = 200702	0.5397	0.0339	<.0001
mcalperiod_CCXS	**L200703**		Categorical of Calendar Period	period = 200703	0.4060	0.0327	<.0001
vpriordef_CCXS_pw1			Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.1103	0.0022	<.0001
mperiodnbr_CCXS	**L02**		Categorical of period_number	period_number = 2	-0.2106	0.0445	<.0001
mperiodnbr_CCXS	**L03**		Categorical of period_number	period_number = 3	0.1119	0.0384	0.0036
mperiodnbr_CCXS	**L04**		Categorical of period_number	period_number = 4	0.1733	0.0368	<.0001
mperiodnbr_CCXS	**L05**		Categorical of period_number	period_number = 5	0.1274	0.0369	0.0005
mperiodnbr_CCXS	**L06**		Categorical of period_number	period_number = 6	0.2243	0.0347	<.0001
mperiodnbr_CCXS	**L07**		Categorical of period_number	period_number = 7	0.1049	0.0352	0.0029
vperiodnbr_CCXS_pw1			Variate piecewise of period_number	median(0,period_number-8,36-8)	-0.0133	0.0012	<.0001
vperiodnbr_CCXS_pw2			Variate piecewise of period_number	median(0,period_number-36,53-36)	-0.0193	0.0024	<.0001
vperiodnbr_CCXS_pw3			Variate piecewise of period_number	median(0,period_number-53,76-53)	-0.0108	0.0008	<.0001
vperiodnbr_CCXS_pw4			Variate piecewise of period_number	median(0,period_number-76,108-76)	-0.0095	0.0007	<.0001
vcredit_CCXS_pw5			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	-0.0046	0.0004	<.0001
vcredit_CCXS_pw6			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	-0.0061	0.0010	<.0001
vcredit_CCXS_pw7			Variate piecewise of credit_score	median(0,credit_score-720,745-720)	-0.0088	0.0023	0.0001
vcredit_CCXS_pw8			Variate piecewise of credit_score	median(0,credit_score-745,800-745)	-0.0073	0.0016	<.0001
mRatioTmpTei_CCXS	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.3454	0.0434	<.0001
vratiotmptei_CCXS_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,19-0)	0.0134	0.0022	<.0001
vratiotmptei_CCXS_pw4			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-33,50-33)	0.0048	0.0015	0.0018

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	2.4531	0.0207	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	2.1886	0.0262	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	1.9274	0.0327	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	1.8770	0.0368	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	1.5271	0.0471	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	1.3623	0.0540	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	1.2832	0.0594	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 8	1.2724	0.0633	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 9	1.1426	0.0714	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L01**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; else	1.0848	0.0348	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	2.8955	0.0223	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	2.5981	0.0291	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	2.3402	0.0372	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	2.1163	0.0458	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	1.8532	0.0569	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	1.6360	0.0677	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	1.6214	0.0732	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 8	1.4694	0.0839	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 9	1.6278	0.0822	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L02**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; else	1.2711	0.0419	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	3.2655	0.0161	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.8490	0.0190	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	2.4677	0.0234	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	2.2896	0.0274	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	1.9830	0.0339	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.7694	0.0399	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	1.5774	0.0468	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 8	1.5488	0.0508	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 9	1.4050	0.0583	<.0001
mpriordef_CCXS*mtimesinceD_CCXS	**L03**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; else	1.1642	0.0340	<.0001
vtimesinced_CCXS_pw1			Variate piecwise of cx_time[1]	median(0,cx_time-10,24-10)	-0.0417	0.0037	<.0001
vtimesinced_CCXS_pw2			Variate piecwise of cx_time[1]	median(0,cx_time-24,40-24)	-0.0158	0.0046	0.0006
vloanraw_CCXS_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-0,64000-0)	-7.E-06	9.E-07	<.0001
vloanraw_CCXS_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-64000,157000-64000)	-3.E-06	2.E-07	<.0001
vhpa2yb_CCXS_pw1			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-0,100-0)	-0.0070	0.0009	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vhpa2yb_CCXS_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-100,104-100)	-0.0268	0.0034	<.0001
vhpa2yb_CCXS_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-113,115-113)	-0.0184	0.0012	<.0001
mseason_grp_CCXS	**L02**		Categorical of season	season = "spring"	-0.3125	0.0114	<.0001
mseason_grp_CCXS	**L03**		Categorical of season	season = "summer"	-0.0923	0.0107	<.0001
vCCI_CCXS_pw1			Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0139	0.0006	<.0001
vCCI_CCXS_pw2			Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0041	0.0007	<.0001
vSBOI_CCXS_pw1			Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0800	0.0034	<.0001
m_product	**ARMSR**		Categorical of product	product = "ARMSR"	-0.1753	0.0234	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.1368	0.0211	<.0001
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.0828	0.0278	0.0029
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	6.1533	0.4973	<.0001

Current Transition Model Parameters – ARM C_D

The model parameters for the ARM current to default transition are shown in Table 43.

Table 43: Current to Default Transition ARM Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-2.7871	0.1504	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	judicial = 1 , judicial state	0.0278	0.0042	<.0001
mdpa_govt	**LGovt**		Categorical of dpa (down payment assistance)	dpa = "govt"	0.1787	0.0222	<.0001
mdpa_nprof	**LNPro**		Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.1828	0.0075	<.0001
mdpa_rel	**LRela**		Categorical of dpa (down payment assistance)	dpa = "relative"	0.0660	0.0066	<.0001
mycslope_cd	**L01**		Categorical of Yield Curve Slope	1<=ycslope<=2	0.2461	0.0060	<.0001
mfrst_tm_by	**1**		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	0.0334	0.0058	<.0001
mrfnc_ind	**2**		Categorical of rfnc_ind (refinanced loan indicator)	frnc_ind = "Y"	0.1071	0.0091	<.0001
mcalperiod_cd	**L200104**		Categorical of Calendar Period	period < 200604	-0.5225	0.0142	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mcalperiod_cd	**L200604**		Categorical of Calendar Period	period = 200604	1.4458	0.0157	<.0001
mcalperiod_cd	**L200701**		Categorical of Calendar Period	period = 200701	0.9441	0.0172	<.0001
mcalperiod_cd	**L200702**		Categorical of Calendar Period	period = 200702	0.7138	0.0180	<.0001
mcalperiod_cd	**L200703**		Categorical of Calendar Period	period = 200703	0.3366	0.0171	<.0001
mperiodnbr_CD	**L02**		Categorical of period_number	period_number = 2	-0.7026	0.0180	<.0001
mperiodnbr_CD	**L03**		Categorical of period_number	period_number = 3	-0.2780	0.0151	<.0001
mperiodnbr_CD	**L04**		Categorical of period_number	period_number = 4	-0.1165	0.0142	<.0001
vperiodnbr_cd_pw1			Variate piecewise of period_number	median(0,period_number-5,27-5)	-0.0218	0.0006	<.0001
vperiodnbr_cd_pw2			Variate piecewise of period_number	median(0,period_number-27,35-27)	-0.0386	0.0020	<.0001
vperiodnbr_cd_pw3			Variate piecewise of period_number	median(0,period_number-35,63-35)	-0.0268	0.0009	<.0001
vperiodnbr_cd_pw4			Variate piecewise of period_number	median(0,period_number-63,68-63)	-0.0171	0.0024	<.0001
vcredit_cd_pw1			Variate piecewise of credit_score	0<credit_score<=450	-1.4841	0.2087	<.0001
vcredit_cd_pw2			Variate piecewise of credit_score	median(0,credit_score-450,500-450)	-0.0127	0.0029	<.0001
vcredit_cd_pw3			Variate piecewise of credit_score	median(0,credit_score-500,600-500)	-0.0045	0.0004	<.0001
vcredit_cd_pw4			Variate piecewise of credit_score	median(0,credit_score-600,630-600)	-0.0071	0.0008	<.0001
vcredit_cd_pw5			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	-0.0115	0.0005	<.0001
vcredit_cd_pw6			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	-0.0109	0.0007	<.0001
vcredit_cd_pw7			Variate piecewise of credit_score	median(0,credit_score-720,745-720)	-0.0105	0.0016	<.0001
vcredit_cd_pw8			Variate piecewise of credit_score	median(0,credit_score-745,800-745)	-0.0101	0.0011	<.0001
icredit_grp0_CD	**L000**		Categorical of credit_score	credit_score=0	-1.6136	0.1444	<.0001
vdeltaUEinit_cd_pw1			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,90-0)	0.0012	0.0002	<.0001
vdeltaUEinit_cd_pw4			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-100,110-100)	0.0025	0.0008	0.0032
vdeltaUEinit_cd_pw5			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-110,140-110)	-0.0009	0.0003	0.0014
mRatioTmpTei_CD	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.4159	0.0166	<.0001
vratiotmptei_cd_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0141	0.0007	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vratiotmptei_cd_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	0.0073	0.0007	<.0001
vratiotmptei_cd_pw3			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	0.0064	0.0011	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	1.5769	0.0403	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	1.3850	0.0409	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	1.1560	0.0416	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	0.8535	0.0428	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	0.6620	0.0440	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	0.5170	0.0453	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	0.4742	0.0463	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 8	0.3097	0.0483	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 9	0.2054	0.0502	<.0001
mpriordef_CD*mtimesinceD_CD	**L01**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 10	0.1656	0.0516	0.0013
mpriordef_CD*mtimesinceD_CD	**L01**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 11	0.1087	0.0430	0.0115
mpriordef_CD*mtimesinceD_CD	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	1.9972	0.0407	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	1.7399	0.0415	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	1.5313	0.0426	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	1.1888	0.0446	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CD*mtimesinceD_CD	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	1.0038	0.0466	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	0.8125	0.0489	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	0.7796	0.0507	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 8	0.5913	0.0542	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 9	0.5374	0.0565	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 10	0.3990	0.0603	<.0001
mpriordef_CD*mtimesinceD_CD	**L02**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 11	0.2602	0.0448	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time <= 1	2.3651	0.0403	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 2	2.0465	0.0406	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 3	1.7960	0.0410	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 4	1.4479	0.0418	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 5	1.2156	0.0427	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 6	1.0408	0.0438	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 7	0.8513	0.0452	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 8	0.7058	0.0468	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 9	0.5291	0.0491	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CD*mtimesinceD_CD	**L03**	**L10**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 10	0.4535	0.0508	<.0001
mpriordef_CD*mtimesinceD_CD	**L03**	**L11**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 3; cx_time = 11	0.2721	0.0433	<.0001
vpriordef_cd_pw1			Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	0.0803	0.0013	<.0001
vtimesinced_cd_pw1			Variate piecwise of cx_time[1]	median(0,cx_time-12,24-12)	-0.0425	0.0020	<.0001
vtimesinced_cd_pw2			Variate piecwise of cx_time[1]	median(0,cx_time-24,40-24)	-0.0161	0.0023	<.0001
vsato_cd_pw1			Variate piecewise of sato (spread at origination)	min(0,sato-(-.1))	0.0352	0.0036	<.0001
vsato_cd_pw2			Variate piecewise of sato (spread at origination)	median(sato-(-.1),0,.7-(-.1))	0.1026	0.0286	0.0003
vperiodnbr_cd_pw2*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-40,53-40); prior_default_cnt ne 0	0.0248	0.0021	<.0001
vperiodnbr_cd_pw3*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-53,68-53); prior_default_cnt ne 0	0.0124	0.0009	<.0001
vltv_cd_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	0.0106	0.0004	<.0001
vltv_cd_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,80-70)	0.0021	0.0010	0.0369
vltv_cd_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-80,94-80)	0.0089	0.0007	<.0001
vhpa2yb_cd_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,95-85)	-0.0109	0.0010	<.0001
vhpa2yb_cd_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-95,113-95)	-0.0087	0.0007	<.0001
vhpa2yb_cd_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-110,118-110)	-0.0100	0.0010	<.0001
vhpa2yb_cd_pw5			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-118,149-118)	-0.0093	0.0006	<.0001
vhpa2yb_cd_pw6			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-149,170-149)	-0.0111	0.0034	0.0011
vUEblend_cd_pw2			Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-420,820-420)	0.0003	0.0000	<.0001
vUEblend_cd_pw3			Variate piecewise of ue_blended_r8 (change in unemployment rate)	median(0,ue_blended_r-820,1500-820)	0.0002	0.0000	<.0001
vdeltaUEpr3_cd_pw1			Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(deltauepr3_r-(-200),0,(-20)-(-200))	0.0003	0.0001	0.0004
vdeltaUEpr3_cd_pw3			Variate piecewise of deltauepr3_r[5] (change in unemployment from 3 quarters prior)	median(deltauepr3_r-10,0,200-10)	0.0008	0.0001	<.0001
mpriordef_ind*icredit_grp0_CD	**L01**	**L000**	Interaction of categorical of prior default indicator and categorical of credit_score	prior_default_cnt ne 0; credit_score=0	0.8961	0.0399	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_ind*icredit_grp1_CD	**L01**	**L450**	Interaction of categorical of prior default indicator and categorical of credit_score	prior_default_cnt ne 0; credit_score<450	0.8314	0.1903	<.0001
vcredit_cd_pw3*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-500,600-500); prior_default_cnt ne 0	0.0037	0.0005	<.0001
vcredit_cd_pw4*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-600,630-600); prior_default_cnt ne 0	0.0051	0.0010	<.0001
vcredit_cd_pw5*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-630,680-630); prior_default_cnt ne 0	0.0078	0.0006	<.0001
vcredit_cd_pw6*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-680,720-680); prior_default_cnt ne 0	0.0069	0.0010	<.0001
vcredit_cd_pw7*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-720,745-720); prior_default_cnt ne 0	0.0070	0.0023	0.0019
vcredit_cd_pw8*mpriordef_ind	**L01**		Interaction of variate piecewise of credit_score and categorical of prior default indicator	median(0,credit_score-745,800-745); prior_default_cnt ne 0	0.0069	0.0017	<.0001
mseason_grp_CD	**L02**		Categorical of season	season = "spring"	-0.2447	0.0052	<.0001
mseason_grp_CD	**L03**		Categorical of season	season = "summer"	-0.0358	0.0050	<.0001
vSBOI_CD_pw1			Variate piecewise of small business optimism index	median(0,SBOI_r-85,100-85)	-0.0129	0.0011	<.0001
vSBOI_CD_pw2			Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	-0.0126	0.0015	<.0001
m_product	**ARMSR**		Categorical of product	product = "ARMSR"	-0.0811	0.0114	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.5548	0.0106	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.1565	0.0123	<.0001
vcredit_subsidy_cohort_pw0			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2003-1999)	-0.1010	0.0025	<.0001
vcredit_subsidy_cohort_pw1			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2003,2014-2003)	-0.0140	0.0015	<.0001
vcredit_subsidy_cohort_pw2			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	0.0526	0.0055	<.0001

Current Transition Model Parameters – ARM C_PRE

The model parameters for the ARM current to prepayment transition are shown in Table 44.

Table 44: Current to Prepayment Transition ARM Model Parameters

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept					-4.3226	0.1880	<.0001
mjudicial	**1**		Categorical of judicial (judicial state)	judicial = 1 , judicial state	-0.0889	0.0042	<.0001
mdpa_govt	**LGovt**		Categorical of dpa (down payment assistance)	dpa = "govt"	-0.3324	0.0320	<.0001
mdpa_nprof	**LNPro**		Categorical of dpa (down payment assistance)	dpa= "nonprof"	-0.2020	0.0104	<.0001
mycslope_CPRE	**L01**		Categorical of Yield Curve Slope	1<=ycslope<=2	0.1415	0.0052	<.0001
mfrst_tm_by	**1**		Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.0715	0.0051	<.0001
mrfnc_ind	**2**		Categorical of rfnc_ind (refinanced loan indicator)	frnc_ind = "Y"	-0.1201	0.0073	<.0001
mcalperiod_CPRE	**L200104**		Categorical of Calendar Period	period < 200604	0.5821	0.0111	<.0001
mcalperiod_CPRE	**L200604**		Categorical of Calendar Period	period = 200604	0.9103	0.0154	<.0001
mcalperiod_CPRE	**L200701**		Categorical of Calendar Period	period = 200701	0.9011	0.0164	<.0001
mcalperiod_CPRE	**L200702**		Categorical of Calendar Period	period = 200702	1.0571	0.0160	<.0001
mcalperiod_CPRE	**L200703**		Categorical of Calendar Period	period = 200703	0.8250	0.0178	<.0001
mperiodnbr_CPRE	**L02**		Categorical of period_number	period_number = 2	-1.6760	0.0229	<.0001
mperiodnbr_CPRE	**L03**		Categorical of period_number	period_number = 3	-0.9149	0.0165	<.0001
mperiodnbr_CPRE	**L04**		Categorical of period_number	period_number = 4	-0.5051	0.0141	<.0001
mperiodnbr_CPRE	**L05**		Categorical of period_number	period_number = 5	-0.1560	0.0126	<.0001
mperiodnbr_CPRE	**L06**		Categorical of period_number	period_number = 6	-0.0411	0.0122	0.0008
mperiodnbr_CPRE	**L07**		Categorical of period_number	period_number = 7	-0.0777	0.0125	<.0001
vperiodnbr_CPRE_pw1			Variate piecewise of period_number	median(0,period_number-8,14-8)	0.0422	0.0016	<.0001
vperiodnbr_CPRE_pw2			Variate piecewise of period_number	median(0,period_number-14,27-14)	-0.0154	0.0007	<.0001
vperiodnbr_CPRE_pw3			Variate piecewise of period_number	median(0,period_number-27,41-27)	-0.0213	0.0008	<.0001
vperiodnbr_CPRE_pw4			Variate piecewise of period_number	median(0,period_number-41,53-41)	-0.0169	0.0011	<.0001
vperiodnbr_CPRE_pw6			Variate piecewise of period_number	median(0,period_number-71,108-71)	-0.0098	0.0010	<.0001
mperiodnbr_CPRE*mdpa_nprof	**L02**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 2; dpa= "nonprof"	-0.9801	0.1157	<.0001
mperiodnbr_CPRE*mdpa_nprof	**L03**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 3; dpa= "nonprof"	-0.8359	0.0728	<.0001
mperiodnbr_CPRE*mdpa_nprof	**L04**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 4; dpa= "nonprof"	-0.5736	0.0533	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mperiodnbr_CPRE*mdpa_nprof	**L05**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 5; dpa= "nonprof"	-0.3221	0.0410	<.0001
mperiodnbr_CPRE*mdpa_nprof	**L06**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 6; dpa= "nonprof"	-0.2333	0.0384	<.0001
mperiodnbr_CPRE*mdpa_nprof	**L07**	**LNPro**	Interaction of Categorical of period_number and Categorical of dpa	period_number = 7; dpa= "nonprof"	-0.1435	0.0386	0.0002
vperiodnbr_CPRE_pw1*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-8,40-8); prior_default_cnt ne 0	-0.0190	0.0067	0.0046
vperiodnbr_CPRE_pw2*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-40,53-40); prior_default_cnt ne 0	0.0178	0.0021	<.0001
vperiodnbr_CPRE_pw3*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-53,68-53); prior_default_cnt ne 0	0.0166	0.0016	<.0001
vperiodnbr_CPRE_pw4*mpriordef_ind	**L01**		Interaction of variate of piecewise of period_number and categorical of prior_default_cnt	median(0,period_number-68,108-68); prior_default_cnt ne 0	0.0067	0.0017	0.0001
vcredit_CPRE_pw2			Variate piecewise of credit_score	median(0,credit_score-450,500-450)	-0.0097	0.0008	<.0001
vcredit_CPRE_pw3			Variate piecewise of credit_score	median(0,credit_score-500,600-500)	0.0027	0.0004	<.0001
vcredit_CPRE_pw5			Variate piecewise of credit_score	median(0,credit_score-630,680-630)	0.0047	0.0003	<.0001
vcredit_CPRE_pw6			Variate piecewise of credit_score	median(0,credit_score-680,720-680)	0.0026	0.0004	<.0001
vcredit_CPRE_pw7			Variate piecewise of credit_score	median(0,credit_score-720,745-720)	0.0025	0.0008	0.0011
vcredit_CPRE_pw8			Variate piecewise of credit_score	median(0,credit_score-745,800-745)	0.0019	0.0004	<.0001
vdeltaUEinit_CPRE_pw1			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,90-0)	0.0016	0.0002	<.0001
vdeltaUEinit_CPRE_pw2			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-90,97-90)	-0.0086	0.0015	<.0001
vdeltaUEinit_CPRE_pw3			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-97,100-97)	-0.0125	0.0034	0.0002
vdeltaUEinit_CPRE_pw5			Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-110,140-110)	0.0007	0.0002	0.0045
mRatioTmpTei_CPRE	**L00**		Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.1675	0.0131	<.0001
vratiotmptei_CPRE_pw1			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	-0.0068	0.0006	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vratiotmptei_CPRE_pw2			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	-0.0104	0.0006	<.0001
vratiotmptei_CPRE_pw3			Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0092	0.0012	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time <= 1	-0.4569	0.0351	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 2	-0.5065	0.0381	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 3	-0.5449	0.0410	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 4	-0.4016	0.0418	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 5	-0.3400	0.0431	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 6	-0.4177	0.0455	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 7	-0.3894	0.0468	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time = 8	-0.3485	0.0477	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L01**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 1; cx_time >= 9	-0.3898	0.0356	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time <= 1	-0.5471	0.0439	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 2	-0.6412	0.0488	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 3	-0.5843	0.0518	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 4	-0.4883	0.0533	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 5	-0.4771	0.0559	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 6	-0.4030	0.0573	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 7	-0.4199	0.0603	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time = 8	-0.4919	0.0641	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L02**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 2; cx_time >= 9	-0.4849	0.0382	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time <= 1	-0.5829	0.0514	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 2	-0.6666	0.0585	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 3	-0.6265	0.0636	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 4	-0.5166	0.0661	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 5	-0.5403	0.0710	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 6	-0.6901	0.0797	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 7	-0.4503	0.0771	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time = 8	-0.7055	0.0893	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L03**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 3; cx_time >= 9	-0.5609	0.0422	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time <= 1	-0.7852	0.0626	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 2	-0.7565	0.0705	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 3	-0.7385	0.0780	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 4	-0.5754	0.0797	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 5	-0.6090	0.0869	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt =42; cx_time = 6	-0.5636	0.0917	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 7	-0.6146	0.0995	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time = 8	-0.7275	0.1104	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L04**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt = 4; cx_time >= 9	-0.5808	0.0464	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L01**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time <= 1	-0.8256	0.0471	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L02**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 2	-0.9112	0.0531	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L03**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 3	-0.8986	0.0580	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L04**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 4	-0.7898	0.0603	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L05**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 5	-0.6135	0.0610	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L06**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 6	-0.5684	0.0638	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L07**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 7	-0.6581	0.0695	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L08**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time = 8	-0.7798	0.0765	<.0001
mpriordef_CPRE*mtimesinceD_CPRE	**L05**	**L09**	Interaction of categorical of prior_default_cnt and categorical of cx_time[1]	prior_default_cnt >= 5; cx_time >= 9	-0.6116	0.0414	<.0001
vsato_CPre_pw1			Variate piecewise of sato (spread at origination)	min(0,sato-(-.1))	0.0541	0.0034	<.0001
vsato_CPre_pw2			Variate piecewise of sato (spread at origination)	median(sato-(-.1),0,.7-(-.1))	0.0823	0.0320	0.0102
vsato_CPre_pw3			Variate piecewise of sato (spread at origination)	max(sato-.7,0)	0.1983	0.1043	0.0571
vloanraw_CPRE_pw1			Variate piecewise of loansize_raw	median(0,loansize_raw-0,64000-0)	8.E-06	6.E-07	<.0001
vloanraw_CPRE_pw2			Variate piecewise of loansize_raw	median(0,loansize_raw-64000,157000-64000)	7.E-06	2.E-07	<.0001
vloanraw_CPRE_pw3			Variate piecewise of loansize_raw	median(0,loansize_raw-157000,425000-157000)	3.E-06	3.E-08	<.0001
mltv_CPRE	**L01**		Categorical of ltv_i_r7 (loan-to-value)	ltv_i_r = .	0.1536	0.0277	<.0001
vltv_CPRE_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	-0.0088	0.0007	<.0001
vltv_CPRE_pw2			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,80-70)	0.0184	0.0010	<.0001

Parameter	Level		Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vltv_CPRE_pw3			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-80,94-80)	-0.0241	0.0006	<.0001
vltv_CPRE_pw4			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,100-94)	-0.1077	0.0042	<.0001
vhpa2yb_CPRE_pw1			Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,hpa2y_blended_r-0,85-0)	-0.0154	0.0020	<.0001
vhpa2yb_CPRE_pw2			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,95-85)	0.0292	0.0024	<.0001
vhpa2yb_CPRE_pw3			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-95,113-95)	0.0314	0.0004	<.0001
vhpa2yb_CPRE_pw4			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-113,120-113)	0.0202	0.0004	<.0001
vhpa2yb_CPRE_pw5			Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-120,149-120)	0.0118	0.0012	<.0001
vUEblend_CPRE_pw1			Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-0,420-0)	-0.0006	0.0001	<.0001
vUEblend_CPRE_pw2			Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-420,820-420)	-0.0007	0.0000	<.0001
vUEblend_CPRE_pw3			Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-820,1500-820)	-0.0008	0.0000	<.0001
vdeltaUEpr3_cpre_pw1			Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-(-200),0,(-20)-(-200))	0.0003	0.0001	0.0051
vdeltaUEpr3_cpre_pw2			Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-(-20),0,10-(-20))	0.0059	0.0002	<.0001
vdeltaUEpr3_cpre_pw3			Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-10,0,200-10)	0.0011	0.0001	<.0001
mseason_grp_CPRE	**L02**		Categorical of season	season = "spring"	0.1508	0.0048	<.0001
mseason_grp_CPRE	**L03**		Categorical of season	season = "summer"	0.1778	0.0048	<.0001
vCCI_CPRE_pw1			Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	-0.0053	0.0003	<.0001
vCCI_CPRE_pw2			Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	-0.0064	0.0005	<.0001
vSBOI_CPRE_pw1			Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	0.0560	0.0026	<.0001
vSBOI_CPRE_pw2			Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	0.0352	0.0022	<.0001
v_UE_CW_growthQ_pw1			Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.3552	0.0155	<.0001
v_UE_CW_growthQ_lag1_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.0544	0.0158	0.0006
v_UE_CW_growthQ_lag2_pw1			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.0486	0.0156	0.0019
v_UE_CW_growthQ_lag2_pw2			Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-4.7461	0.2684	<.0001

Default Transition Model Parameters – FRM30NSR D_CLM

The model parameters for the FRM30NSR default to claim transition are shown in Table 45.

Table 45: Default to Claim Transition FRM30NSR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-0.9910	0.0722	<.0001
mrfnc_ind	**2**	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind = "N"	0.0723	0.0041	<.0001
mDeltaTm3_DCLM	**L01**	Categorical of DeltaTm3Init_r[12] (change in 3 month treasury from policy inception to current)	DeltaTm3Init_r12 > 600	-0.1522	0.0067	<.0001
mseason	**1**	Categorical of season	season = "winter"	0.0347	0.0031	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.0514	0.0031	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.0555	0.0031	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.2026	0.0023	<.0001
mdpa	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	0.0133	0.0070	0.0574
mdpa	**2**	Categorical of dpa (down payment assistance)	base level: else	0.3108	0.0035	<.0001
mdpa	**3**	Categorical of dpa (down payment assistance)	dpa = "Relative"	-0.0157	0.0034	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.0829	0.0031	<.0001
mhpa2yb_DCLM	**L085**	Categorical of hpa2y_blended_r[6]	hpa2y_blended_r <= 80	0.1033	0.0106	<.0001
vhpa2yb_DCLM_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-80,98-80)	-0.0041	0.0005	<.0001
vhpa2yb_DCLM_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-98,108-98)	0.0390	0.0005	<.0001
vhpa2yb_DCLM_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-108,117-108)	-0.0238	0.0005	<.0001
vhpa2yb_DCLM_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,180-117)	-0.0338	0.0004	<.0001
mperiodnbr_DCLM	**L02**	Categorical of period_number	period number <= 2	-1.0874	0.1465	<.0001
mperiodnbr_DCLM	**L03**	Categorical of period_number	period number = 3	-0.8828	0.0441	<.0001
mperiodnbr_DCLM	**L04**	Categorical of period_number	period number = 4	-0.3004	0.0199	<.0001
vperiodnbr_DCLM_pw1		Variate piecewise of period_number	median(0,period_number-5,9-5)	0.0385	0.0022	<.0001
vperiodnbr_DCLM_pw2		Variate piecewise of period_number	median(0,period_number-9,17-9)	-0.0200	0.0006	<.0001
vperiodnbr_DCLM_pw4		Variate piecewise of period_number	median(0,period_number-60,86-60)	-0.0166	0.0006	<.0001
mcredit_DCLM	**L01**	Categorical of credit_score	credit_score = 0	-0.0938	0.0062	<.0001
vcredit_DCLM_pw1		Variate piecewise of credit_score	median(0,credit_score-525,635-525)	0.0020	0.0001	<.0001
vcredit_DCLM_pw2		Variate piecewise of credit_score	median(0,credit_score-635,780-635)	0.0038	0.0000	<.0001
mdurdefepi_DCLM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.8797	0.0055	<.0001
mdurdefepi_DCLM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	1.4203	0.0054	<.0001
mdurdefepi_DCLM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	1.6498	0.0054	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCLM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	1.7419	0.0056	<.0001
mdurdefepi_DCLM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	1.7610	0.0058	<.0001
mdurdefepi_DCLM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	1.7529	0.0061	<.0001
mdurdefepi_DCLM	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	1.7247	0.0065	<.0001
mdurdefepi_DCLM	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	1.6974	0.0069	<.0001
mdurdefepi_DCLM	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	1.6687	0.0073	<.0001
mdurdefepi_DCLM	**L11**	Categorical of dur_def_episode (duration of default episode)	else	1.6569	0.0060	<.0001
vdurdefepi_DCLM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	-0.0198	0.0005	<.0001
vdurdefepi_DCLM_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	-0.0565	0.0020	<.0001
vdeltaUEInit_DCLM_pw1		Variate piecewise of DeltaUEInit_r (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,63-0)	0.0046	0.0003	<.0001
vdeltaUEInit_DCLM_pw2		Variate piecewise of DeltaUEInit_r (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-63,100-63)	-0.0006	0.0001	0.0001
vdeltaUEInit_DCLM_pw3		Variate piecewise of DeltaUEInit_r (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-100,116-100)	0.0055	0.0003	<.0001
vdeltaUEInit_DCLM_pw4		Variate piecewise of DeltaUEInit_r (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-116,218-116)	0.0019	0.0001	<.0001
vdeltaUEInit_DCLM_pw5		Variate piecewise of DeltaUEInit_r (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-218,330-218)	0.0012	0.0001	<.0001
mRatioTmpTei_DCLM	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.2367	0.0102	<.0001
vratiotmptei_DCLM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0065	0.0004	<.0001
vratiotmptei_DCLM_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	0.0026	0.0003	<.0001
vratiotmptei_DCLM_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0122	0.0007	<.0001
mpriordef_DCLM	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.2158	0.0029	<.0001
mpriordef_DCLM	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.4081	0.0039	<.0001
mpriordef_DCLM	**L03**	Categorical of prior_default_cnt	prior_default_cnt = 3	-0.5786	0.0050	<.0001
mpriordef_DCLM	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.7490	0.0062	<.0001
mpriordef_DCLM	**L05**	Categorical of prior_default_cnt	prior_default_cnt = 5	-0.9201	0.0078	<.0001
mpriordef_DCLM	**L06**	Categorical of prior_default_cnt	prior_default_cnt = 6	-1.0809	0.0098	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_DCLM	**L07**	Categorical of prior_default_cnt	prior_default_cnt = 7	-1.2330	0.0125	<.0001
mpriordef_DCLM	**L08**	Categorical of prior_default_cnt	prior_default_cnt = 8	-1.3594	0.0161	<.0001
mpriordef_DCLM	**L09**	Categorical of prior_default_cnt	prior_default_cnt = 9	-1.4781	0.0208	<.0001
mpriordef_DCLM	**L10**	Categorical of prior_default_cnt	prior_default_cnt = 10	-1.5759	0.0269	<.0001
mpriordef_DCLM	**L11**	Categorical of prior_default_cnt	prior_default_cnt = 11	-1.6843	0.0353	<.0001
mpriordef_DCLM	**L12**	Categorical of prior_default_cnt	prior_default_cnt >= 12	-1.9236	0.0319	<.0001
vUEblend_DCLM_pw1		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-200,450-200)	0.0007	0.0000	<.0001
vUEblend_DCLM_pw2		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-450,850-450)	-0.0004	0.0000	<.0001
vUEblend_DCLM_pw3		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-850,1500-850)	-0.0001	0.0000	<.0001
vltv_DCLM_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	-0.0089	0.0011	<.0001
vloanraw_DCLM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-27000,65000-27000)	-5.E-06	2.E-07	<.0001
vloanraw_DCLM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-65000,120000-65000)	4.E-07	7.E-08	<.0001
vloanraw_DCLM_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-120000,500000-120000)	-1.E-06	2.E-08	<.0001
mDeltaTY10_DCLM	**L01**	Categorical of DeltaTy10Init_r[2] (10 year treasury rate)	DeltaTy10Init_r2 < 53	0.0908	0.0034	<.0001
mDeltaTY10_DCLM	**L02**	Categorical of DeltaTy10Init_r[2] (10 year treasury rate)	DeltaTy10Init_r2 > 130	-0.2325	0.0098	<.0001
mprior3_ue_DCLM	**L01**	Categorical of prior3_ue_r[11] (state unemployment 3 prior quarters)	prior3_ue_r < 1400	-1.1956	0.0255	<.0001
vSBOI_DCLM_pw1		Variate piecewise of small business optimism index	median(0,mSBOI-85,100-85)	0.0171	0.0005	<.0001
vSBOI_DCLM_pw2		Variate piecewise of small business optimism index	median(0,mSBOI-100,108-100)	0.0229	0.0008	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.2309	0.0093	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.4619	0.0099	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.6284	0.0110	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	16.8286	0.2395	<.0001
vMTG_RATE30Y_growthQ_DCLM1		Variate piecewise of 30 year mortgate rate quarterly growth	min(MTG_RATE30Y_growthQ, 0.1)	0.1080	0.0236	<.0001
vMTG_RATE30Y_growthQ_DCLM2		Variate piecewise of 30 year mortgate rate quarterly growth	max(MTG_RATE30Y_growthQ, 0.1)	0.1546	0.0603	0.0104
v_MTG_RATE30Y_lag4_DCLM1		Variate piecewise of 30 year mortgate rate with 4Q lag	min(MTG_RATE30Y_lag4,5)	-0.0999	0.0035	<.0001
v_MTG_RATE30Y_lag4_DCLM2		Variate piecewise of 30 year mortgate rate with 4Q lag	max(MTG_RATE30Y_lag4,5)	0.1154	0.0024	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0,credit_subsidy_cohort -1999,2002-1999)	0.2193	0.0017	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2002,2014-2002)	-0.0822	0.0009	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2014,2022-2014)	-0.3276	0.0029	<.0001

Default Transition Model Parameters – FRM30NSR D_CXM

The model parameters for the FRM30NSR default to modified cure transition are shown in Table 46.

Table 46: Default to Modified Cure Transition FRM30NSR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-5.6505	0.0300	<.0001
mcalperiod_DCXM	**L01**	Categorical of Calendar Period	period < 200604	-6.9069	0.0539	<.0001
mseason	**1**	Categorical of season	season = "winter"	-0.0204	0.0032	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.2842	0.0031	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.1584	0.0031	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.0172	0.0019	<.0001
mdpa_govt	**LGovt**	Categorical of dpa (down payment assistance)	dpa = "govt"	-0.0576	0.0060	<.0001
mdpa_rel	**LRela**	Categorical of dpa (down payment assistance)	dpa = "Relative"	-0.0190	0.0025	<.0001
mfrst_tm_by	**1**	Categorical of frst tm by (first-time buyer)	frst_tm_by = "Y"	0.0656	0.0022	<.0001
mycslope_DCXM	**L01**	Categorical of ycslope r^9 (yield curve slope)	ycslope_r<=300	0.2358	0.0034	<.0001
mycslope_DCXM	**L02**	Categorical of ycslope_r^9 (yield curve slope)	ycslope_r>=900	-0.2296	0.0037	<.0001
mycslope_DCXM	**L03**	Categorical of ycslope_r^9 (yield curve slope)	ycslope_r>=1500	-0.1602	0.0032	<.0001
mhpa2yb_DCXM	**L085**	Categorical of hpa2y_blended_r^6	hpa2y_blended_r6 <= 85	-0.0976	0.0056	<.0001
vhpa2yb_DCXM_pw2		Variate piecewise of hpa2y_blended_r^6	median(0,hpa2y_blended_r-106,111-106)	0.0507	0.0003	<.0001
mperiodnbr_DCXM	**L02**	Categorical of period_number	period_number <= 2	-0.7241	0.0633	<.0001
mperiodnbr_DCXM	**L03**	Categorical of period_number	eriod_number = 3 , else mperiodnbr_DCXM="Z04"	-0.2091	0.0192	<.0001
vperiodnbr_DCXM_pw1		Variate piecewise of period_number	median(0,period_number-4,9-4)	0.1164	0.0015	<.0001
vperiodnbr_DCXM_pw2		Variate piecewise of period_number	median(0,period_number-9,15-9)	-0.0275	0.0007	<.0001
vperiodnbr_DCXM_pw3		Variate piecewise of period_number	median(0,period_number-15,25-15)	0.0064	0.0004	<.0001
vperiodnbr_DCXM_pw4		Variate piecewise of period_number	median(0,period_number-25,59-25)	-0.0070	0.0002	<.0001
vperiodnbr_DCXM_pw5		Variate piecewise of period_number	median(0,period_number-59,90-59)	-0.0101	0.0003	<.0001
vcredit_DCXM_pw1		Variate piecewise of credit_score	median(0,credit_score-530,640-530)	-0.0011	0.0000	<.0001
vcredit_DCXM_pw3		Variate piecewise of credit_score	median(0,credit_score-680,780-680)	-0.0005	0.0001	<.0001
mdurdefepi_DCXM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.4260	0.0030	<.0001
mdurdefepi_DCXM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	0.5581	0.0032	<.0001
mdurdefepi_DCXM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	0.6349	0.0035	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCXM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	0.5662	0.0038	<.0001
mdurdefepi_DCXM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	0.5855	0.0042	<.0001
mdurdefepi_DCXM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	0.4269	0.0048	<.0001
mdurdefepi_DCXM	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	0.2550	0.0057	<.0001
mdurdefepi_DCXM	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	-0.0117	0.0071	0.0974
mdurdefepi_DCXM	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 10	-0.2593	0.0057	<.0001
vdurdefepi_DCXM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,23-10)	-0.0753	0.0009	<.0001
vdeltaUEInit_DCXM_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,66-0)	0.0011	0.0002	<.0001
vdeltaUEInit_DCXM_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-66,95-66)	0.0010	0.0001	<.0001
vdeltaUEInit_DCXM_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-95,230-95)	0.0009	0.0000	<.0001
vdeltaUEInit_DCXM_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-230,300-230)	-0.0009	0.0001	<.0001
mRatioTmpTei_DCXM	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0, else MRatioTmpTei_DCXM = "Z00"	0.5742	0.0273	<.0001
vratiotmptei_DCXM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,14-0)	0.0269	0.0016	<.0001
vratiotmptei_DCXM_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-14,26-14)	0.0130	0.0003	<.0001
vratiotmptei_DCXM_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-26,44-26)	-0.0006	0.0002	0.0109
vratiotmptei_DCXM_pw4		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-44,52-44)	-0.0156	0.0021	<.0001
mpriordef_DCXM	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.0317	0.0040	<.0001
mpriordef_DCXM	**L05**	Categorical of prior_default_cnt	prior_default_cnt = 5	-0.0610	0.0048	<.0001
mpriordef_DCXM	**L06**	Categorical of prior_default_cnt	prior_default_cnt = 6	-0.0946	0.0058	<.0001
mpriordef_DCXM	**L07**	Categorical of prior_default_cnt	prior_default_cnt = 7	-0.1312	0.0070	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_DCXM	**L08**	Categorical of prior_default_cnt	prior_default_cnt = 8	-0.1564	0.0084	<.0001
mpriordef_DCXM	**L09**	Categorical of prior_default_cnt	prior_default_cnt = 9	-0.1731	0.0101	<.0001
mpriordef_DCXM	**L10**	Categorical of prior_default_cnt	prior_default_cnt = >10	-0.1863	0.0101	<.0001
vpriordef_DCXM_pw1		Variate of prior_default_cnt	median(0,prior_default_cnt-10,16-10)	-0.0387	0.0041	<.0001
vsato_DCXM_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-(-.6))	0.3293	0.0097	<.0001
vsato_DCXM_pw2		Variate piecewise of sato (spread at origination)	median(sato-(-.6),0,.9-(-.6))	0.0413	0.0026	<.0001
vsato_DCXM_pw3		Variate piecewise of sato (spread at origination)	median(sato-.9,0,1.82-.9)	-0.0354	0.0088	<.0001
vloanraw_DCXM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,70000-0)	9.E-06	2.E-07	<.0001
vloanraw_DCXM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-70000,98000-70000)	5.E-06	2.E-07	<.0001
vloanraw_DCXM_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-98000,180000-98000)	2.E-06	4.E-08	<.0001
vloanraw_DCXM_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-180000,500000-180000)	5.E-07	2.E-08	<.0001
vSBOI_DCXM_pw1		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	0.0009	0.0004	0.0143
vSBOI_DCXM_pw2		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-100,108-100)	-0.0868	0.0008	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.1638	0.0052	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	min(UE_CW_growthQ_lag2, -0.2)	0.1522	0.0032	<.0001
vMTG_RATE30Y_growthQ_lag3_DCXM1		Variate piecewise of 30 year mortgage rate quarterly growth with 3Q lag	min(MTG_RATE30Y_growthQ_lag3,0.1)	1.0538	0.0232	<.0001
vMTG_RATE30Y_growthQ_lag3_DCXM2		Variate piecewise of 30 year mortgage rate quarterly growth with 3Q lag	max(MTG_RATE30Y_growthQ_lag3,0.1)	2.3006	0.0738	<.0001
v_CCI_growthY_lag3_DCXM1		Variate piecewise of CCI yearly growth with 3Q lag	min(CCI_growthY_lag3,0.25)	-0.3692	0.0060	<.0001
v_CCI_growthY_lag3_DCXM2		Variate piecewise of CCI yearly growth with 3Q lag	max(CCI_growthY_lag3,0.25)	1.1739	0.0160	<.0001
v_TR1Q_growthQ_DCXM1		Variate piecewise of Quarterly treasure rate quarterly growth	median(0,TR1Q_growthQ-0,2-0)	0.2390	0.0022	<.0001
v_TR1Q_growthQ_DCXM2		Variate piecewise of Quarterly treasure rate quarterly growth	max(TR1Q_growthQ,2)	0.0445	0.0025	<.0001

Default Transition Model Parameters – FRM30NSR D_CXS

The model parameters for the FRM30NSR default to self-cure transition are shown in Table 47.

Table 47: Default to Self-Cure Transition FRM30NSR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-1.7208	0.0486	<.0001
mseason	**1**	Categorical of season	season = "winter"	0.2202	0.0014	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mseason	**2**	Categorical of season	season = "spring"	0.2674	0.0015	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.1119	0.0015	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.1048	0.0010	<.0001
mdpa_rel	**LRela**	Categorical of dpa (down payment assistance)	dpa = "Relative"	0.0377	0.0013	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.0201	0.0011	<.0001
mycslope_DCXS	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=111	-0.1108	0.0019	<.0001
mycslope_DCXS	**L02**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=2000	0.1958	0.0024	<.0001
mycslope_DCXS	**L03**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=875	0.1529	0.0024	<.0001
mhpa2yb_DCXS	**L080**	Categorical of hpa2y_blended_r[6]	hpa2y_blended_r <= 80	-0.0670	0.0053	<.0001
vhpa2yb_DCXS_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-80,99-80)	0.0119	0.0002	<.0001
vhpa2yb_DCXS_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-99,105-99)	-0.0239	0.0004	<.0001
vhpa2yb_DCXS_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-105,115-105)	0.0092	0.0002	<.0001
vhpa2yb_DCXS_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-115,180-115)	-0.0008	0.0001	<.0001
mperiodnbr_DCXS	**L02**	Categorical of period_number	period_number <= 2	1.2905	0.0104	<.0001
mperiodnbr_DCXS	**L03**	Categorical of period_number	period_number = 3	0.3951	0.0049	<.0001
vperiodnbr_DCXS_pw1		Variate piecewise of period_number	median(0,period_number-4,9-4)	-0.0286	0.0006	<.0001
vperiodnbr_DCXS_pw2		Variate piecewise of period_number	median(0,period_number-9,17-9)	0.0059	0.0003	<.0001
vperiodnbr_DCXS_pw3		Variate piecewise of period_number	median(0,period_number-17,30-17)	0.0096	0.0002	<.0001
vperiodnbr_DCXS_pw4		Variate piecewise of period_number	median(0,period_number-30,38-30)	0.0077	0.0003	<.0001
vperiodnbr_DCXS_pw5		Variate piecewise of period_number	median(0,period_number-38,57-38)	0.0102	0.0002	<.0001
vperiodnbr_DCXS_pw6		Variate piecewise of period_number	median(0,period_number-57,85-57)	0.0047	0.0002	<.0001
vperiodnbr_DCXS_pw7		Variate piecewise of period_number	median(0,period_number-85,105-85)	-0.0021	0.0005	<.0001
mcredit_DCXS	**L01**	Categorical of credit_score	credit_score = 0	0.2153	0.0034	<.0001
vcredit_DCXS_pw1		Variate piecewise of credit_score	median(0,credit_score-500,625-500)	0.0031	0.0000	<.0001
vcredit_DCXS_pw2		Variate piecewise of credit_score	median(0,credit_score-625,680-625)	0.0030	0.0000	<.0001
vcredit_DCXS_pw3		Variate piecewise of credit_score	median(0,credit_score-680,780-680)	0.0004	0.0000	<.0001
mdurdefepi_DCXS	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	-0.6160	0.0013	<.0001
mdurdefepi_DCXS	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	-0.9900	0.0016	<.0001
mdurdefepi_DCXS	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	-1.3444	0.0021	<.0001
mdurdefepi_DCXS	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	-1.5429	0.0025	<.0001
mdurdefepi_DCXS	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	-1.6985	0.0030	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCXS	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	-1.9046	0.0037	<.0001
mdurdefepi_DCXS	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	-2.1084	0.0045	<.0001
mdurdefepi_DCXS	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	-2.2511	0.0053	<.0001
mdurdefepi_DCXS	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	-2.3960	0.0061	<.0001
mdurdefepi_DCXS	**L11**	Categorical of dur_def_episode (duration of default episode)	else	-2.5322	0.0067	<.0001
vdurdefepi_DCXS_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,16-10)	-0.0174	0.0016	<.0001
vdurdefepi_DCXS_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-16,30-16)	-0.0164	0.0007	<.0001
vdeltaUEInit_DCXS_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,60-0)	0.0014	0.0001	<.0001
vdeltaUEInit_DCXS_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-60,100-60)	-0.0017	0.0001	<.0001
vdeltaUEInit_DCXS_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-100,116-100)	-0.0058	0.0001	<.0001
vdeltaUEInit_DCXS_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-116,218-116)	-0.0016	0.0000	<.0001
mRatioTmpTei_DCXS	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.3137	0.0060	<.0001
vratiotmptei_DCXS_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	-0.0145	0.0002	<.0001
vratiotmptei_DCXS_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	-0.0099	0.0002	<.0001
vratiotmptei_DCXS_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0011	0.0003	0.0002
mpriordef_DCXS	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.0934	0.0015	<.0001
mpriordef_DCXS	**L02**	Categorical of prior_default_cnt	prior_default_cnt > 1	-0.1307	0.0016	<.0001
vpriordef_DCXS_pw1		Variate of prior_default_cnt	median(0,prior_default_cnt-1,22-1)	0.0068	0.0003	<.0001
vdeltaUEpr3_DCXS_pw1		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(0,delta_ue_sa_st_r-(-20),-30-(-20))	0.0022	0.0002	<.0001
vdeltaUEpr3_DCXS_pw2		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(0,delta_ue_sa_st_r-(-20),10-(-20))	-0.0002	0.0001	0.0177

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vUEblend_DCXS_pw1		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-200,480-200)	-0.0005	0.0000	<.0001
vUEblend_DCXS_pw2		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-480,800-480)	-0.0002	0.0000	<.0001
vltv_DCXS_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,71-0)	-0.0019	0.0009	0.0358
vloanraw_DCXS_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-27000,70000-27000)	-8.E-07	9.E-08	<.0001
vloanraw_DCXS_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-70000,98000-70000)	-1.E-06	7.E-08	<.0001
vloanraw_DCXS_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-98000,180000-98000)	-7.E-07	2.E-08	<.0001
vloanraw_DCXS_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-180000,500000-180000)	-5.E-07	1.E-08	<.0001
mDeltaTY10_DCXS	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r 2< 53	-0.0166	0.0016	<.0001
mDeltaTY10_DCXS	**L02**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r2 > 112	0.0466	0.0018	<.0001
mDeltaTm3_DCXS	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTm3Init_r12 > 1000	0.0830	0.0020	<.0001
mTY30_DCXS	**L01**	Categorical of treasury_yr_30	treasury_yr_30 > 6	-0.0363	0.0062	<.0001
mcalperiod_DCXS	**L01**	Categorical of Calendar Period	period < 200102	0.0283	0.0071	<.0001
vSBOI_DCXS_pw1		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	-0.0275	0.0002	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.2544	0.0025	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.2062	0.0023	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.3103	0.0025	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	7.6036	0.0381	<.0001
v_CCI_lag2_DCXS_pw1		Variate piecewise of CCI with 2Q lag	min(CCI_lag2,50)	0.0151	0.0003	<.0001
v_CCI_lag2_DCXS_pw2		Variate piecewise of CCI with 2Q lag	max(CCI_lag2,50)	0.0036	0.0001	<.0001
v_HPI_CW_lag1_DCXS_pw1		Variate piecewise of country wide HPI with 1Q lag	min(HPI_CW_lag1,180)	0.0150	0.0002	<.0001
v_HPI_CW_lag1_DCXS_pw2		Variate piecewise of country wide HPI with 1Q lag	median(0,HPI_CW_lag1 - 180, 230 - 180)	0.0074	0.0001	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_HPI_CW_lag1_DCXS_pw3		Variate piecewise of country wide HPI with 1Q lag	max(HPI_CW_lag1,230)	-0.0024	0.0000	<.0001

Default Transition Model Parameters – FRM30NSR D_END

The model parameters for the FRM30NSR default to end (prepayment or refinance) transition are shown in Table 48.

Table 48: Default to End Transition FRM30NSR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-2.7520	0.0361	<.0001
mseason	**1**	Categorical of season	season = "winter"	-0.0965	0.0044	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.1329	0.0043	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.1826	0.0043	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.2004	0.0030	<.0001
mdpa	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	-0.1358	0.0105	<.0001
mdpa	**2**	Categorical of dpa (down payment assistance)	dpa = "nonprof"	-0.2834	0.0072	<.0001
mdpa	**3**	Categorical of dpa (down payment assistance)	dpa = "relative"	0.0443	0.0038	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.1833	0.0033	<.0001
mycslope_DEND	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=111	0.2330	0.0049	<.0001
mycslope_DEND	**L02**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=875	-0.4733	0.0063	<.0001
mycslope_DEND	**L03**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=2000	-0.4748	0.0070	<.0001
vhpa2yb_DEND_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-80,105-80)	0.0099	0.0006	<.0001
vhpa2yb_DEND_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-105,120-105)	0.0596	0.0004	<.0001
vhpa2yb_DEND_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-120,180-120)	0.0343	0.0002	<.0001
vperiodnbr_DEND_pw2		Variate piecewise of period_number	median(0,period_number-6,30-6)	0.0244	0.0003	<.0001
vperiodnbr_DEND_pw3		Variate piecewise of period_number	median(0,period_number-30,65-30)	0.0084	0.0002	<.0001
vperiodnbr_DEND_pw5		Variate piecewise of period_number	median(0,period_number-97,120-97)	0.0584	0.0017	<.0001
vcredit_DEND_pw1		Variate piecewise of credit_score	median(0,credit_score-450,600-450)	-0.0002	0.0001	0.0193
vcredit_DEND_pw2		Variate piecewise of credit_score	median(0,credit_score-600,680-600)	0.0038	0.0001	<.0001
vcredit_DEND_pw3		Variate piecewise of credit_score	median(0,credit_score-680,780-680)	0.0035	0.0001	<.0001
mdurdefepi_DEND	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	-0.4840	0.0043	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DEND	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	-0.6684	0.0052	<.0001
mdurdefepi_DEND	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	-0.7585	0.0059	<.0001
mdurdefepi_DEND	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	-0.8446	0.0068	<.0001
mdurdefepi_DEND	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	-0.9046	0.0076	<.0001
mdurdefepi_DEND	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	-0.9545	0.0086	<.0001
mdurdefepi_DEND	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	-0.9845	0.0095	<.0001
mdurdefepi_DEND	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	-1.0173	0.0106	<.0001
mdurdefepi_DEND	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	-1.0376	0.0114	<.0001
mdurdefepi_DEND	**L11**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >10	-1.1055	0.0075	<.0001
vdurdefepi_DEND_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	0.0143	0.0007	<.0001
vdurdefepi_DEND_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	-0.0318	0.0022	<.0001
vdeltaUEInit_DEND_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,60-0)	-0.0050	0.0003	<.0001
vdeltaUEInit_DEND_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-60,120-60)	0.0002	0.0001	0.0086
vdeltaUEInit_DEND_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-190,200-190)	-0.0096	0.0008	<.0001
mRatioTmpTei_DEND	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.4491	0.0209	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vratiotmptei_DEND_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,15-0)	-0.0236	0.0014	<.0001
vratiotmptei_DEND_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-15,24-15)	-0.0124	0.0006	<.0001
vratiotmptei_DEND_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,50-24)	-0.0042	0.0003	<.0001
mpriordef_DEND	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.3155	0.0039	<.0001
mpriordef_DEND	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.4924	0.0051	<.0001
mpriordef_DEND	**L03**	Categorical of prior_default_cnt	prior_default_cnt = 3	-0.6430	0.0065	<.0001
mpriordef_DEND	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.7641	0.0079	<.0001
mpriordef_DEND	**L05**	Categorical of prior_default_cnt	prior_default_cnt = 5	-0.8649	0.0094	<.0001
mpriordef_DEND	**L06**	Categorical of prior_default_cnt	prior_default_cnt = 6	-0.9363	0.0111	<.0001
mpriordef_DEND	**L07**	Categorical of prior_default_cnt	prior_default_cnt = 7	-0.9758	0.0129	<.0001
mpriordef_DEND	**L08**	Categorical of prior_default_cnt	prior_default_cnt = 8	-1.0278	0.0152	<.0001
mpriordef_DEND	**L09**	Categorical of prior_default_cnt	prior_default_cnt = 9	-1.0456	0.0178	<.0001
mpriordef_DEND	**L10**	Categorical of prior_default_cnt	prior_default_cnt >= 10	-1.0865	0.0130	<.0001
vsato_DEND_pw1		Variate piecewise of sato (spread at origination)	median(sato-(-.4),0,.95-(-.4))	0.0175	0.0035	<.0001
vdeltaUEpr3_DEND_pw1		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(0,delta_ue_sa_st_r-(-20),-30-(-20))	0.0046	0.0005	<.0001
vdeltaUEpr3_DEND_pw2		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(0,delta_ue_sa_st_r-(-20),10-(-20))	0.0038	0.0002	<.0001
vUEblend_DEND_pw1		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-0,450-0)	-0.0008	0.0000	<.0001
vUEblend_DEND_pw2		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-450,850-450)	-0.0008	0.0000	<.0001
vUEblend_DEND_pw3		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-850,1500-850)	-0.0001	0.0000	<.0001
vltv_DEND_pw6		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,99-94)	-0.2085	0.0035	<.0001
vloanraw_DEND_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-30000,70000-30000)	0.0000	0.0000	<.0001
vloanraw_DEND_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-70000,98000-70000)	6.E-06	2.E-07	<.0001
vloanraw_DEND_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-98000,180000-98000)	3.E-06	7.E-08	<.0001
vloanraw_DEND_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-180000,500000-180000)	7.E-07	3.E-08	<.0001
mDeltaTY10_DEND	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.0700	0.0050	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mprior3_ue_DEND	**L01**	Categorical of prior3_ue_r[11] (state unemployment 3 prior quarters)	prior3_ue_r < 1400	0.1052	0.0165	<.0001
vSBOI_DEND_pw1		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-85,100-85)	0.0468	0.0010	<.0001
vSBOI_DEND_pw2		Variate piecewise of SBOI (small business optimism index)	median(0,mSBOI-100,108-100)	0.0541	0.0010	<.0001
vCCI_DEND_pw1		Variate piecewise of SBOI (small business optimism index)	median(0,mCCI-25,100-25)	-0.0116	0.0002	<.0001
vCCI_DEND_pw2		Variate piecewise of SBOI (small business optimism index)	median(0,mCCI-100,142-100)	-0.0167	0.0002	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.1636	0.0084	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.2360	0.0065	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.2737	0.0059	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-2.0512	0.0967	<.0001
vcredit_subsidy_cohort_pw0		Variate of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2002-1999)	-0.0499	0.0021	<.0001
vcredit_subsidy_cohort_pw1		Variate of credit subsidy cohort	median(0, credit_subsidy_cohort - 2002,2008-2002)	-0.0634	0.0021	<.0001
vcredit_subsidy_cohort_pw2		Variate of credit subsidy cohort	median(0, credit_subsidy_cohort - 2008,2012-2008)	0.0967	0.0017	<.0001
vcredit_subsidy_cohort_pw3		Variate of credit subsidy cohort	median(0, credit_subsidy_cohort - 2019,2021-2019)	-0.4931	0.0089	<.0001

Default Transition Model Parameters – FRM30SR D_CLM

The model parameters for the FRM30SR default to claim transition are shown in Table 49.

Table 49: Default to Claim Transition FRM30SR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-2.1888	0.0919	<.0001
mseason_grp_DCLM	**L02**	Categorical of season	mseason = 2	0.0405	0.0062	<.0001
mseason_grp_DCLM	**L03**	Categorical of season	mseason = 3	0.0779	0.0063	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.2627	0.0054	<.0001
mcalperiod_DCLM	**L199704**	Categorical of Calendar Period	period < 199704	1.3244	0.0259	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mcalperiod_DCLM	**L200104**	Categorical of Calendar Period	period < 200104	0.8514	0.0210	<.0001
mcalperiod_DCLM	**L200604**	Categorical of Calendar Period	period < 200604	0.2836	0.0129	<.0001
mycslope_DCLM	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=141	-0.1572	0.0093	<.0001
vycslope_DCLM_pw1		Categorical of ycslope_r[9] (yield curve slope)	median(0,ycslope_r-141,1270-141)	-0.0002	0.0000	<.0001
vhpa2yb_DCLM_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-45,85-45)	-0.0196	0.0013	<.0001
vhpa2yb_DCLM_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,100-85)	0.0282	0.0010	<.0001
vhpa2yb_DCLM_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-100,138-100)	-0.0212	0.0004	<.0001
vhpa2yb_DCLM_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-138,160-138)	-0.0275	0.0031	<.0001
mperiodnbr_DCLM	**L02**	Categorical of period_number	period_number <= 2	-0.6302	0.1756	0.0003
mperiodnbr_DCLM	**L03**	Categorical of period_number	period_number = 3	-0.4768	0.0585	<.0001
mperiodnbr_DCLM	**L04**	Categorical of period_number	period_number = 4	-0.3685	0.0342	<.0001
mperiodnbr_DCLM	**L07**	Categorical of period_number	period_number = 7	0.0235	0.0172	0.1726
mperiodnbr_DCLM	**L08**	Categorical of period_number	period_number = 8	0.0713	0.0161	<.0001
mperiodnbr_DCLM	**L56**	Categorical of period_number	period_number in (5,6)	-0.0490	0.0160	0.0021
vperiodnbr_DCLM_pw1		Variate piecewise of period_number	median(0,period_number-9,17-9)	0.0141	0.0014	<.0001
vperiodnbr_DCLM_pw2		Variate piecewise of period_number	median(0,period_number-17,59-17)	0.0027	0.0004	<.0001
vperiodnbr_DCLM_pw3		Variate piecewise of period_number	median(0,period_number-59,86-59)	-0.0220	0.0019	<.0001
vcredit_DCLM_pw1		Variate piecewise of credit_score	median(0,credit_score-550,635-550)	-0.0012	0.0002	<.0001
vcredit_DCLM_pw2		Variate piecewise of credit_score	median(0,credit_score-635,780-635)	0.0047	0.0002	<.0001
mdurdefepi_DCLM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.6725	0.0114	<.0001
mdurdefepi_DCLM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	1.1494	0.0112	<.0001
mdurdefepi_DCLM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	1.3805	0.0114	<.0001
mdurdefepi_DCLM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	1.4701	0.0119	<.0001
mdurdefepi_DCLM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	1.4823	0.0127	<.0001
mdurdefepi_DCLM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	1.4790	0.0135	<.0001
mdurdefepi_DCLM	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	1.4232	0.0145	<.0001
mdurdefepi_DCLM	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	1.4394	0.0154	<.0001
mdurdefepi_DCLM	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	1.4085	0.0165	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCLM	**L11**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 11	1.3783	0.0177	<.0001
mdurdefepi_DCLM	**L12**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 12	1.3589	0.0190	<.0001
mdurdefepi_DCLM	**L13**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 13	1.3750	0.0201	<.0001
mdurdefepi_DCLM	**L14**	Categorical of dur_def_episode (duration of default episode)	else	1.3385	0.0153	<.0001
vdurdefepi_DCLM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-13,40-13)	-0.0197	0.0015	<.0001
vdurdefepi_DCLM_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-40,50-40)	-0.1902	0.0160	<.0001
vdeltaUEinit_DCLM_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,53-0)	-0.0075	0.0010	<.0001
vdeltaUEinit_DCLM_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-53,98-53)	-0.0127	0.0002	<.0001
vratiotmptei_DCLM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0050	0.0003	<.0001
mpriordef_DCLM	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.3685	0.0069	<.0001
mpriordef_DCLM	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.5558	0.0093	<.0001
mpriordef_DCLM	**L03**	Categorical of prior_default_cnt	prior_default_cnt = 3	-0.7051	0.0120	<.0001
mpriordef_DCLM	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.8559	0.0156	<.0001
mpriordef_DCLM	**L05**	Categorical of prior_default_cnt	prior_default_cnt = 5	-0.9431	0.0198	<.0001
mpriordef_DCLM	**L06**	Categorical of prior_default_cnt	prior_default_cnt = 6	-1.1388	0.0263	<.0001
mpriordef_DCLM	**L07**	Categorical of prior_default_cnt	prior_default_cnt = 7	-1.2224	0.0341	<.0001
mpriordef_DCLM	**L08**	Categorical of prior_default_cnt	prior_default_cnt = 8	-1.3916	0.0460	<.0001
mpriordef_DCLM	**L09**	Categorical of prior_default_cnt	else	-1.2696	0.0731	<.0001
vpriordef_DCLM_pw1		Variate of prior_default_cnt	median(0,prior_default_cnt-8,15-8)	-0.1632	0.0290	<.0001
vdeltaUEpr3_DCLM_pw2		Variate piecewise of deltauepr3 r[5] (change in unemployment from 3 quarters prior)	median(0,delta ue sa st r-(-20),10-(-20))	-0.0039	0.0003	<.0001
vUEblend_DCLM_pw1		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-200,550-200)	0.0025	0.0001	<.0001
vUEblend_DCLM_pw2		Variate piecewise of ue blended r[8] (unemployment rate)	median(0,ue_blended_r-550,850-550)	-0.0002	0.0000	<.0001
vUEblend_DCLM_pw3		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-850,1500-850)	0.0002	0.0000	<.0001
vltv_DCLM_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-40,70-40)	0.0010	0.0005	0.0658

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vltv_DCLM_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,81-70)	0.0326	0.0013	<.0001
vltv_DCLM_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-81,92-81)	0.0108	0.0010	<.0001
vltv_DCLM_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-92,100-92)	0.0240	0.0029	<.0001
vloanraw_DCLM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-60000,100000-60000)	0.0000	0.0000	<.0001
vloanraw_DCLM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-100000,200000-100000)	-1.E-06	9.E-08	<.0001
vloanraw_DCLM_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-200000,500000-200000)	-2.E-06	7.E-08	<.0001
mTY30_DCLM	**L07**	Categorical of treasury_yr_30	treasury_yr_30 > 7	0.4000	0.0300	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.2620	0.0223	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.4932	0.0233	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.7044	0.0258	<.0001
v_MTG_RATE30Y_growthQ_DCLM_pw1		Variate piecewise of 30 year mortgage rate quarterly growth	min(MTG_RATE30Y_growthQ,0.1)	0.2721	0.0530	<.0001
v_MTG_RATE30Y_growthQ_DCLM_pw2		Variate piecewise of 30 year mortgage rate quarterly growth	max(MTG_RATE30Y_growthQ,0.1)	-0.2635	0.1193	0.0271
v_MTG_RATE30Y_lag4_DCLM_pw1		Variate piecewise of 30 year mortgage rate with 4Q lag	min(MTG_RATE30Y_lag4,5)	0.0307	0.0079	<.0001
v_MTG_RATE30Y_lag4_DCLM_pw2		Variate piecewise of 30 year mortgage rate with 4Q lag	max(MTG_RATE30Y_lag4,5)	-0.1659	0.0077	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.2470	0.0746	0.0009

Default Transition Model Parameters – FRM30SR D_CXM

The model parameters for the FRM30SR default to modified cure transition are shown in Table 50.

Table 50: Default to Modified Cure Transition FRM30SR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-6.0658	0.0835	<.0001
mcalperiod_DCXM	**L200604**	Categorical of Calendar Period	period < 200604	-6.6047	0.1476	<.0001
mseason_grp_DCXM	**L02**	Categorical of season	mseason = 2	0.2489	0.0065	<.0001
mseason_grp_DCXM	**L03**	Categorical of season	mseason = 3	0.1270	0.0067	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.0204	0.0049	<.0001
vhpa2yb_DCXM_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-65,83-65)	0.0189	0.0020	<.0001
vhpa2yb_DCXM_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-83,94-83)	-0.0080	0.0014	<.0001
vhpa2yb_DCXM_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-94,115-94)	0.0093	0.0005	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vhpa2yb_DCXM_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-115,140-115	0.0409	0.0005	<.0001
mperiodnbr_DCXM	**L03**	Categorical of period_number	period_number = 3	0.1339	0.0356	0.0002
mperiodnbr_DCXM	**L04**	Categorical of period_number	period_number = 4	0.1772	0.0265	<.0001
vperiodnbr_DCXM_pw1		Variate piecewise of period_number	median(0,period_number-4,8-4)	0.1679	0.0057	<.0001
vperiodnbr_DCXM_pw2		Variate piecewise of period_number	median(0,period_number-8,12-8)	-0.0893	0.0031	<.0001
vperiodnbr_DCXM_pw3		Variate piecewise of period_number	median(0,period_number-12,21-12)	0.0309	0.0011	<.0001
vperiodnbr_DCXM_pw4		Variate piecewise of period_number	median(0,period_number-21,59-21)	-0.0026	0.0004	<.0001
mdurdefepi_DCXM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.4030	0.0073	<.0001
mdurdefepi_DCXM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	0.4639	0.0079	<.0001
mdurdefepi_DCXM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	0.4864	0.0085	<.0001
mdurdefepi_DCXM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	0.4004	0.0095	<.0001
mdurdefepi_DCXM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	0.4538	0.0103	<.0001
mdurdefepi_DCXM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	0.2693	0.0122	<.0001
mdurdefepi_DCXM	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	0.2020	0.0144	<.0001
vdurdefepi_DCXM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-7,14-7)	-0.1563	0.0035	<.0001
vdurdefepi_DCXM_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-14,40-14)	-0.0285	0.0023	<.0001
vdeltaUEinit_DCXM_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-66,90-66)	0.0013	0.0004	0.0003
vdeltaUEinit_DCXM_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-90,131-90)	0.0053	0.0002	<.0001
vdeltaUEinit_DCXM_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-131,200-131	0.0033	0.0002	<.0001
mRatioTmpTei_DCXM	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.1873	0.0336	<.0001
vratiotmptei_DCXM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0111	0.0017	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vratiotmptei_DCXM_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	0.0049	0.0017	0.0035
vratiotmptei_DCXM_pw3		Variate piecewise of ratio tmp tei (front-end ratio)	median(0,ratio_tmp_tei-36,100-36)	-0.0031	0.0008	<.0001
mpriordef_DCXM	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	0.0370	0.0066	<.0001
mpriordef_DCXM	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	0.0419	0.0079	<.0001
mpriordef_DCXM	**L03**	Categorical of prior_default_cnt	prior_default_cnt = 3	0.0102	0.0092	0.2687
mpriordef_DCXM	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.0056	0.0107	0.6052
mpriordef_DCXM	**L05**	Categorical of prior_default_cnt	prior_default_cnt >= 5	-0.0506	0.0114	<.0001
vpriordef_DCXM_pw1		Variate pf prior_default_cnt	median(0,prior_default_cnt-5,9-5)	-0.0285	0.0050	<.0001
vpriordef_DCXM_pw2		Variate pf prior_default_cnt	median(0,prior_default_cnt-9,14-9)	-0.0518	0.0078	<.0001
vsato_DCXM_pw1		Variate piecewise of sato (spread at origination)	median(sato-(-1.4),0,.6-(-1.4))	0.0152	0.0070	0.0292
vsato_DCXM_pw2		Variate piecewise of sato (spread at origination)	max(sato-.6,0)	0.1489	0.0236	<.0001
vUEblend_DCXM_pw1		Variate piecewise of ue blended r^8 (change in unemployment rate)	median(0,ue_blended_r-200,420-200)	0.0003	0.0001	<.0001
vUEblend_DCXM_pw2		Variate piecewise of ue blended r^8 (change in unemployment rate)	median(0,ue_blended_r-420,940-420)	-0.0008	0.0000	<.0001
vltv_DCXM_pw1		Variate piecewise of ltv_i_r^7 (loan-to-value)	median(0,ltv_i_r-48,82-48)	0.0043	0.0004	<.0001
vltv_DCXM_pw2		Variate piecewise of ltv i r^7 (loan-to-value)	median(0,ltv_i_r-82,91-82)	0.0087	0.0009	<.0001
vloanraw_DCXM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,70000-0)	0.0000	0.0000	<.0001
vloanraw_DCXM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-70000,120000-70000)	4.E-06	2.E-07	<.0001
vloanraw_DCXM_pw3		Variate piecewise of loansize_raw	median(0,loansize raw-120000,400000-120000)	1.E-06	4.E-08	<.0001
mDeltaTY10_DCXM	**L01**	Categorical of DeltaTy10Init_r^2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.1000	0.0070	<.0001
mDeltaTM3_DCXM	**L02**	Categorical of DeltaTm3Init_r^{12} (change in 3 month treasury from policy inception to current)	DeltaTM3Init_r > 550	-0.2132	0.0085	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.1176	0.0154	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.1408	0.0098	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.3632	0.0074	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-0.5815	0.1362	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vMTG_RATE30Y_growthQ_lag3_DCXM1		Variate piecewise of 30 year mortgage rate quarterly growth with 3Q lag	min(MTG_RATE30Y_growthQ_lag3,0.1)	1.1557	0.0569	<.0001
vMTG_RATE30Y_growthQ_lag3_DCXM2		Variate piecewise of 30 year mortgage rate quarterly growth with 3Q lag	max(MTG_RATE30Y_growthQ_lag3,0.1)	0.5840	0.1687	0.0005
v_CCI_growthY_lag3_DCXM_pw1		Variate piecewise of CCI yearly growth with 3Q lag	min(CCI_growthY_lag3,0.25)	-0.1854	0.0149	<.0001
v_CCI_growthY_lag3_DCXM_pw2		Variate piecewise of CCI yearly growth with 3Q lag	max(CCI_growthY_lag3,0.25)	1.0388	0.0347	<.0001
v_TR1Q_growthQ_DCXM_pw1		Variate piecewise of quarterly treature rate quarterly growth	median(0,TR1Q_growthQ-0,2-0)	0.1978	0.0054	<.0001
v_TR1Q_growthQ_DCXM_pw2		Variate piecewise of quarterly treature rate quarterly growth	max(TR1Q_growthQ,2)	0.0567	0.0058	<.0001

Default Transition Model Parameters – FRM30SR D_CXS

The model parameters for the FRM30SR default to self-cure transition are shown in Table 51.

Table 51: Default to Self-Cure Transition FRM30SR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-0.1587	0.0509	0.0018
mcalperiod_DCXS	**L200104**	Categorical of Calendar Period	period < 200104	-1.4647	0.0088	<.0001
mcalperiod_DCXS	**L200604**	Categorical of Calendar Period	period < 200604	-0.7912	0.0061	<.0001
mseason	**1**	Categorical of season	season = "winter"	0.1783	0.0035	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.2292	0.0035	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.1030	0.0037	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.1117	0.0026	<.0001
mhpa2yb_DCXS	**L085**	Categorical of hpa2y_blended_r[6]	hpa2y_blended_r <= 80	0.0273	0.0127	0.0314
vhpa2yb_DCXS_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-80,99-80)	0.0090	0.0005	<.0001
vhpa2yb_DCXS_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-99,105-99)	-0.0056	0.0010	<.0001
vhpa2yb_DCXS_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-105,116-105)	0.0104	0.0004	<.0001
vhpa2yb_DCXS_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-116,180-116)	0.0006	0.0003	0.0467
mperiodnbr_DCXS	**L02**	Categorical of period_number	period_number <= 2	1.4936	0.0210	<.0001
mperiodnbr_DCXS	**L03**	Categorical of period_number	period_number = 3	0.5018	0.0102	<.0001
mperiodnbr_DCXS	**L04**	Categorical of period_number	period_number = 4	0.1394	0.0086	<.0001
vperiodnbr_DCXS_pw1		Variate piecewise of period_number	median(0,period_number-5,15-5)	-0.0170	0.0006	<.0001
vperiodnbr_DCXS_pw2		Variate piecewise of period_number	median(0,period_number-15,25-15)	0.0090	0.0005	<.0001
vperiodnbr_DCXS_pw3		Variate piecewise of period_number	median(0,period_number-25,57-25)	-0.0014	0.0002	<.0001
vperiodnbr_DCXS_pw4		Variate piecewise of period_number	median(0,period_number-57,85-57)	0.0055	0.0005	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vperiodnbr_DCXS_pw5		Variate piecewise of period_number	median(0,period_number-85,105-85)	-0.0069	0.0015	<.0001
vcredit_DCXS_pw1		Variate piecewise of credit_score	median(0,credit_score-550,700-550)	0.0001	0.0000	0.0386
mdurdefepi_DCXS	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	-0.6783	0.0032	<.0001
mdurdefepi_DCXS	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	-1.0691	0.0041	<.0001
mdurdefepi_DCXS	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	-1.4243	0.0052	<.0001
mdurdefepi_DCXS	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	-1.6276	0.0064	<.0001
mdurdefepi_DCXS	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	-1.7606	0.0076	<.0001
mdurdefepi_DCXS	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	-1.9708	0.0093	<.0001
mdurdefepi_DCXS	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	-2.1536	0.0113	<.0001
mdurdefepi_DCXS	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	-2.3062	0.0133	<.0001
mdurdefepi_DCXS	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	-2.4425	0.0153	<.0001
mdurdefepi_DCXS	**L11**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >10	-2.5164	0.0208	<.0001
vdurdefepi_DCXS_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,14-10)	-0.0294	0.0067	<.0001
vdurdefepi_DCXS_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-14,35-14)	-0.0194	0.0014	<.0001
vdeltaUEinit_DCXS_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,59-0)	0.0031	0.0003	<.0001
vdeltaUEinit_DCXS_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-59,95-59)	0.0016	0.0002	<.0001
vdeltaUEinit_DCXS_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-95,104-95)	-0.0091	0.0005	<.0001
vdeltaUEinit_DCXS_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-104,200-104)	-0.0009	0.0001	<.0001
mRatioTmpTei_DCXS	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.1805	0.0082	<.0001
vratiotmptei_DCXS_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-10,24-10)	-0.0107	0.0008	<.0001
vratiotmptei_DCXS_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,46-24)	-0.0056	0.0006	<.0001
mpriordef_DCXS	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.0168	0.0035	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mpriordef_DCXS	**L02**	Categorical of prior_default_cnt	else	-0.0342	0.0035	<.0001
vsato_DCXS_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-0)	-0.0439	0.0066	<.0001
vsato_DCXS_pw2		Variate piecewise of sato (spread at origination)	median(sato-0,0,.6-0)	-0.0848	0.0067	<.0001
vsato_DCXS_pw3		Variate piecewise of sato (spread at origination)	median(sato-.6,0,1.82-.6)	-0.0942	0.0112	<.0001
vdeltaUEpr3_DCXS_pw1		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	min(0,delta_ue_sa_st_r-(-20))	0.0004	0.0000	<.0001
vdeltaUEpr3_DCXS_pw2		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(delta_ue_sa_st_r-(-20),0,10-(-20))	0.0019	0.0001	<.0001
vdeltaUEpr3_DCXS_pw3		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	max(delta_ue_sa_st_r-10,0)	0.0003	0.0000	<.0001
vUEblend_DCXS_pw1		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-200,473-200)	-0.0006	0.0000	<.0001
vUEblend_DCXS_pw2		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-473,750-473)	-0.0003	0.0000	<.0001
vUEblend_DCXS_pw3		Variate piecewise of ue_blended_r[8] (unemployment rate)	median(0,ue_blended_r-750,1500-750)	-0.0003	0.0000	<.0001
vltv_DCXS_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-69,85-69)	-0.0051	0.0003	<.0001
vltv_DCXS_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-85,94-85)	-0.0212	0.0006	<.0001
vltv_DCXS_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,99-94)	-0.0216	0.0024	<.0001
vloanraw_DCXS_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-27000,158000-27000)	-2.E-06	0.0000	<.0001
vloanraw_DCXS_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-158000,520000-158000)	-7.E-07	0.0000	<.0001
mDeltaTY10_DCXS	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 127	0.0905	0.0048	<.0001
mDeltaTm3_DCXS	**L01**	Categorical of DeltaTm3Init_r[12] (change in 3 month treasury from policy inception to current)	DeltaTm3Init_r > 1000	0.1087	0.0049	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.2796	0.0067	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.4455	0.0110	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.5235	0.0074	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	5.3273	0.1619	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_CCI_lag2_DCXS_pw1		Variate piecewise of CCI with 2Q lag	min(CCI_lag2,50)	0.0275	0.0007	<.0001
v_CCI_lag2_DCXS_pw2		Variate piecewise of CCI with 2Q lag	max(CCI_lag2,50)	0.0030	0.0001	<.0001

Default Transition Model Parameters – FRM30SR D_END

The model parameters for the FRM30SR default to end (prepayment or refinance) transition are shown in Table 52.

Table 52: Default to End Transition FRM30SR Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-3.2988	0.0777	<.0001
mseason_grp_DEND	**L02**	Categorical of season	mseason = 2	0.1474	0.0088	<.0001
mseason_grp_DEND	**L03**	Categorical of season	mseason = 3	0.2017	0.0091	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (yes)	-0.2141	0.0076	<.0001
mycslope_DEND	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=125	0.1859	0.0096	<.0001
mycslope_DEND	**L02**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=470	-0.3926	0.0119	<.0001
mycslope_DEND	**L03**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=2200	-0.6276	0.0169	<.0001
vhpa2yb_DEND_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,102-85)	0.0059	0.0017	0.0005
vhpa2yb_DEND_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-102,109-102)	0.0728	0.0026	<.0001
vhpa2yb_DEND_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-109,120-109)	0.0638	0.0012	<.0001
vhpa2yb_DEND_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-120,180-120)	0.0301	0.0006	<.0001
mperiodnbr_DEND	**L02**	Categorical of period_number	period_number = 2	0.3731	0.0803	<.0001
mperiodnbr_DEND	**L03**	Categorical of period_number	period_number = 3	0.0777	0.0382	0.0419
vperiodnbr_DEND_pw1		Variate piecewise of period_number	median(0,period_number-3,8-3)	0.0452	0.0050	<.0001
vperiodnbr_DEND_pw2		Variate piecewise of period_number	median(0,period_number-8,32-8)	0.0150	0.0006	<.0001
vperiodnbr_DEND_pw4		Variate piecewise of period_number	median(0,period_number-48,95-48)	0.0082	0.0008	<.0001
mcredit_score_DEND	**L00**	Categorical of credit_score	credit_score = 0	0.0888	0.0164	<.0001
vcredit_DEND_pw1		Variate piecewise of credit_score	median(0,credit_score-642,780-642)	0.0028	0.0003	<.0001
mdurdefepi_DEND	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	-0.5350	0.0103	<.0001
mdurdefepi_DEND	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	-0.7197	0.0124	<.0001
mdurdefepi_DEND	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	-0.8585	0.0147	<.0001
mdurdefepi_DEND	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	-0.9047	0.0167	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DEND	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	-0.9426	0.0189	<.0001
mdurdefepi_DEND	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 9	-1.0919	0.0150	<.0001
mdurdefepi_DEND	**L20**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 20	-1.1691	0.0137	<.0001
mdurdefepi_DEND	**L34**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 34	-1.0601	0.0221	<.0001
mdurdefepi_DEND	**L60**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 60	-1.3561	0.0468	<.0001
mdurdefepi_DEND	**L61**	Categorical of dur_def_episode (duration of default episode)	else	-2.7148	0.1681	<.0001
vdeltaUEinit_DEND_pw1		Variate piecewise of DeltaUEInit_r4 (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-50,98-50)	0.0078	0.0003	<.0001
mpriordef_DEND	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.3285	0.0097	<.0001
mpriordef_DEND	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.5630	0.0130	<.0001
mpriordef_DEND	**L03**	Categorical of prior_default_cnt	prior_default_cnt = 3	-0.7520	0.0163	<.0001
mpriordef_DEND	**L04**	Categorical of prior_default_cnt	prior_default_cnt = 4	-0.8841	0.0196	<.0001
mpriordef_DEND	**L05**	Categorical of prior_default_cnt	prior_default_cnt = 5	-1.0014	0.0233	<.0001
mpriordef_DEND	**L07**	Categorical of prior_default_cnt	prior_default_cnt <= 7	-1.1386	0.0217	<.0001
mpriordef_DEND	**L10**	Categorical of prior_default_cnt	prior_default_cnt <= 10	-1.3158	0.0267	<.0001
mpriordef_DEND	**L11**	Categorical of prior_default_cnt	prior_default_cnt > 10	-1.4432	0.0380	<.0001
vdeltaUEpr3_DEND_pw1		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(delta_ue_sa_st_r-(-20),0,10-(-20))	0.0077	0.0003	<.0001
vdeltaUEpr3_DEND_pw2		Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	max(delta_ue_sa_st_r-10,0)	0.0011	0.0001	<.0001
vUEblend_DEND_pw1		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-200,700-200)	-0.0011	0.0000	<.0001
vUEblend_DEND_pw2		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-700,900-700)	-0.0019	0.0001	<.0001
mltv_DEND	**L00**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r= .	-0.2843	0.0524	<.0001
vltv_DEND_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-20,55-20)	-0.0154	0.0016	<.0001
vltv_DEND_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-55,83-55)	-0.0043	0.0007	<.0001
vltv_DEND_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-83,96-83)	-0.0200	0.0010	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vloanraw_DEND_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-98000,180000-98000)	1.E-06	1.E-07	<.0001
vloanraw_DEND_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-180000,500000-180000)	0.0000	0.0000	<.0001
mDeltaTY10_DEND	**L01**	Categorical of DeltaTy10Init_r^2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.1002	0.0136	<.0001
mcalperiod_DEND	**L200202**	Categorical of Calendar Period	period < 200202	-0.6375	0.0161	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.2689	0.0196	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.3790	0.0270	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.2173	0.0178	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-1.2279	0.1972	<.0001

Default Transition Model Parameters – FRM15 D_CLM

The model parameters for the FRM15 default to claim transition are shown in Table 53.

Table 53: Default to Claim Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-4.0599	0.4506	<.0001
mdpa	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	0.3260	0.1333	0.0144
mdpa	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.2598	0.0359	<.0001
mdpa	**3**	Categorical of dpa (down payment assistance)	dpa = "relative"	-0.2197	0.0508	<.0001
mperiodnbr_DCLM	**L08**	Categorical of period number	period_number <= 8	0.1492	0.0514	0.0037
vperiodnbr_DCLM_pw2		Variate piecewise of period_number	median(0,period_number-8,20-8)	0.0190	0.0052	0.0003
vcredit_DCLM_pw3		Variate piecewise of credit_score	median(0,credit_score-630,800-630)	0.0050	0.0003	<.0001
mdurdefepi_DCLM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	1.3101	0.0573	<.0001
mdurdefepi_DCLM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	1.8200	0.0564	<.0001
mdurdefepi_DCLM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	2.1490	0.0565	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCLM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	2.3954	0.0572	<.0001
mdurdefepi_DCLM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	2.5050	0.0590	<.0001
mdurdefepi_DCLM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 17	2.5222	0.0523	<.0001
mdurdefepi_DCLM	**L18**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 18	2.3120	0.0645	<.0001
vloanraw_DCLM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,48000-0)	-2.E-05	2.E-06	<.0001
vloanraw_DCLM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-48000,200000-48000)	-2.E-06	3.E-07	<.0001
vloanraw_DCLM_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-200000,425000-200000)	-2.E-06	7.E-07	0.004
vdeltaUEinit_DCLM_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-0,80-0)	-0.0091	0.0014	<.0001
vdeltaUEinit_DCLM_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-163,200-163)	0.0076	0.0015	<.0001
vdeltaUEinit_DCLM_pw5		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-200,300-200)	-0.0023	0.0011	0.0415
vratiotmptei_DCLM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,20-0)	0.0133	0.0017	<.0001
vratiotmptei_DCLM_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-20,36-20)	0.0070	0.0024	0.0032
vratiotmptei_DCLM_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0182	0.0078	0.0195
mpriordef_DCLM	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.1533	0.0262	<.0001
mpriordef_DCLM	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.3344	0.0345	<.0001
mpriordef_DCLM	**L03**	Categorical of prior_default_cnt	prior_default_cnt >= 3	-0.4767	0.0391	<.0001
vpriordef_DCLM_pw1		Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,15-3)	-0.1262	0.0163	<.0001
vsato_DCLM_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-(.4))	0.1150	0.0243	<.0001
vltv_DCLM_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,65-0)	0.0231	0.0010	<.0001
vltv_DCLM_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-65,76-65)	0.0377	0.0035	<.0001
vltv_DCLM_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-76,93-76)	0.0520	0.0042	<.0001
mhpa2yb_DCLM	**L085**	Categorical of hpa2y_blended_r[6]	0<hpa2y_blended_r <= 85	0.5712	0.0828	<.0001
vhpa2yb_DCLM_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-85,104-85)	0.0457	0.0037	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vhpa2yb_DCLM_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-104,140-104)	-0.0221	0.0020	<.0001
vDeltaTY1_DCLM_pw1		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-0,87-0)	-0.0030	0.0006	<.0001
vDeltaTY1_DCLM_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-87,150-87)	-0.0031	0.0007	<.0001
vCCI_DCLM_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0179	0.0018	<.0001
vCCI_DCLM_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0115	0.0014	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.3880	0.0929	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	10.8836	1.6435	<.0001
vMTG_RATE30Y_lag4_DCLM1		Variate piecewise of 30 year mortgage rate with 4Q lag	min(MTG_RATE30Y_lag4,5)	-0.1489	0.0317	<.0001
vMTG_RATE30Y_lag4_DCLM2		Variate piecewise of 30 year mortgage rate with 4Q lag	max(MTG_RATE30Y_lag4,5)	-0.0665	0.0311	0.0326
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2004-1999)	0.1552	0.0109	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2004,2014-2004)	-0.0732	0.0068	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	-0.2663	0.0272	<.0001

Default Transition Model Parameters – FRM15 D_CXM

The model parameters for the FRM15 default to modified cure transition are shown in Table 54.

Table 54: Default to Modified Cure Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-5.5806	0.1688	<.0001
vperiodnbr_DCXM_pw1		Variate piecewise of period_number	median(0,period_number-2,10-2)	0.1157	0.0078	<.0001
vperiodnbr_DCXM_pw2		Variate piecewise of period_number	median(0,period_number-10,31-10)	0.0280	0.0017	<.0001
vperiodnbr_DCXM_pw4		Variate piecewise of period_number	median(0,period_number-48,60-48)	0.0551	0.0066	<.0001
mcredit_score_DCXM	**L00**	Categorical of credit_score	credit_score = 0	-0.6017	0.0737	<.0001
vcredit_DCXM_pw1		Variate piecewise of credit_score	median(0,credit_score-450,545-450)	-0.0056	0.0008	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCXM	**L01**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 1	-0.8847	0.0339	<.0001
vdurdefepi_DCXM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-0,3-0)	-0.3128	0.0196	<.0001
vdurdefepi_DCXM_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-3,10-3)	-0.0716	0.0048	<.0001
vdurdefepi_DCXM_pw3		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,20-10)	-0.1244	0.0068	<.0001
vloanraw_DCXM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,62000-0)	8.E-06	1.E-06	<.0001
vloanraw_DCXM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-62000,97000-62000)	4.E-06	7.E-07	<.0001
vloanraw_DCXM_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-97000,200000-97000)	2.E-06	3.E-07	<.0001
vDeltaUEinit_DCXM_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-95,184-95)	0.0021	0.0003	<.0001
mRatioTmpTei_DCXM	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.5865	0.0477	<.0001
vratiotmptei_DCXM_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0259	0.0020	<.0001
vpriordef_DCXM_pw1		Variate piecewise of prior default count	median(0,prior_default_cnt-2,10-2)	-0.0459	0.0051	<.0001
vsato_DCXM_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-(-.56))	0.1750	0.0465	0.0002
vsato_DCXM_pw3		Variate piecewise of sato (spread at origination)	median(sato-(-.15),0,.2-(-.15))	0.1933	0.0604	0.0014
vsato_DCXM_pw4		Variate piecewise of sato (spread at origination)	max(sato-.2,0)	-0.2049	0.0439	<.0001
vltv_DCXM_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,20-0)	0.0208	0.0040	<.0001
vltv_DCXM_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-20,92-20)	0.0057	0.0007	<.0001
vhpa2yb_DCXM_pw1		Variate piecewise of blended hpa	median(0,hpa2y_blended_R-84,100-84)	0.0106	0.0024	<.0001
vhpa2yb_DCXM_pw3		Variate piecewise of blended hpa	median(0,hpa2y_blended_R-116,140-116)	0.0285	0.0017	<.0001
muest_DCXM	**L79**	Categorical of ue_sa_st_r[10] (seasonally adjusted state unemployment)	ue_sa_st_r>790	-0.0639	0.0201	0.0014
mseason_grp_DCXM	**L02**	Categorical of season	season = “spring”	0.1819	0.0174	<.0001
mseason_grp_DCXM	**L03**	Categorical of season	season = “summer”	0.1324	0.0182	<.0001
vCCI_DCXM_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	-0.0167	0.0010	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	-0.2534	0.0446	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.0845	0.0263	0.0013
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.2798	0.0196	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-1.8801	0.3520	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2004-1999)	0.2184	0.0086	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2004,2014-2004)	0.0215	0.0037	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	0.1901	0.0084	<.0001

Default Transition Model Parameters – FRM15 D_CXS

The model parameters for the FRM15 default to self-cure transition are shown in Table 55.

Table 55: Default to Self-Cure Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				1.3235	0.0912	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1	-0.0804	0.0059	<.0001
mperiodnbr_DCXS	**L02**	Categorical of period number	period_number = 2	1.3790	0.0630	<.0001
mperiodnbr_DCXS	**L03**	Categorical of period number	period_number = 3	0.6222	0.0336	<.0001
mperiodnbr_DCXS	**L04**	Categorical of period number	period_number = 4	0.3388	0.0271	<.0001
mperiodnbr_DCXS	**L05**	Categorical of period number	period_number = 5	0.2199	0.0239	<.0001
mperiodnbr_DCXS	**L06**	Categorical of period number	period_number = 6	0.2173	0.0218	<.0001
mperiodnbr_DCXS	**L07**	Categorical of period number	period_number = 7	0.1471	0.0206	<.0001
mperiodnbr_DCXS	**L08**	Categorical of period number	period_number = 8	0.0831	0.0199	<.0001
vperiodnbr_DCXS_pw2		Variate piecewise of period_number	median(0,period_number-31,52-31)	-0.0050	0.0007	<.0001
mcredit_score_DCXS	**L00**	Categorical of credit_score	credit_score = 0	0.4667	0.0197	<.0001
vcredit_DCXS_pw1		Variate piecewise of credit_score	median(0,credit_score-465,643-465)	0.0040	0.0001	<.0001
vcredit_DCXS_pw2		Variate piecewise of credit_score	median(0,credit_score-643,800-643)	0.0014	0.0001	<.0001
mdurdefepi_DCXS	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	-0.6542	0.0075	<.0001
mdurdefepi_DCXS	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	-1.0183	0.0097	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCXS	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	-1.3823	0.0124	<.0001
mdurdefepi_DCXS	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	-1.5280	0.0150	<.0001
mdurdefepi_DCXS	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	-1.6671	0.0178	<.0001
mdurdefepi_DCXS	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <= 7	-1.9438	0.0167	<.0001
vdurdefepi_DCXS_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-6,20-6)	-0.0782	0.0024	<.0001
vloanraw_DCXS_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-0,37000-0)	4.E-06	1.E-06	0.0031
vloanraw_DCXS_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-37000,130000-37000)	7.E-07	1.E-07	<.0001
vdeltaUEinit_DCXS_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-0,78-0)	0.0015	0.0004	0.0002
vdeltaUEinit_DCXS_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-78,107-78)	-0.0028	0.0005	<.0001
vdeltaUEinit_DCXS_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-107,125-107)	-0.0040	0.0008	<.0001
vdeltaUEinit_DCXS_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-125,200-125)	-0.0011	0.0002	<.0001
mRatioTmpTei_DCXS	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.2509	0.0501	<.0001
vratiotmptei_DCXS_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,12-0)	-0.0106	0.0043	0.0138
vratiotmptei_DCXS_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-12,28-12)	-0.0156	0.0008	<.0001
vratiotmptei_DCXS_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-28,50-28)	-0.0065	0.0010	<.0001
mpriordef_DCXS	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.1171	0.0082	<.0001
mpriordef_DCXS	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.1593	0.0096	<.0001
mpriordef_DCXS	**L07**	Categorical of prior_default_cnt	prior_default_cnt >= 7	-0.1362	0.0138	<.0001
mpriordef_DCXS	**PW1**	Categorical of prior_default_cnt	3 <= prior_default_cnt <= 6	-0.1661	0.0086	<.0001
vsato_DCXS_pw1		Variate piecewise of sato (spread at origination)	min(0,sato-(-0.4))	0.0554	0.0152	0.0003
vsato_DCXS_pw2		Variate piecewise of sato (spread at origination)	median(sato-(-.4),0,.14-(-.4))	-0.1077	0.0170	<.0001
vsato_DCXS_pw3		Variate piecewise of sato (spread at origination)	max(sato-.14,0)	-0.0508	0.0153	0.0009
vltv_DCXS_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,19-0)	0.0211	0.0009	<.0001
vltv_DCXS_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-19,83-19)	-0.0083	0.0003	<.0001
vltv_DCXS_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-83,88-83)	-0.0263	0.0044	<.0001
vltv_DCXS_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-88,91-88)	-0.0497	0.0120	<.0001
vltv_DCXS_pw5		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-91,100-91)	-0.0324	0.0119	0.0063
vUEblend_DCXS_pw1		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_R-0,525-0)	-0.0002	0.0001	0.0024

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vUEblend_DCXS_pw2		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_R-525,800-525)	-0.0003	0.0000	<.0001
vUEblend_DCXS_pw3		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_R-800,1500-800)	-0.0002	0.0000	<.0001
vDeltaTY1_DCXS_pw1		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-0,22-0)	-0.0073	0.0007	<.0001
vDeltaTY1_DCXS_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-22,80-22)	0.0016	0.0002	<.0001
mseason_grp_DCXS	**L02**	Categorical of season	season = "spring"	0.1144	0.0070	<.0001
mseason_grp_DCXS	**L03**	Categorical of season	season = "summer"	-0.0326	0.0072	<.0001
vCCI_DCXS_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0033	0.0005	<.0001
vCCI_DCXS_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0247	0.0007	<.0001
vSBOI_DCXS_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0120	0.0017	<.0001
vSBOI_DCXS_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.1070	0.0027	<.0001
m_product	**FRM15SR**	Categorical of product	product = "FRM15SR"	0.1409	0.0126	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.2405	0.0155	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.2567	0.0141	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	6.9458	0.2243	<.0001

Default Transition Model Parameters – FRM15 D_END

The model parameters for the fixed rate 15-year mortgage default to end transition are shown in Table 56.

Table 56: Default to End Transition FRM15 Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-1.2359	0.1473	<.0001
vhpa2yb_DEND_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_R-104,140-104)	0.0197	0.0011	<.0001
vperiodnbr_DEND_pw2		Variate piecewise of period_number	median(0,period_number-30,52-30)	0.0040	0.0020	0.0468
vperiodnbr_DEND_pw3		Variate piecewise of period_number	median(0,period_number-52,60-52)	0.1551	0.0056	<.0001
mcredit_score_DEND	**L00**	Categorical of credit_score	credit_score = 0	0.7503	0.0416	<.0001
vcredit_DEND_pw1		Variate piecewise of credit_score	median(0,credit_score-470,800-470)	0.0042	0.0002	<.0001
vdurdefepi_DEND_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode,12)	-0.1515	0.0029	<.0001
vdurdefepi_DEND_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-12,54-12)	0.0069	0.0021	0.001
vloanraw_DEND_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-55000,120000-55000)	2.E-06	4.E-07	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vloanraw_DEND_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-120000,200000-120000)	4.E-06	4.E-07	<.0001
vdeltaUEinit_DEND_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_R-0,175-0)	0.0016	0.0003	<.0001
mpriordef_DEND	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.3925	0.0209	<.0001
mpriordef_DEND	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.5784	0.0259	<.0001
mpriordef_DEND	**L03**	Categorical of prior_default_cnt	prior_default_cnt >= 3	-0.8095	0.0258	<.0001
vpriordef_DEND_pw1		Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-3,14-3)	-0.0474	0.0068	<.0001
vUEblend_DEND_pw1		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_R-0,800-0)	-0.0012	0.0001	<.0001
vUEblend_DEND_pw2		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_R-800,1500-800)	-0.0010	0.0001	<.0001
mltv_DEND	**Miss**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i = .	-0.4605	0.0420	<.0001
vltv_DEND_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-0,63-0)	-0.0150	0.0009	<.0001
vltv_DEND_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_R-63,100-63)	-0.0195	0.0014	<.0001
vDeltaTY1_DEND_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-6,200-6)	0.0009	0.0002	<.0001
Mperiod_DEND	**L01**	Categorical of period (calendar period)	period < 200603	0.2007	0.0372	<.0001
mseason_grp_DEND	**L02**	Categorical of season	season = "spring"	0.0598	0.0186	0.0013
mseason_grp_DEND	**L03**	Categorical of season	season = "summer"	0.0914	0.0192	<.0001
vSBOI_DEND_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0251	0.0045	<.0001
vSBOI_DEND_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	0.0336	0.0052	<.0001
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.4810	0.0428	<.0001
v_UE_CW_growthQ_lag1_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	-0.0962	0.0352	0.0062
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.0847	0.0304	0.0053
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	2.5511	0.5518	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 (judicial state)	-0.0765	0.0155	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2004-1999)	-0.0459	0.0066	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2004,2014-2004)	-0.0143	0.0041	0.0006

Default Transition Model Parameters – ARM D_CLM

The model parameters for the ARM default to claim transition are shown in Table 57.

Table 57: Default to Claim Transition ARM Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-1.2795	0.4794	0.0076
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 , judicial state	-0.1504	0.0103	<.0001
mdpa	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	0.3380	0.0446	<.0001
mdpa	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.3886	0.0163	<.0001
mdpa	**3**	Categorical of dpa (down payment assistance)	dpa = "relative"	0.0478	0.0168	0.0045
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.1798	0.0130	<.0001
vperiodnbr_DCLM_pw1		Variate piecewise of period_number	median(0,period_number-0,9-0)	-0.0737	0.0097	<.0001
vperiodnbr_DCLM_pw2		Variate piecewise of period_number	median(0,period_number-9,15-9)	0.0211	0.0039	<.0001
vperiodnbr_DCLM_pw3		Variate piecewise of period_number	median(0,period_number-15,55-15)	-0.0204	0.0009	<.0001
mcredit_DCLM	**L01**	Categorical of credit_score	credit_score = 0	0.6115	0.0643	<.0001
vcredit_DCLM_pw1		Variate piecewise of credit_score	median(0,credit_score-300,720-300)	0.0022	0.0002	<.0001
vcredit_DCLM_pw2		Variate piecewise of credit_score	median(0,credit_score-720,800-720)	0.0070	0.0009	<.0001
mdurdefepi_DCLM	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.6265	0.0249	<.0001
mdurdefepi_DCLM	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	1.3549	0.0233	<.0001
mdurdefepi_DCLM	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	1.6447	0.0236	<.0001
mdurdefepi_DCLM	**L05**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	1.7028	0.0246	<.0001
mdurdefepi_DCLM	**L06**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	1.7107	0.0258	<.0001
mdurdefepi_DCLM	**L07**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	1.7016	0.0271	<.0001
mdurdefepi_DCLM	**L08**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	1.6563	0.0287	<.0001
mdurdefepi_DCLM	**L09**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	1.6082	0.0305	<.0001
mdurdefepi_DCLM	**L10**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	1.5878	0.0322	<.0001
mdurdefepi_DCLM	**L11**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 11	1.5519	0.0265	<.0001
vdurdefepi_DCLM_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	-0.0239	0.0022	<.0001
vdurdefepi_DCLM_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	-0.0452	0.0076	<.0001
vdeltaUEinit_dclm_pw2		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-63,100-63)	-0.0084	0.0007	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdeltaUEinit_dclm_pw3		Variate piecewise of DeltaUEInit r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit r-100,116-100)	0.0043	0.0011	<.0001
vdeltaUEinit_dclm_pw5		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-218,330-218)	0.0017	0.0004	<.0001
mRatioTmpTei_DCLM	**L00**	Categorical of ratio tmp tei (front-end ratio)	ratio_tmp_tei=0	-0.1812	0.0251	<.0001
vratiotmptei_DCLM_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio tmp tei-24,36-24)	0.0049	0.0015	0.0008
vratiotmptei_DCLM_pw3		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-36,50-36)	-0.0143	0.0031	<.0001
mpriordef_DCLM	**L00**	Categorical of prior_default_cnt	prior_default_cnt = 0	0.1524	0.0150	<.0001
vpriordef_DCLM_pw1		Variate piecewise of prior default count	median(0,prior default cnt-0,6-0)	-0.1003	0.0056	<.0001
vpriordef_DCLM_pw2		Variate piecewise of prior default count	median(0,prior_default_cnt-6,20-6)	-0.1041	0.0124	<.0001
vloanraw_DCLM_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-30000,109000-30000)	-4.E-06	3.E-07	<.0001
vloanraw_DCLM_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-109000,143000-109000)	4.E-06	3.E-07	<.0001
vloanraw_DCLM_pw3		Variate piecewise of loansize_raw	median(0,loansize raw-143000,200000-143000)	-2.E-06	1.E-07	<.0001
mltv_DCLM	**L01**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	-0.1473	0.0927	0.1123
vltv_DCLM_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,70-0)	0.0183	0.0017	<.0001
vltv_DCLM_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-70,81-70)	0.0115	0.0023	<.0001
vltv_DCLM_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-81,94-81)	0.0195	0.0018	<.0001
vltv_DCLM_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-94,100-94)	0.0351	0.0144	0.015
mhpa2yb_DCLM	**L085**	Categorical of hpa2y_blended_r[6]	hpa2y_blended_r <= 85	0.2753	0.0311	<.0001
vhpa2yb_DCLM_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,98-85)	0.0068	0.0026	0.0093
vhpa2yb_DCLM_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y blended r-98,108-98)	0.0290	0.0023	<.0001
vhpa2yb_DCLM_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-108,130-108)	-0.0283	0.0011	<.0001
vhpa2yb_DCLM_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-130,180-130)	-0.0663	0.0042	<.0001
vUEblend_DCLM_pw2		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-450,850-450)	-0.0001	0.0001	0.0206
vUEblend_DCLM_pw3		Variate piecewise of ue blended r[8] (change in unemployment rate)	median(0,ue_blended_r-850,1500-850)	0.0003	0.0001	<.0001
vdeltaUEpr3_DCLM_pw1		Variate piecewise of deltaueprr3 r[5] (change in unemployment from 3 quarters prior)	median(deltaueprr3 r-(-200),0,(-20)-(-200))	-0.0015	0.0002	<.0001
vprior3uest_DCLM_pw1		Variate piecewise of prior3 ue sa st (change in prior-3 seasonally adjusted unemployment rate)	median(2.4,prior3_ue_sa_st,5)	0.1995	0.0155	<.0001
mDeltaTY10_DCLM	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	0.2359	0.0163	<.0001
vCCI_DCLM_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0020	0.0005	<.0001
vCCI_DCLM_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0141	0.0012	<.0001
vSBOI_DCLM_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.1006	0.0059	<.0001
vSBOI_DCLM_pw3		Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	0.0383	0.0042	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
m_product	ARMSR	Categorical of product	product = "ARMSR"	0.3625	0.0259	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.2588	0.0887	0.0035
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	22.0063	2.1729	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2004,2014-2004)	-0.0960	0.0036	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2014,2022-2014)	-0.3373	0.0467	<.0001

Default Transition Model Parameters – ARM D_CXM

The model parameters for the ARM default to modified cure transition are shown in Table 58.

Table 58: Default to Modified Cure Transition ARM Model Parameters

Parameter	Level	DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
Intercept		1			-5.7719	0.1629	1255.606	<.0001
mdpa_DCXM	2	1	Categorical of dpa (down payment assistance)	dpa= "nonprof"	0.1558	0.0169	85.2007	<.0001
mdpa_DCXM	3	1	Categorical of dpa (down payment assistance)	dpa = "govt" or dpa = "relative"	0.0398	0.0168	5.6073	0.0179
mycslope_DCXM	L01	1	Categorical of ycslope_r9 (yield curve slope)	ycslope_r<=111	-0.1215	0.0290	17.5083	<.0001
mycslope_DCXM	L02	1	Categorical of ycslope_r9 (yield curve slope)	ycslope_r>=875	-0.0489	0.0240	4.128	0.0422
mycslope_DCXM	L03	1	Categorical of ycslope_r9 (yield curve slope)	ycslope_r>=2000	0.3071	0.0250	150.6181	<.0001
mperiodnbr_DCXM	L05	1	Categorical of period_number	period_number <= 5	-0.9205	0.0770	142.8629	<.0001
vperiodnbr_DCXM_pw1		1	Variate piecewise of period_number	median(0,period_number-5,9-5)	0.0381	0.0028	184.0668	<.0001
vperiodnbr_DCXM_pw2		1	Variate piecewise of period_number	median(0,period_number-9,18-9)	0.0105	0.0014	55.0368	<.0001
vperiodnbr_DCXM_pw3		1	Variate piecewise of period_number	median(0,period_number-18,36-18)	0.0360	0.0021	292.7309	<.0001
vperiodnbr_DCXM_pw4		1	Variate piecewise of period_number	median(0,period_number-36,50-36)	0.0101	0.0014	53.8269	<.0001
mcredit_DCXM	L01	1	Categorical of credit_score	credit_score = 0	-0.1575	0.0311	25.5756	<.0001
vcredit_DCXM_pw1		1	Variate piecewise of credit_score	median(0,credit_score-525,645-525)	-0.0014	0.0003	30.9883	<.0001
vcredit_DCXM_pw2		1	Variate piecewise of credit_score	median(0,credit_score-645,800-645)	-0.0008	0.0003	6.3155	0.012
vdurdefepi_DCXM_pw2		1	Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-7,40-7)	-0.1082	0.0024	2065.777	<.0001
vdeltaUEinit_DCXM_pw1		1	Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-0,63-0)	0.0081	0.0014	33.4347	<.0001
vdeltaUEinit_DCXM_pw2		1	Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,deltaUEinit_r-63,100-63)	-0.0028	0.0005	37.6412	<.0001
vdeltaUEinit_DCXM_pw3		1	Variate piecewise of DeltaUEInit_r^4 (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-116,218-116)	0.0030	0.0002	161.4948	<.0001

Parameter	Level	DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
mRatioTmpTei_DCXM	**L00**	**1**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	0.3737	0.0494	57.2921	<.0001
vratiotmptei_DCXM_pw1		**1**	Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	0.0214	0.0019	123.2927	<.0001
mpriordef_DCXM	**L00**	**1**	Categorical of prior_default_cnt	prior_default_cnt = 0	-0.2188	0.0175	155.7249	<.0001
vpriordef_DCXM_pw1		**1**	Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-0,5-0)	0.0561	0.0050	124.1363	<.0001
vpriordef_DCXM_pw2		**1**	Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-5,22-5)	-0.0279	0.0045	37.8957	<.0001
vloanraw_DCXM_pw1		**1**	Variate piecewise of loansize_raw	median(30000,loansize_raw,109000)	6.E-06	5.E-07	199.7698	<.0001
vloanraw_DCXM_pw2		**1**	Variate piecewise of loansize_raw	median(0,loansize_raw-109000,143000-109000)	2.E-06	5.E-07	17.039	<.0001
vltv_DCXM_pw1		**1**	Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,68-0)	0.0038	0.0015	6.3313	0.0119
vltv_DCXM_pw2		**1**	Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-68,81-68)	0.0102	0.0020	26.7371	<.0001
vhpa2yb_DCXM_pw1		**1**	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,98-85)	-0.0043	0.0019	5.2046	0.0225
vhpa2yb_DCXM_pw2		**1**	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-98,108-98)	-0.0444	0.0027	263.3065	<.0001
vhpa2yb_DCXM_pw3		**1**	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-108,117-108)	0.0044	0.0026	2.9643	0.0851
vhpa2yb_DCXM_pw4		**1**	Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,180-117)	-0.0107	0.0017	41.7223	<.0001
vdeltaUEpr3_DCXM_pw3		**1**	Variate piecewise of deltaueprr3_r[5] (change in unemployment from 3 quarters prior)	median(deltaueprr3_r-10,0,200-10)	-0.0032	0.0002	309.444	<.0001
vprior3uest_DCXM_pw2		**1**	Variate piecewise of prior3_ue_sa_st (change in prior-3 seasonally adjusted unemployment rate)	median(0,prior3_ue_sa_st-5,12.3-5)	-0.0526	0.0048	121.6802	<.0001
mDeltaTY10_DCXM	**L01**	**1**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.3471	0.0160	470.7453	<.0001
mseason_grp_DCXM	**L02**	**1**	Categorical of season	season = "spring"	0.1825	0.0130	197.4167	<.0001
mseason_grp_DCXM	**L03**	**1**	Categorical of season	season = "summer"	0.1335	0.0145	84.5392	<.0001
vCCI_DCXM_pw1		**1**	Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0076	0.0011	45.737	<.0001
vCCI_DCXM_pw2		**1**	Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	0.0676	0.0020	1125.039	<.0001
vCCI_DCXM_pw3		**1**	Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0215	0.0029	54.4187	<.0001
vSBOI_DCXM_pw1		**1**	Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.1562	0.0041	1482.773	<.0001
vSBOI_DCXM_pw2		**1**	Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.2023	0.0086	557.3099	<.0001
m_product	**ARMSR**	**1**	Categorical of product	product = "ARMSR"	0.0935	0.0272	11.8323	0.0006
v_UE_CW_growthQ_lag1_pw1		**1**	Variate piecewise of country wide unemployment rate quarterly growth with 1Q lag	max(0.4,UE_CW_growthQ_lag1)	0.6153	0.0384	256.3103	<.0001
v_UE_CW_growthQ_lag2_pw1		**1**	Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	0.8460	0.0322	689.0782	<.0001

Parameter	Level	DF	Description	Description Detail	Estimate	StdErr	Wald	Pr > ChiSq
v_TR1Q_growthY_lag3_DCXM_pw1		**1**	Variate piecewise of quarterly treasure rate yearly growth with 3Q lag	min(TR1Q_growthY_lag3,0)	0.1812	0.0230	61.9578	<.0001
v_TR1Q_growthY_lag3_DCXM_pw2		**1**	Variate piecewise of quarterly treasure rate yearly growth with 3Q lag	median(0,TR1Q_growthY_lag3, 5)	-0.1163	0.0071	265.5877	<.0001
v_TR1Q_growthY_lag3_DCXM_pw3		**1**	Variate piecewise of quarterly treasure rate yearly growth with 3Q lag	max(TR1Q_growthY_lag3,5)	0.1046	0.0076	189.9995	<.0001
vcredit_subsidy_cohort_pw0			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -1999,2004-1999)	0.1562	0.0057	757.8428	<.0001
vcredit_subsidy_cohort_pw1			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2004,2014-2004)	0.0751	0.0038	390.7771	<.0001
vcredit_subsidy_cohort_pw2			Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort -2014,2022-2014)	0.2300	0.0118	379.3153	<.0001

Default Transition Model Parameters – ARM D_CXS

The model parameters for the ARM default to self-cure transition are shown in Table 59.

Table 59: Default to Self-Cure Transition ARM Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				0.4913	0.0810	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 , judicial state	-0.1342	0.0053	<.0001
mpda_DCXS	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	-0.1429	0.0283	<.0001
mpda_DCXS	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	-0.1810	0.0092	<.0001
mrfnc_ind	**2**	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	-0.1222	0.0103	<.0001
mycslope_DCXS	**L01**	Categorical of ycslope_r9 (yield curve slope)	ycslope_r<=111	-0.1648	0.0110	<.0001
mycslope_DCXS	**L02**	Categorical of ycslope_r9 (yield curve slope)	ycslope_r>=875	0.0648	0.0100	<.0001
mperiodnbr_DCXS	**L02**	Categorical of period_number	period_number <= 2	1.5957	0.0851	<.0001
mperiodnbr_DCXS	**L03**	Categorical of period_number	period_number = 3	0.6474	0.0377	<.0001
mperiodnbr_DCXS	**L04**	Categorical of period_number	period_number = 4	0.1540	0.0307	<.0001
vperiodnbr_DCXS_pw1		Variate piecewise of period_number	median(0,period_number-5,9-5)	-0.0610	0.0051	<.0001
vperiodnbr_DCXS_pw2		Variate piecewise of period_number	median(0,period_number-9,18-9)	0.0116	0.0009	<.0001
vperiodnbr_DCXS_pw3		Variate piecewise of period_number	median(0,period_number-18,36-18)	0.0096	0.0012	<.0001
vperiodnbr_DCXS_pw4		Variate piecewise of period_number	median(0,period_number-36,50-36)	0.0057	0.0010	<.0001
mcredit_DCXS	**L01**	Categorical of credit_score	credit_score = 0	0.1527	0.0188	<.0001
vcredit_DCXS_pw1		Variate piecewise of credit_score	median(0,credit_score-525,645-525)	0.0019	0.0002	<.0001
vcredit_DCXS_pw2		Variate piecewise of credit_score	median(0,credit_score-645,800-645)	0.0011	0.0002	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
mdurdefepi_DCXS	**L01**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode <=1	1.4943	0.0096	<.0001
mdurdefepi_DCXS	**L02**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	0.8902	0.0104	<.0001
mdurdefepi_DCXS	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	0.5451	0.0115	<.0001
mdurdefepi_DCXS	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	0.1985	0.0131	<.0001
vdurdefepi_DCXS_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-5,7-5)	-0.1375	0.0024	<.0001
vdurdefepi_DCXS_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-7,40-7)	-0.0139	0.0012	<.0001
vdeltaUEinit_DCXS_pw3		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-100,116-100)	-0.0034	0.0005	<.0001
vdeltaUEinit_DCXS_pw4		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-116,218-116)	-0.0009	0.0001	<.0001
mRatioTmpTei_DCXS	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.2533	0.0212	<.0001
vratiotmptei_DCXS_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	-0.0100	0.0009	<.0001
vratiotmptei_DCXS_pw2		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-24,36-24)	-0.0076	0.0008	<.0001
mpriordef_DCXS	**L00**	Categorical of prior_default_cnt	prior_default_cnt = 0	0.0719	0.0071	<.0001
vpriordef_DCXS_pw1		Variate piecewise of prior_default_cnt	median(0,prior_default_cnt-0,22-0)	-0.0063	0.0012	<.0001
vloanraw_DCXS_pw1		Variate piecewise of loansize_raw	median(30000,loansize_raw,143000)	-7.E-07	1.E-07	<.0001
vloanraw_DCXS_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-143000,200000-143000)	-3.E-06	2.E-07	<.0001
vloanraw_DCXS_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-200000,425000-200000)	-4.E-07	8.E-08	<.0001
vdeltaUEpr3_DCXS_pw3		Variate piecewise of deltauepr3_r5 (change in unemployment from 3 quarters prior)	median(deltauepr3_r-10,0,200-10)	-0.0015	0.0001	<.0001
mltv_DCXS	**L01**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	0.2189	0.0306	<.0001
vltv_DCXS_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,68-0)	-0.0044	0.0005	<.0001
vltv_DCXS_pw2		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-68,81-68)	-0.0105	0.0010	<.0001
vltv_DCXS_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-81,91-81)	-0.0093	0.0013	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vltv_DCXS_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-91,100-91)	-0.0343	0.0034	<.0001
vhpa2yb_DCXS_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,98-85)	0.0058	0.0010	<.0001
vhpa2yb_DCXS_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-108,117-108)	0.0082	0.0010	<.0001
vhpa2yb_DCXS_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,130-117)	-0.0031	0.0011	0.0057
vhpa2yb_DCXS_pw5		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-130,180-130)	0.0089	0.0012	<.0001
vprior3uest_DCXS_pw1		Variate piecewise of prior3_ue_sa_st (change in prior-3 seasonally adjusted unemployment rate)	median(2.5,prior3_ue_sa_st,5)	-0.0385	0.0061	<.0001
vprior3uest_DCXS_pw2		Variate piecewise of prior3_ue_sa_st (change in prior-3 seasonally adjusted unemployment rate)	median(0,prior3_ue_sa_st-5,12.1-5)	-0.0322	0.0025	<.0001
mDeltaTY10_DCXS	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.0357	0.0081	<.0001
vDeltaTY1_DCXS_pw1		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-0,22-0)	-0.0067	0.0006	<.0001
vDeltaTY1_DCXS_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-22,80-22)	0.0015	0.0002	<.0001
vDeltaTY1_DCXS_pw3		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-80,150-80)	0.0005	0.0002	0.0015
mseason	**1**	Categorical of season	season = "winter"	0.1660	0.0072	<.0001
mseason	**2**	Categorical of season	season = "spring"	0.2296	0.0074	<.0001
mseason	**3**	Categorical of season	season = "summer"	0.0752	0.0076	<.0001
vCCI_DCXS_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-50,92-50)	0.0060	0.0005	<.0001
vCCI_DCXS_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-92,110-92)	0.0150	0.0007	<.0001
vCCI_DCXS_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	0.0167	0.0010	<.0001
vSBOI_DCXS_pw1		Variate piecewise of small business optimism index	median(0,SBOI_r-83,95-83)	-0.0380	0.0023	<.0001
vSBOI_DCXS_pw2		Variate piecewise of small business optimism index	median(0,SBOI_r-95,100-95)	-0.0814	0.0025	<.0001
vSBOI_DCXS_pw3		Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	-0.0152	0.0027	<.0001
m_product	**ARMSR**	Categorical of product	product = "ARMSR"	0.0311	0.0151	0.0396

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
v_UE_CW_growthQ_pw1		Variate piecewise of country wide unemployment rate quarterly growth	max(0.4,UE_CW_growthQ)	0.1601	0.0158	<.0001
v_UE_CW_growthQ_lag2_pw1		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	max(0.4,UE_CW_growthQ_lag2)	-0.1315	0.0175	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	6.7026	0.2698	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2004,2014-2004)	0.0225	0.0017	<.0001

Default Transition Model Parameters – ARM D_END

The model parameters for the ARM default to end transition are shown in Table 60.

Table 60: Default to End Transition ARM Model Parameters

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
Intercept				-4.8653	0.2137	<.0001
mjudicial	**1**	Categorical of judicial (judicial state)	judicial = 1 , judicial state	-0.1808	0.0124	<.0001
mpda_DEND	**1**	Categorical of dpa (down payment assistance)	dpa = "govt"	-0.4272	0.0910	<.0001
mpda_DEND	**2**	Categorical of dpa (down payment assistance)	dpa= "nonprof"	-0.3593	0.0303	<.0001
mfrst_tm_by	**1**	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	-0.0956	0.0145	<.0001
mycslope_DEND	**L01**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r<=111	0.1745	0.0218	<.0001
mycslope_DEND	**L02**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=875	-0.5750	0.0333	<.0001
mycslope_DEND	**L03**	Categorical of ycslope_r[9] (yield curve slope)	ycslope_r>=2000	-0.4652	0.0408	<.0001
mperiodnbr_DEND	**L02**	Categorical of period_number	period_number <= 2	1.0712	0.3197	0.0008
mperiodnbr_DEND	**L03**	Categorical of period_number	period_number = 3	0.2733	0.1176	0.0201
vperiodnbr_DEND_pw3		Variate piecewise of period_number	median(0,period_number-18,38-18)	0.0094	0.0014	<.0001
vperiodnbr_DEND_pw4		Variate piecewise of period_number	median(0,period_number-38,68-38)	0.0022	0.0013	0.0954
mcredit_DEND	**L01**	Categorical of credit_score	credit_score = 0	0.1151	0.0656	0.0794
vcredit_DEND_pw1		Variate piecewise of credit_score	median(0,credit_score-525,645-525)	0.0019	0.0005	0.0005
vcredit_DEND_pw2		Variate piecewise of credit_score	median(0,credit_score-645,800-645)	0.0031	0.0004	<.0001
mdurdefepi_DEND	**L01**	Categorical of dur_def episode (duration of default episode)	dur_def_episode <=1	0.6827	0.0261	<.0001
mdurdefepi_DEND	**L02**	Categorical of dur_def episode (duration of default episode)	dur_def_episode = 2	0.3343	0.0281	<.0001
mdurdefepi_DEND	**L03**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	0.1432	0.0305	<.0001
mdurdefepi_DEND	**L04**	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	0.1167	0.0322	0.0003

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vdurdefepi_DEND_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-5,7-5)	-0.0868	0.0134	<.0001
vdurdefepi_DEND_pw3		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-24,40-24)	-0.0171	0.0029	<.0001
vdeltaUEinit_DEND_pw1		Variate piecewise of DeltaUEInit_r[4] (change in unemployment rate from policy inception to current)	median(0,DeltaUEInit_r-0,63-0)	0.0059	0.0016	0.0003
mRatioTmpTei_DEND	**L00**	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	-0.2430	0.0470	<.0001
vratiotmptei_DEND_pw1		Variate piecewise of ratio_tmp_tei (front-end ratio)	median(0,ratio_tmp_tei-0,24-0)	-0.0132	0.0017	<.0001
mpriordef_DEND	**L01**	Categorical of prior_default_cnt	prior_default_cnt = 1	-0.1877	0.0151	<.0001
mpriordef_DEND	**L02**	Categorical of prior_default_cnt	prior_default_cnt = 2	-0.3567	0.0202	<.0001
mpriordef_DEND	**L03**	Categorical of prior_default_cnt	3 <= prior_default_cnt	-0.4576	0.0239	<.0001
vpriordef_DEND_pw1		Variate piecewise of prior default count	median(0,prior_default_cnt-3,6-3)	-0.1604	0.0133	<.0001
vpriordef_DEND_pw2		Variate piecewise of prior default count	median(0,prior_default_cnt-6,14-6)	-0.0424	0.0091	<.0001
vloanraw_DEND_pw1		Variate piecewise of loansize_raw	median(30000,loansize_raw,143000)	5.E-06	2.E-07	<.0001
vloanraw_DEND_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-200000,425000-200000)	9.E-07	2.E-07	<.0001
mltv_DEND	**L01**	Categorical of ltv_i_r[7] (loan-to-value)	ltv_i_r = .	0.4947	0.0676	<.0001
vltv_DEND_pw1		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-0,68-0)	-0.0062	0.0014	<.0001
vltv_DEND_pw3		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-81,91-81)	-0.0127	0.0025	<.0001
vltv_DEND_pw4		Variate piecewise of ltv_i_r[7] (loan-to-value)	median(0,ltv_i_r-91,100-91)	-0.1108	0.0070	<.0001
vhpa2yb_DEND_pw1		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-85,98-85)	0.0150	0.0039	0.0001
vhpa2yb_DEND_pw2		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-98,108-98)	0.0274	0.0036	<.0001
vhpa2yb_DEND_pw3		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-108,117-108)	0.0567	0.0023	<.0001
vhpa2yb_DEND_pw4		Variate piecewise of hpa2y_blended_r[6]	median(0,hpa2y_blended_r-117,180-117)	0.0268	0.0008	<.0001
vUEblend_DEND_pw1		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(200,ue_blended_r,450)	-0.0015	0.0002	<.0001
vUEblend_DEND_pw3		Variate piecewise of ue_blended_r[8] (change in unemployment rate)	median(0,ue_blended_r-850,1500-850)	-0.0008	0.0001	<.0001
mDeltaTY10_DEND	**L01**	Categorical of DeltaTy10Init_r[2] (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	-0.0665	0.0266	0.0123
vDeltaTY1_DEND_pw1		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-0,22-0)	0.0187	0.0021	<.0001
vDeltaTY1_DEND_pw2		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-22,80-22)	0.0037	0.0005	<.0001
vDeltaTY1_DEND_pw3		Variate piecewise of DeltaTy1Init_r[3] (change in 1-year Treasury rate from policy inception to current)	median(0,DeltaTy1Init_R-80,150-80)	0.0047	0.0004	<.0001
mseason_grp_DEND	**L02**	Categorical of season	season = "spring"	0.1368	0.0142	<.0001
mseason_grp_DEND	**L03**	Categorical of season	season = "summer"	0.1254	0.0143	<.0001
vCCI_DEND_pw1		Variate piecewise of consumer confidence index	median(0,CCI_r-30,75-30)	0.0035	0.0014	0.0136
vCCI_DEND_pw2		Variate piecewise of consumer confidence index	median(0,CCI_r-75,110-75)	-0.0054	0.0009	<.0001

Parameter	Level	Description	Description Detail	Estimate	StdErr	Pr > ChiSq
vCCI_DEND_pw3		Variate piecewise of consumer confidence index	median(0,CCI_r-110,134-110)	-0.0080	0.0020	<.0001
vSBOI_DEND_pw3		Variate piecewise of small business optimism index	median(0,SBOI_r-100,108-100)	0.0371	0.0044	<.0001
m_product	**ARMSR**	Categorical of product	product = "ARMSR"	-0.1416	0.0334	<.0001
v_UE_CW_growthQ_lag2_pw2		Variate piecewise of country wide unemployment rate quarterly growth with 2Q lag	min(UE_CW_growthQ_lag2, -0.2)	-5.1073	0.6322	<.0001
vcredit_subsidy_cohort_pw0		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 1999,2004-1999)	-0.1321	0.0063	<.0001
vcredit_subsidy_cohort_pw1		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2004,2014-2004)	-0.0319	0.0050	<.0001
vcredit_subsidy_cohort_pw2		Variate piecewise of credit subsidy cohort	median(0, credit_subsidy_cohort - 2014,2022-2014)	0.1377	0.0182	<.0001

cx_time[1] = time since last condition D

DeltaTy10Init_r[2] = round(DeltaTy10Init*100,1)

DeltaTy1Init_r[3] = round(DeltaTy1Init*100,1)

DeltaUEInit_r[4] = round(100*DeltaUEInit,1)

deltaueprr3_r[5] = round(delta_ue_sa_st*100,1)

hpa2y_blended_r[6] = round(hpa2y_blended*100,1); HPA2Y = 2 year house price appreciation

ltv_i_r[7] = round(ltv_i*100,1)

ue_blended_r[8] = round(ue_blended*100,1)

ycslope_r[9] = round(ycslope*100,1)

ue_sa_st_r[10] = round(ue_sa_st*100,1)

prior3_ue_r[11] = round(prior3_ue_sa_st*100,1) state unemployment 3rd prior quarter

DeltaTm3Init_r[12] = Round(DeltaTm3Init*100,1)

refi_incent2_r[13] = round(100*int_rt/frm30_rate,1); int_rt = loan interest rate; frm30_rate = current frm30 rate

Section 4: Model Validation

Model validation was accomplished in part by applying the model structure developed using the training set to the validation dataset. The application of the model to the validation data produces the probability of each type of transition. The actual target variable is then compared to the predicted target variable to ensure the model fits the transition process without over-fitting the actual data.

Specifically, for the final condition transition state, we calculate the actual transition rate and the predicted transition rate. The actual transition is 1 for the final transition state of the record and 0 for all other transition states. The probability of each final transition state for each record in the validation dataset is derived from the model parameters. The sum of all predicted final condition transition states' probabilities is 1 for each record.

Simple quantile plots are then created for each final condition transition state. All records are sorted in increasing order by the predicted probability. Ten equal sized decile groups are created with 10% of the records in each group. The sum of the actual probability and the sum of the predicted probability for each ending condition within each decile is calculated. The total number of actual and predicted transitions are compared for consistency. The objective of a model is to have a significant spread in predicted values while maintaining a close relationship between the resulting actual and predicted values.

The validation charts shown below show that the spread in prediction is consistent between the actual and predicted experience, and the actual vs. predicted ratio for each decile are consistent as well.

Current FRM30NSR Transition Models

The validation charts by ending condition for the FRM30NSR models are shown in Figures 16 through 19.

Figure 16: Current FRM30NSR Transition Model Validation - Ending Condition Streamlined Refinance

Figure 17: Current FRM30NSR Transition Model Validation - Ending Condition Prepayment

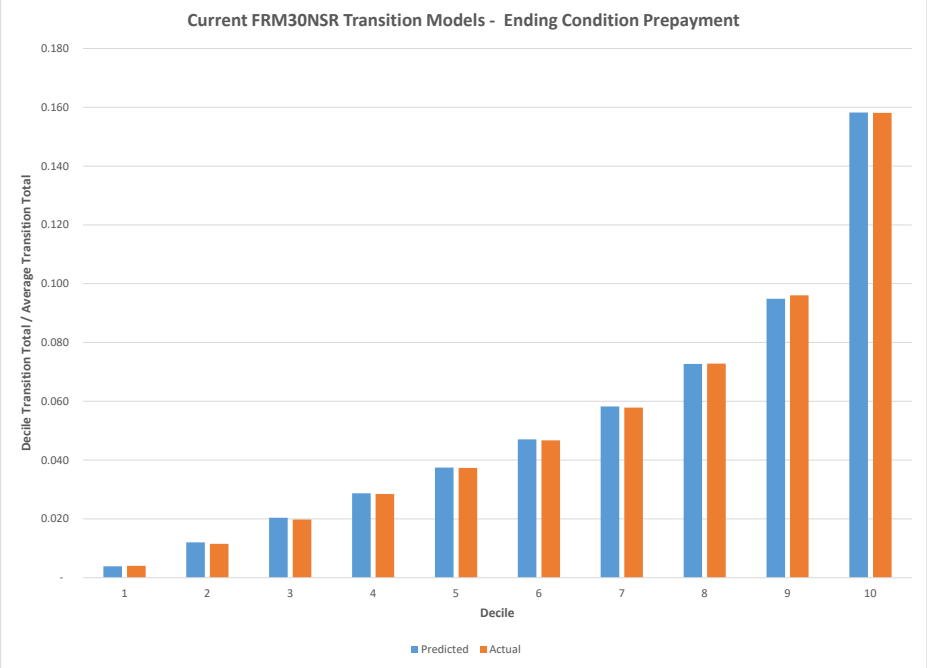


Figure 18: Current FRM30NSR Transition Model Validation - Ending Condition Self-Cure

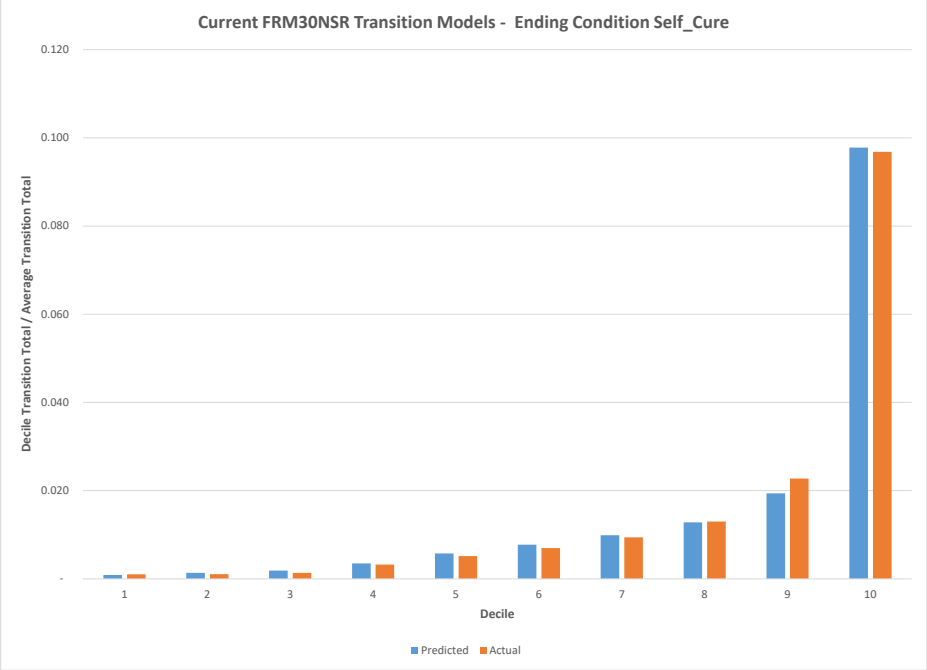
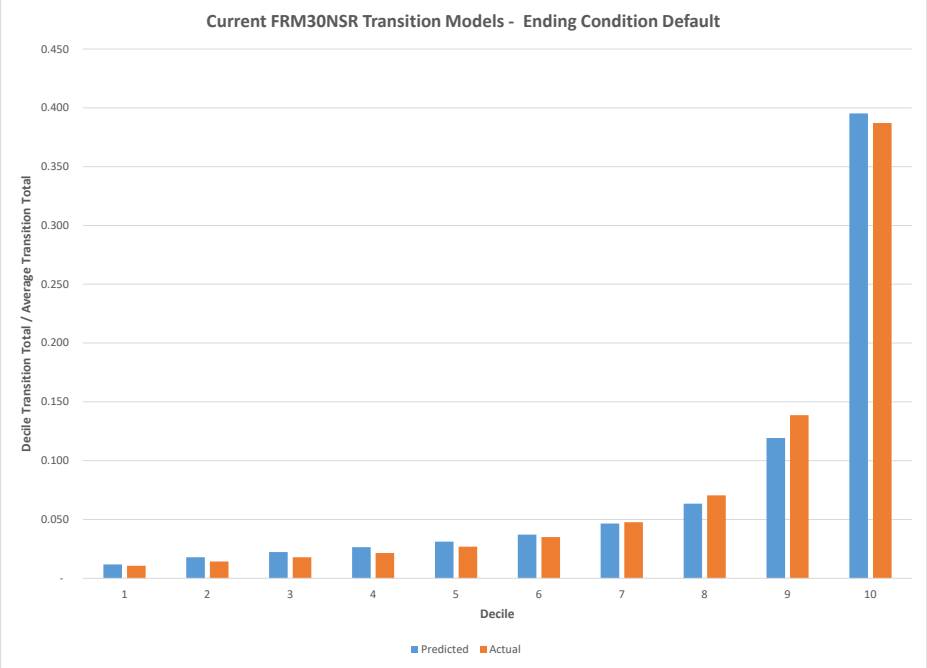


Figure 19: Current FRM30NSR Transition Model Validation - Ending Condition Default



Current FRM30SR Transition Models

The validation charts by ending condition for the FRM30SR models are shown in Figures 20 through 22.

Figure 20: Current FRM30SR Transition Model Validation - Ending Condition Self-Cure

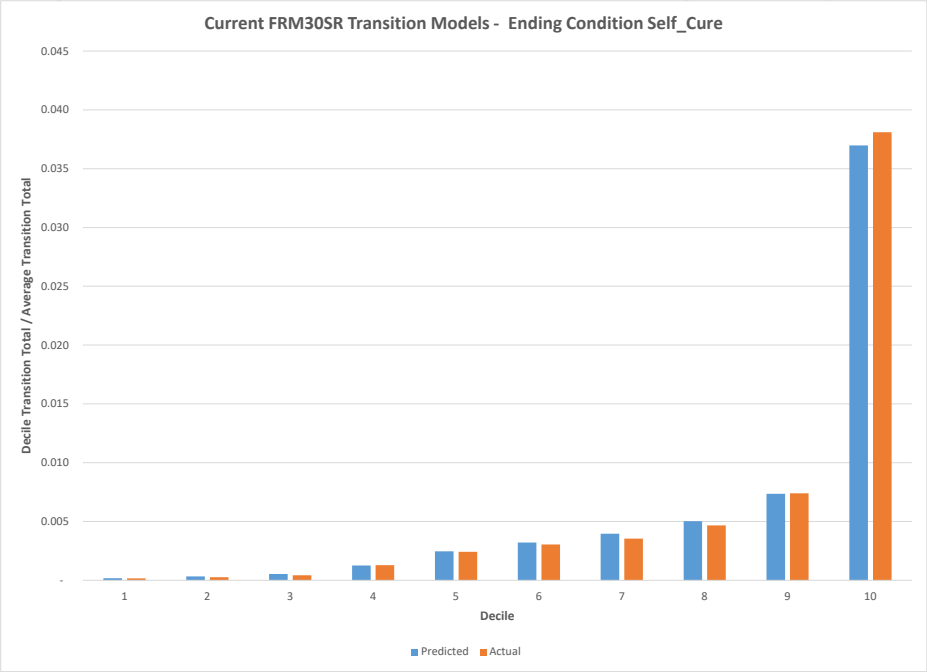


Figure 21: Current FRM30SR Transition Model Validation - Ending Condition Default

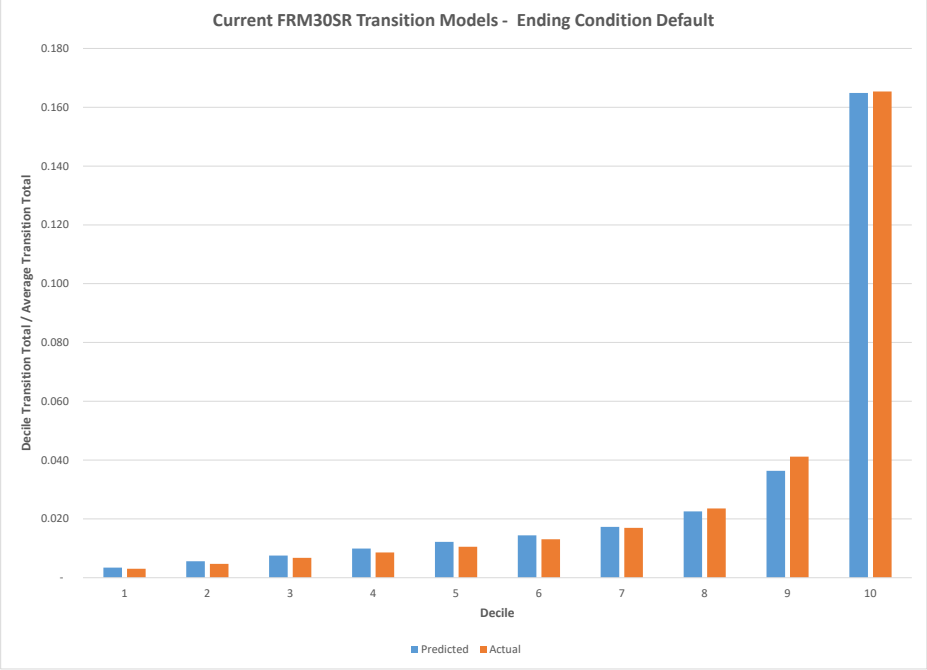
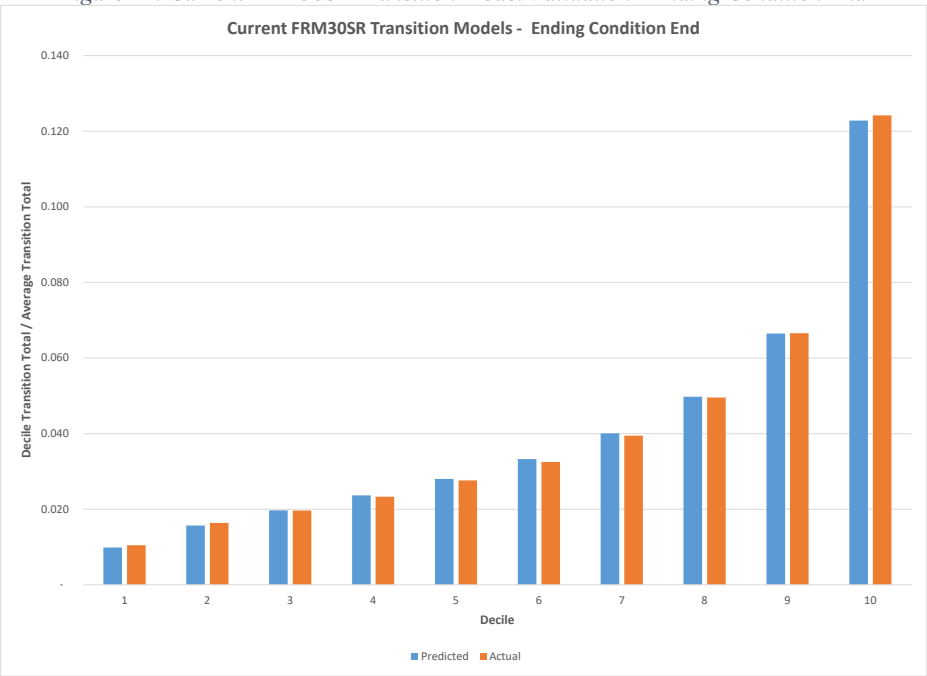


Figure 22: Current FRM30SR Transition Model Validation - Ending Condition End



Current FRM15 Transition Models

The validation charts by ending condition for the FRM15 models are shown in Figures 23 through 26.

Figure 23: Current FRM15 Transition Model Validation - Ending Condition Streamlined Refinance

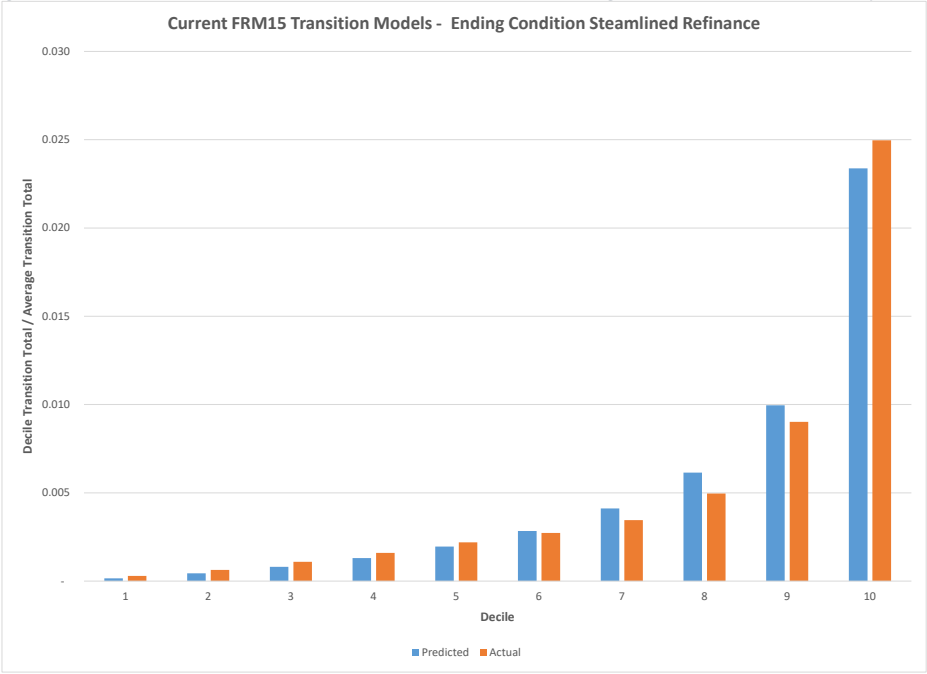


Figure 24: Current FRM15 Transition Model Validation - Ending Condition Default

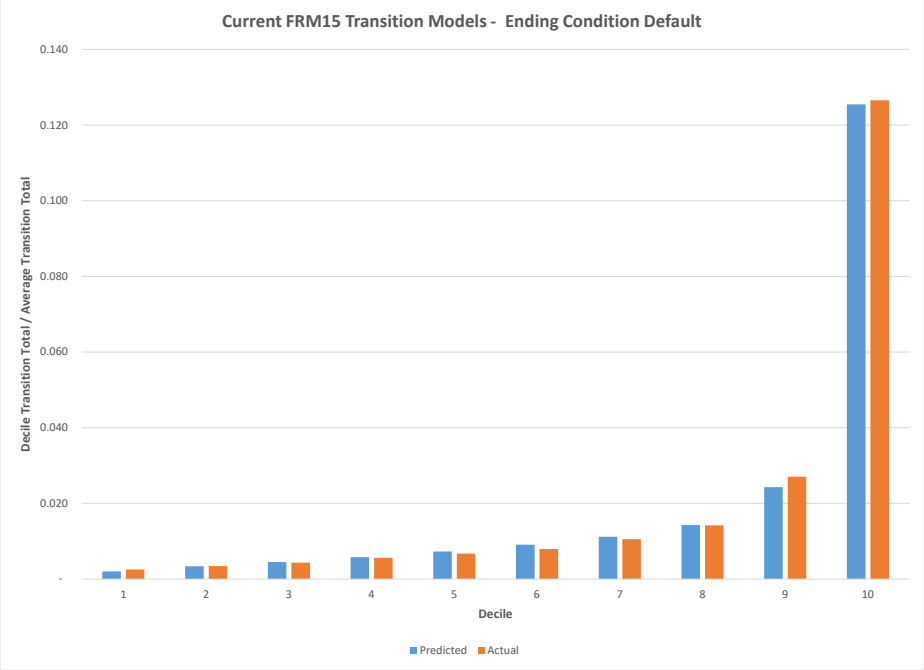


Figure 25: Current FRM15 Transition Model Validation - Ending Condition Self-Cure

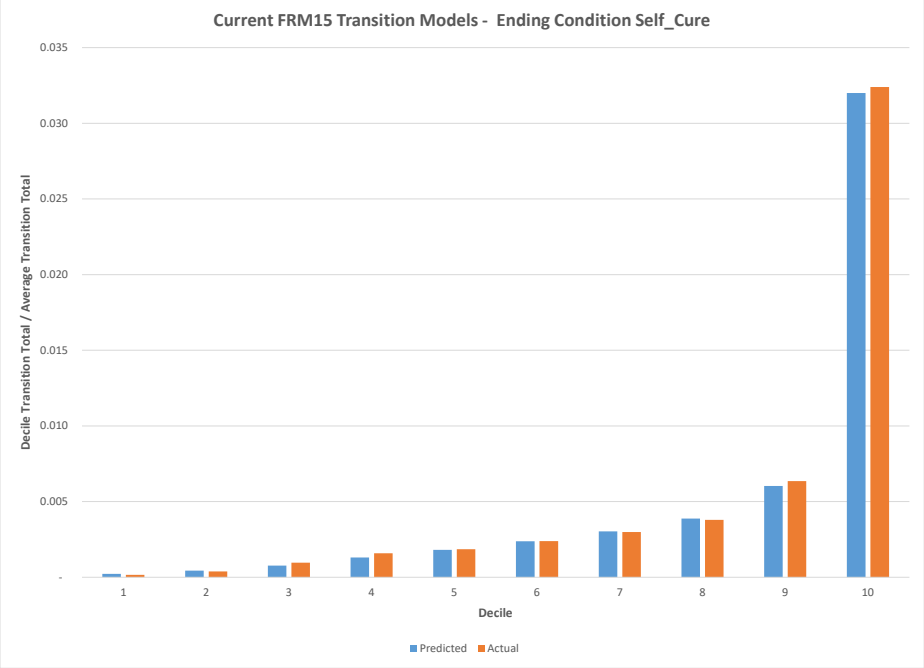
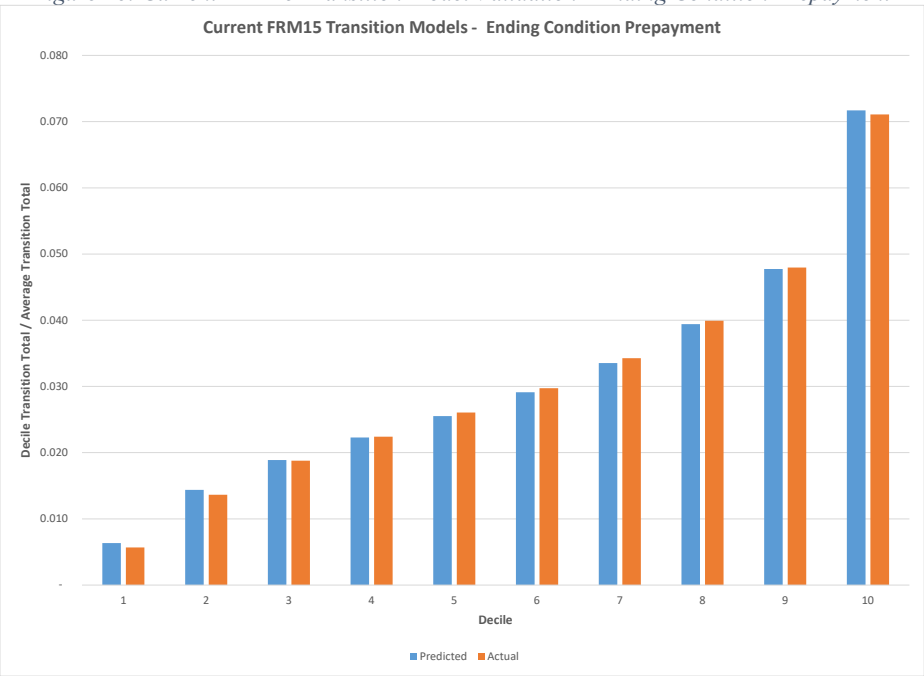


Figure 26: Current FRM15 Transition Model Validation - Ending Condition Prepayment



Current ARM Transition Models

The validation charts by ending condition for the ARM models are shown in Figures 27 through 30.

Figure 27: Current ARM Transition Model Validation - Ending Condition Streamlined Refinance

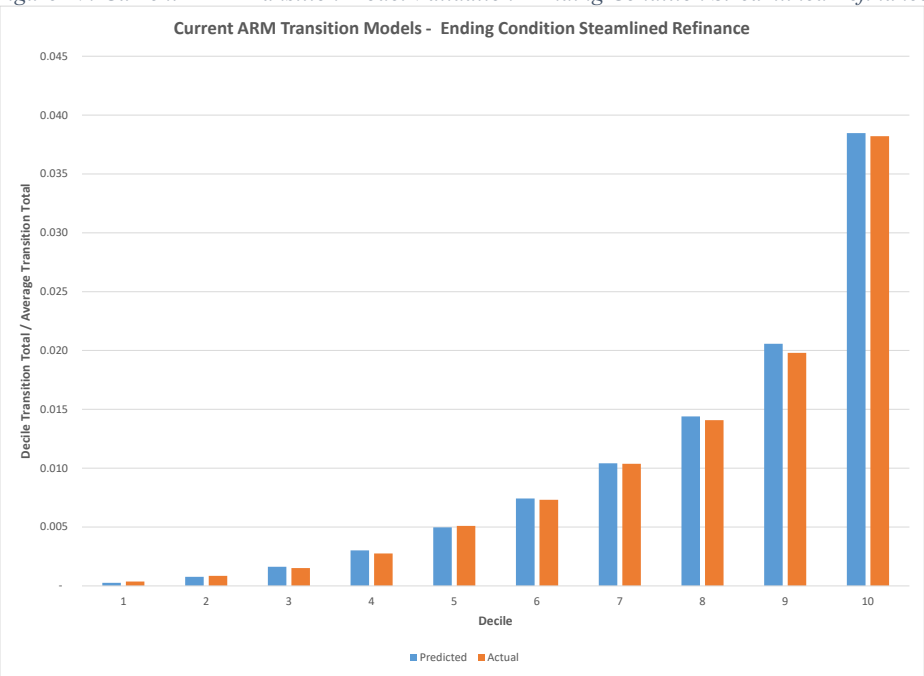


Figure 28: Current ARM Transition Model Validation - Ending Condition Default

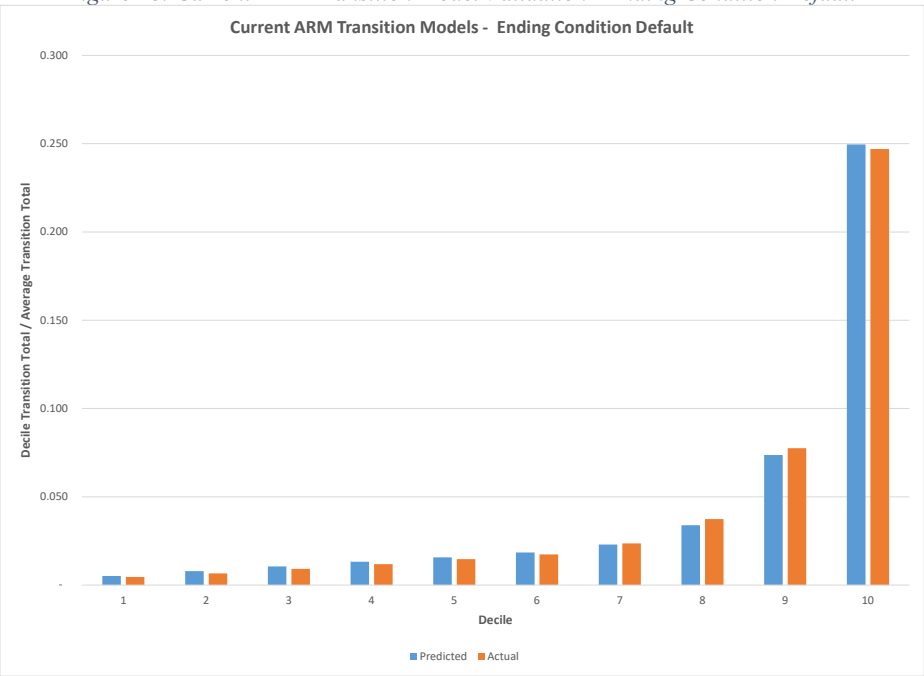


Figure 29: Current ARM Transition Model Validation - Ending Condition Self-Cure

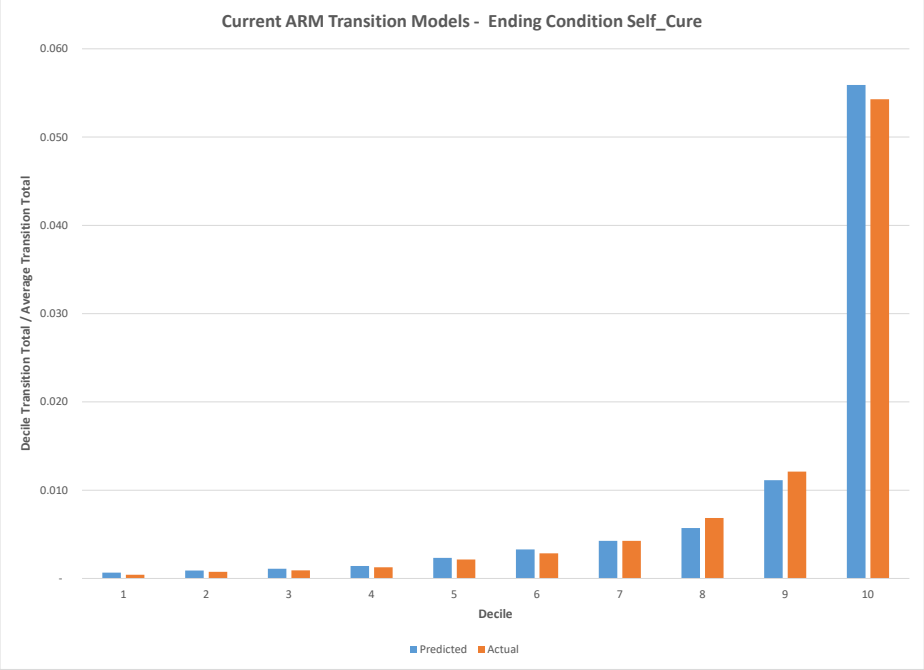
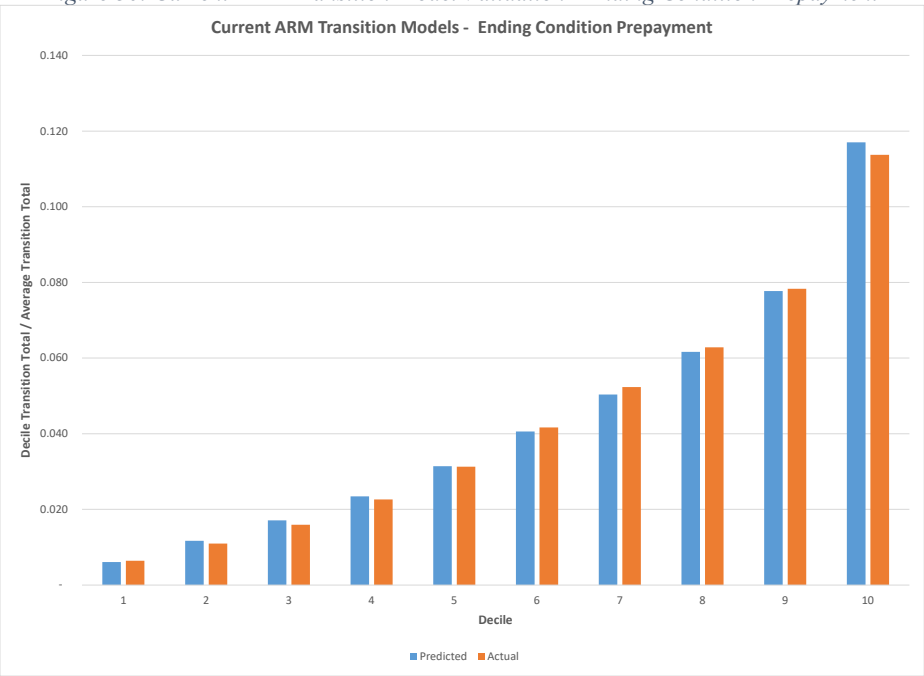


Figure 30: Current ARM Transition Model Validation - Ending Condition Prepayment



Default FRM30NSR Transition Models

The validation charts by ending condition for the FRM30NSR models are shown in Figures 31 through 34.

Figure 31: Default FRM30 Transition Model Validation - Ending Condition Claim

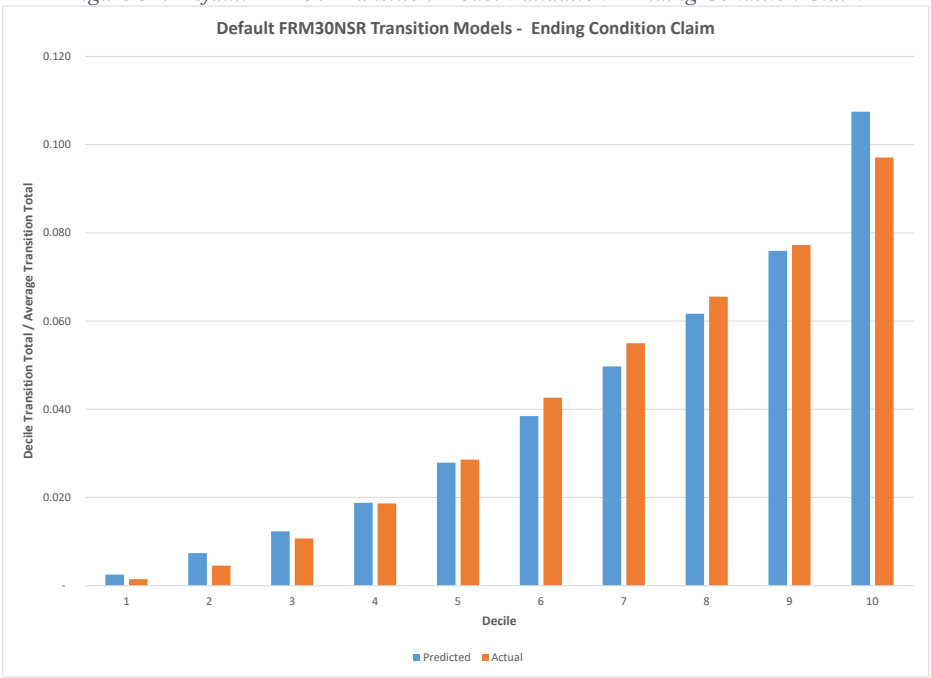


Figure 32: Default FRM30 Transition Model Validation - Ending Condition Cure with Modification

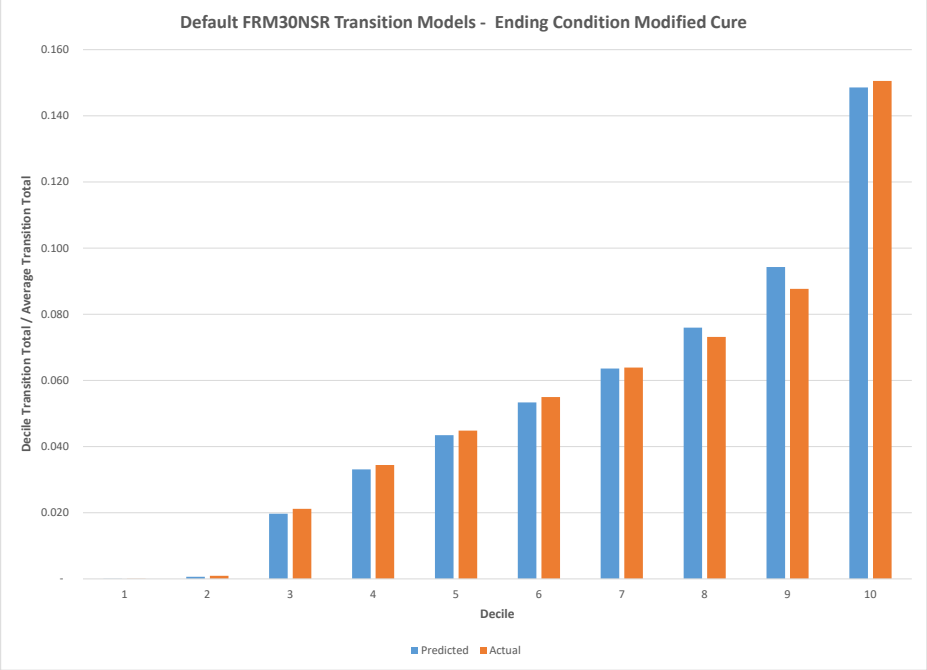


Figure 33: Default FRM30 Transition Model Validation - Ending Condition Self-Cure

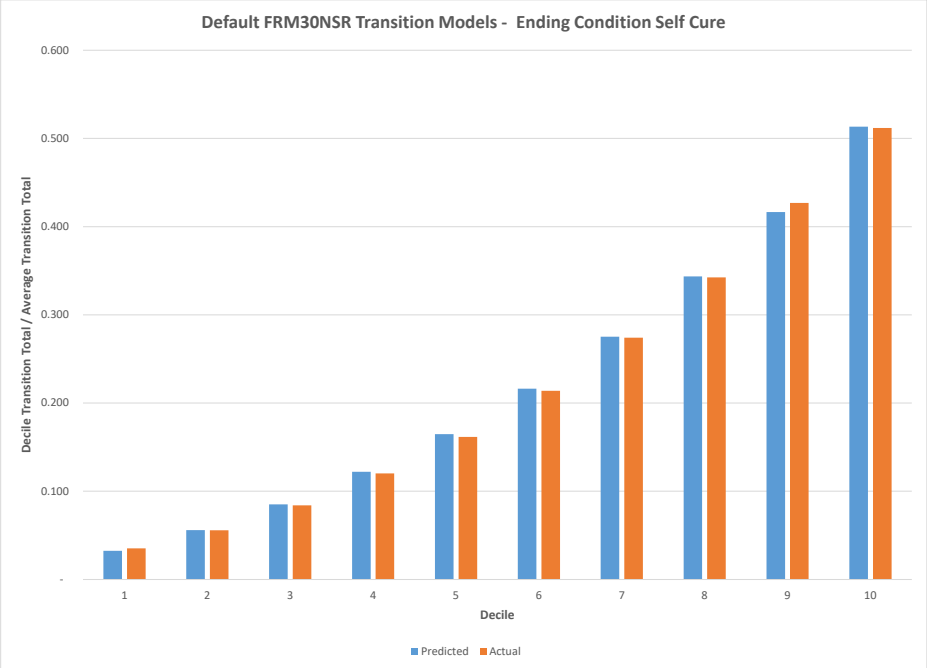
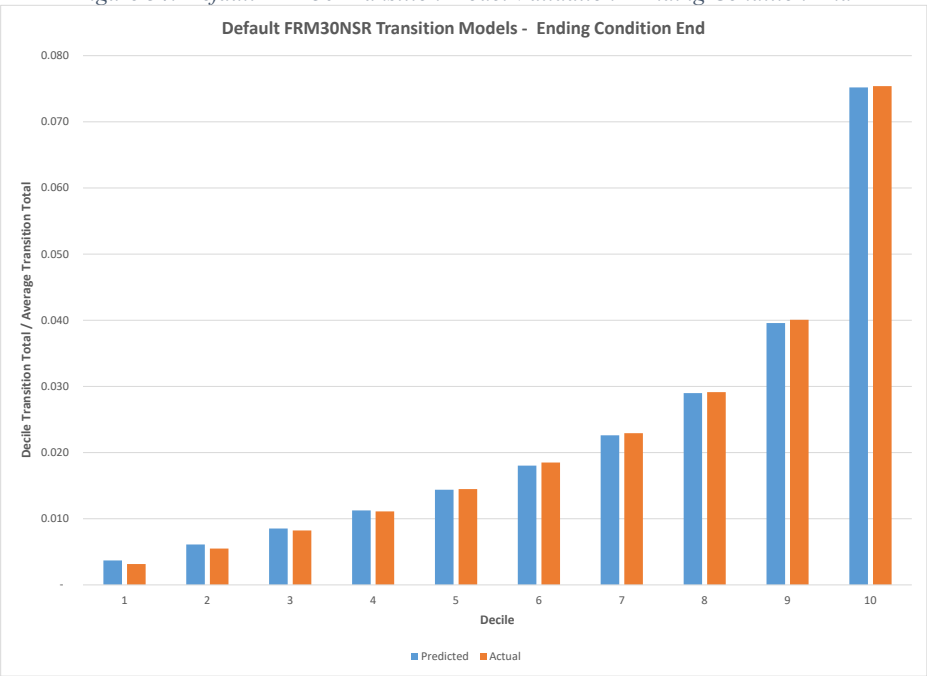


Figure 34: Default FRM30 Transition Model Validation - Ending Condition End



Default FRM30SR Transition Models

The validation charts by ending condition for the FRM30SR models are shown in Figures 35 through 38.

Figure 35: Default FRM30SR Transition Model Validation - Ending Condition Claim

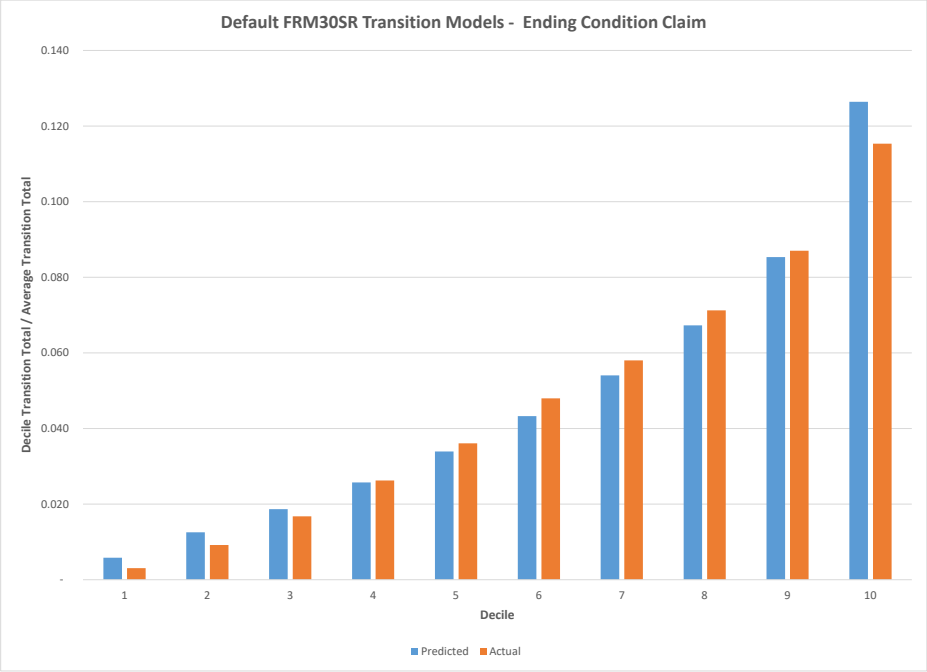


Figure 36: Default FRM30SR Transition Model Validation - Ending Condition Cure with Modification

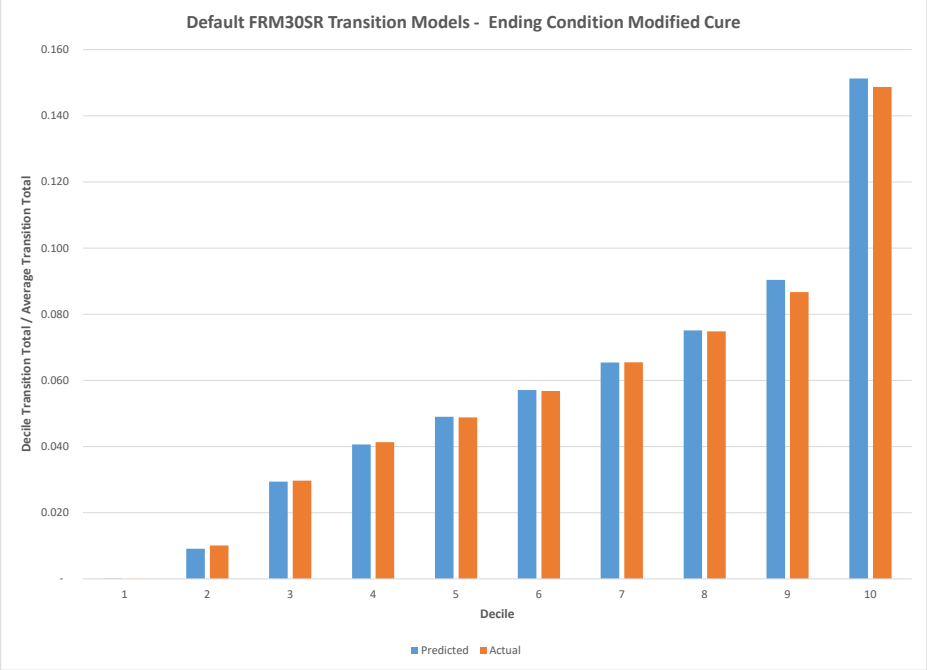


Figure 37: Default FRM30SR Transition Model Validation - Ending Condition Self-Cure

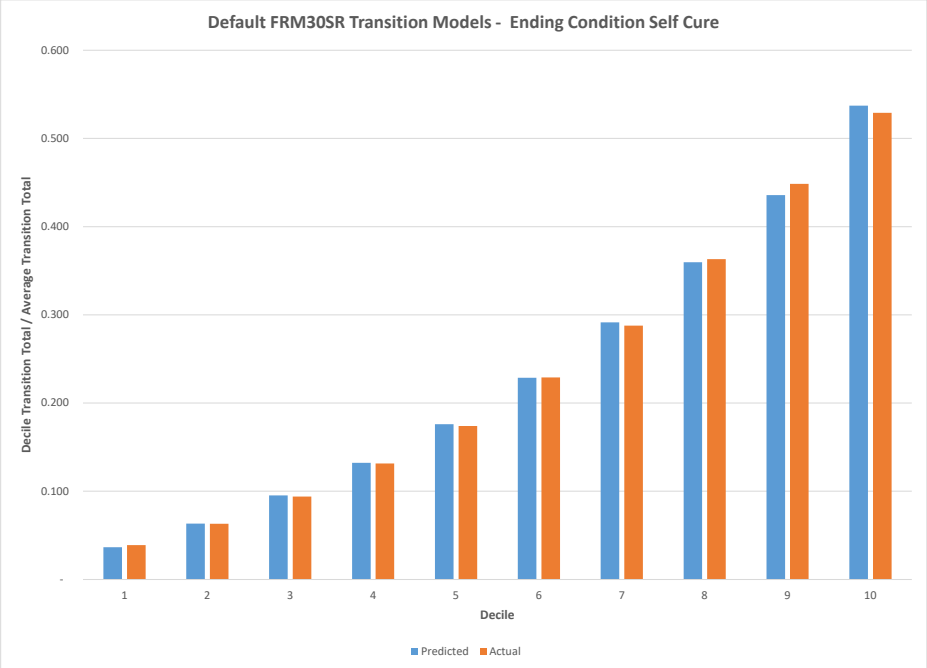
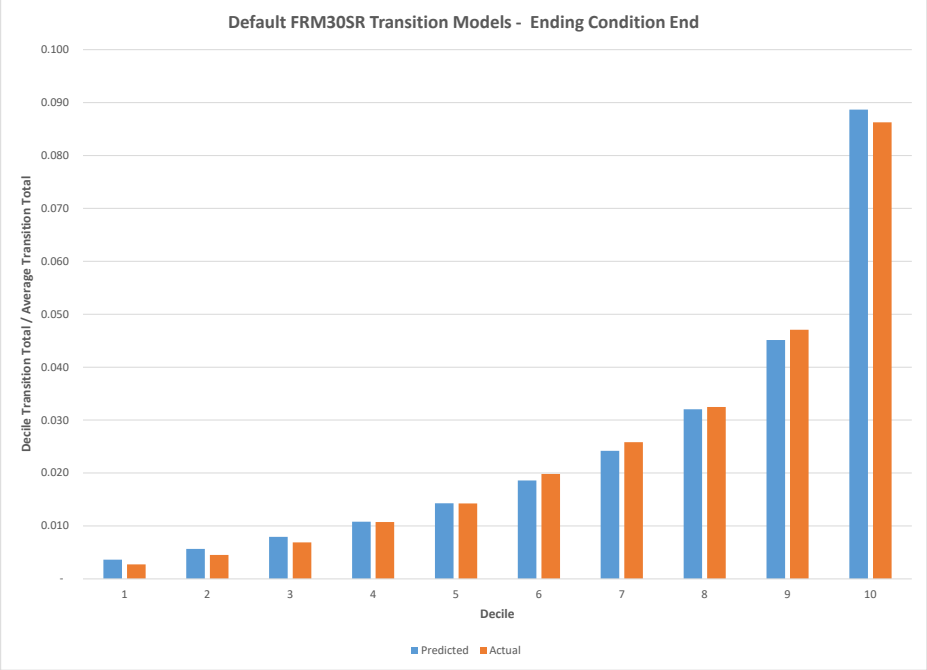


Figure 38: Default FRM30SR Transition Model Validation - Ending Condition End



Default FRM15 Transition Models

The validation charts by ending condition for the FRM15 models are shown in Figures 39 through 42.

Figure 39: Default FRM15 Transition Model Validation - Ending Condition Claim

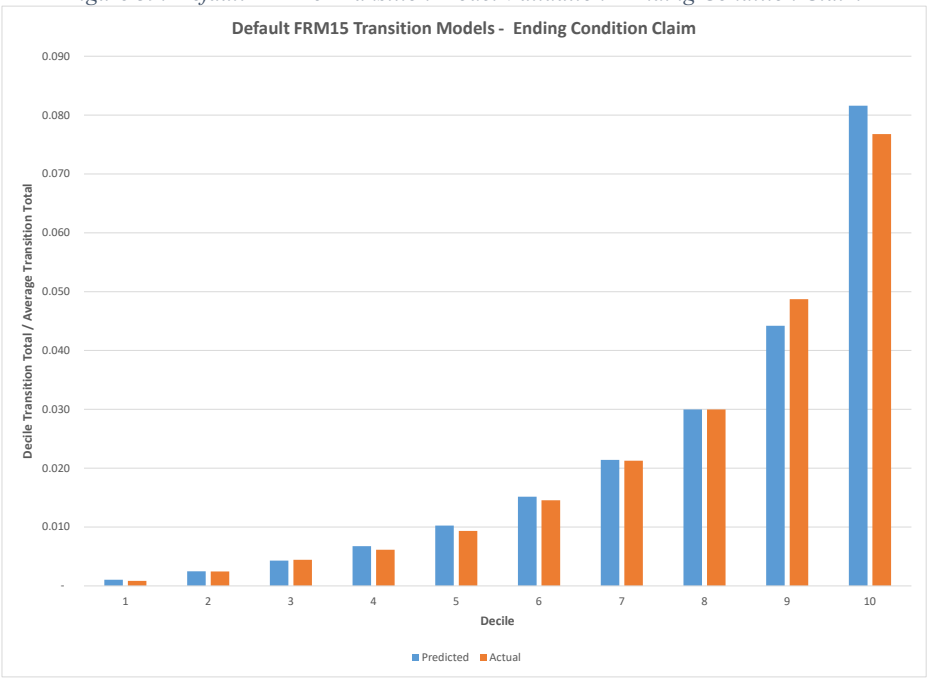


Figure 40: Default FRM15 Transition Model Validation - Ending Condition Cure with Modification

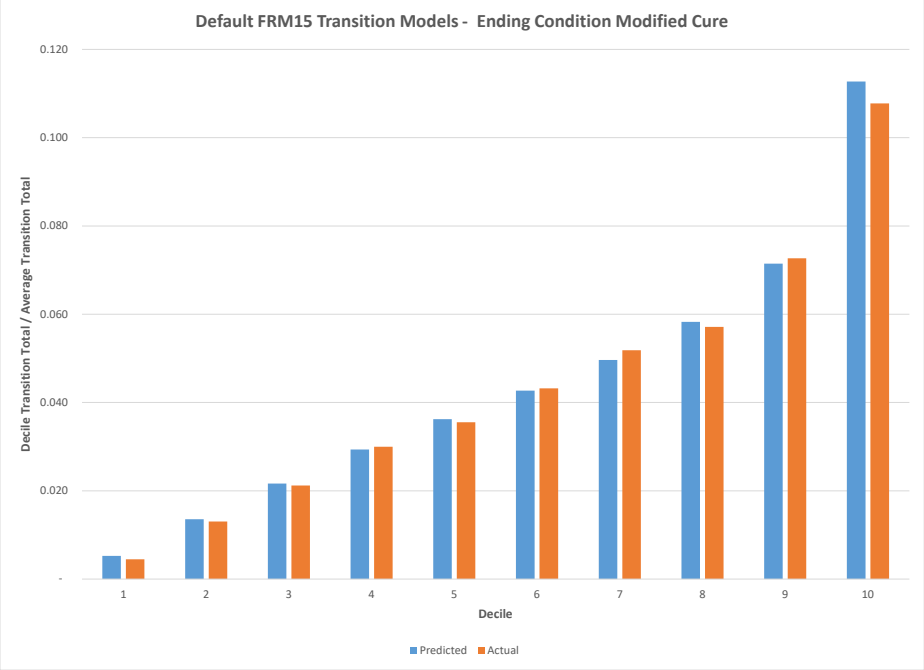


Figure 41: Default FRM15 Transition Model Validation - Ending Condition Self-Cure

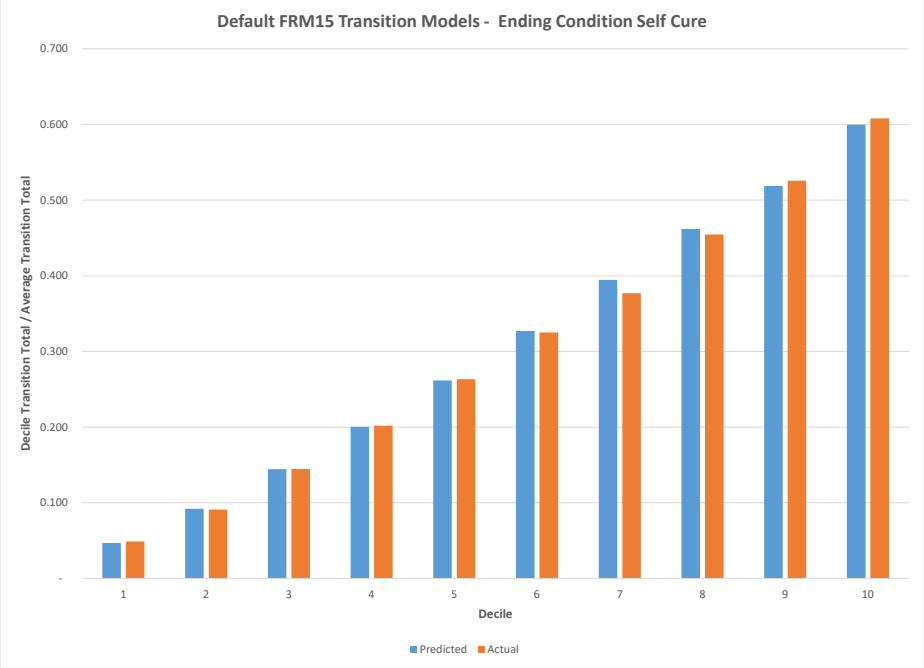
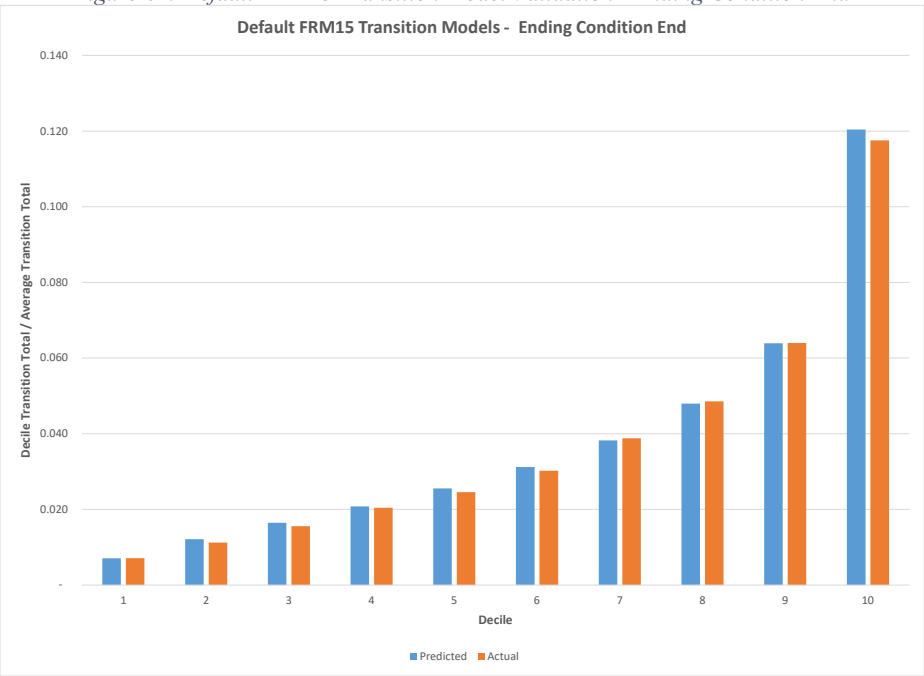


Figure 42: Default FRM15 Transition Model Validation - Ending Condition End



Default ARM Transition Models

The validation charts by ending condition for the ARM models are shown in Figures 43 through 46.

Figure 43: Default ARM Transition Model Validation - Ending Condition Claim

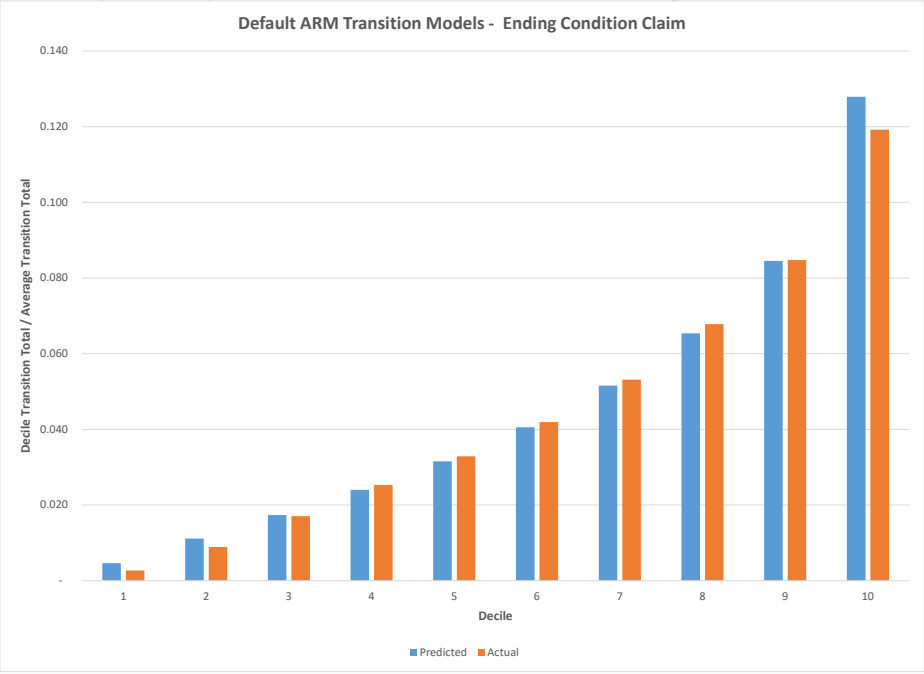


Figure 44: Default ARM Transition Model Validation - Ending Condition Cure with Modification

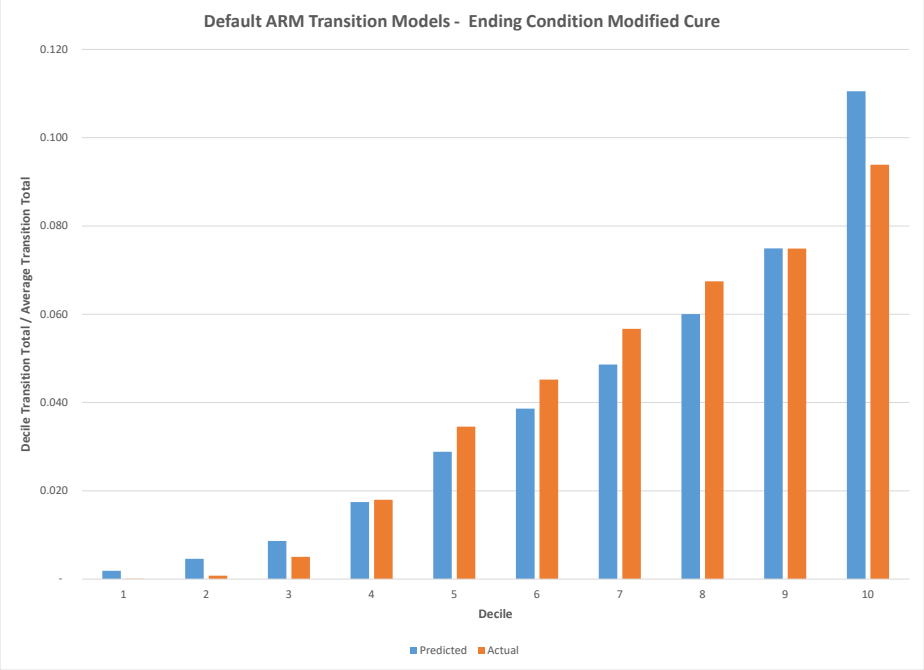
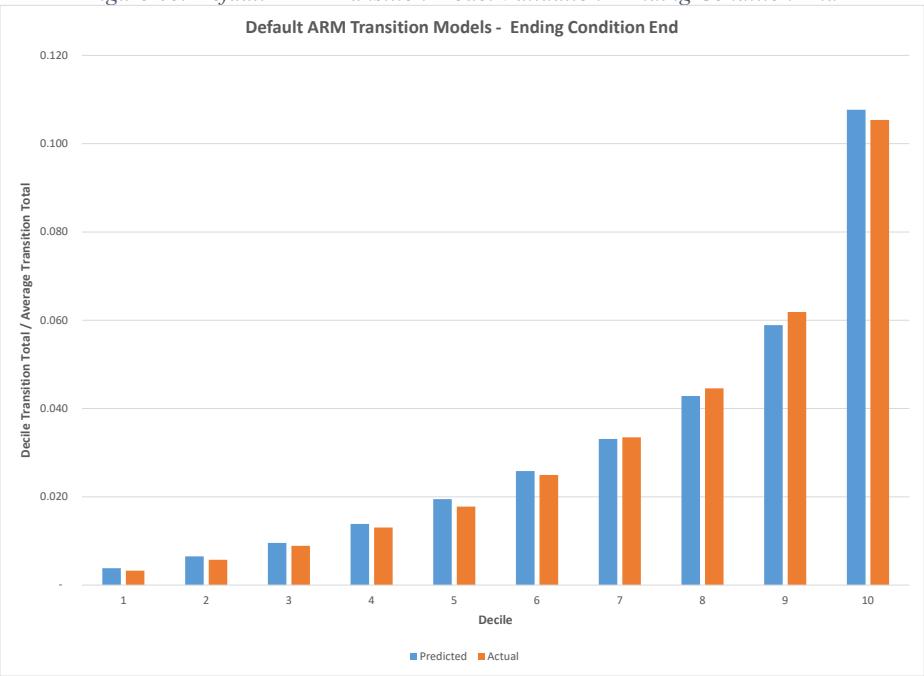


Figure 45: Default ARM Transition Model Validation - Ending Condition Self-Cure

Figure 46: Default ARM Transition Model Validation - Ending Condition End



Appendix C: Loss Severity Models

This appendix describes the loss severity models used in this Actuarial Review. One of the primary sources of variation in the MMI performance has been the loss severity experienced on mortgages that terminate as claims. In the case of a single mortgage, net loss is defined as the difference between the acquisition cost to HUD (acq_cost_to_HUD) from the IDB table and the recoveries realized by FHA on properties owned. We predict the net loss by modeling the probability of the type of claim that develops, then modeling separately the loss for each type of claim and the recovery for real estate owned (REO) claims.

In this appendix, we also summarize the model specifications, describe the explanatory variables used, provide the model parameters, and provide validation exhibits for the final models.

Model Specifications

Typically, when an FHA-endorsed mortgage terminates as a claim, the property is conveyed to FHA, and FHA makes a payment to the lender to settle the claim and acquire the underlying property. That is, the underlying house becomes REO. The claim payment FHA makes to the servicer, known as the acquisition cost, consists of three components:

1. the outstanding unpaid principal balance on the mortgage.
2. the foregone interest advanced by the servicer due to the mortgage default.
3. legal and administrative costs paid by the servicer associated with foreclosure, including any expenses associated with the cost of repairing or maintaining the property prior to conveyance.

The formula for acquisition cost is:

$$Acquisition\ Cost = Unpaid\ Principal\ Balance + Foregone\ Interest + Foreclosure\ Expense$$

Following acquisition, FHA attempts to sell the property, sometimes at a reduced price to assist low-income prospective homebuyers in achieving homeownership. During the period when the property is held by FHA, but not yet sold, FHA incurs various holding costs associated with maintenance, repairs, tax payments and expenses incurred in preparing the property for sale. Upon sale of the collateral property, FHA receives the sale price less any sales expenses. In sum, the net loss amount is the net amount that FHA cannot recoup from this process:

$$Net\ Loss = Acquisition\ Cost + Holding\ Cost - Sale\ Price + Sale\ Expense$$

Table 61 shows the distribution of different types of FHA claim terminations. Conveyance refers to the foreclosure procedure discussed above, wherein the property is conveyed to FHA after foreclosure is completed. Until 2016, this was the most common type of claim.

FHA permits pre-foreclosure sales (PFS) as an alternative to the foreclosure process. In the case of a PFS, the property is sold by the borrower without the foreclosure process being completed, or even started in some cases. Instead of acquiring the foreclosed house, FHA directly pays the loss amount claimed by the lender. The loss amount of a PFS case is reported as an acquisition cost to FHA. By 2012, the percentage of PFS was just under 24%. The percentage of PFS decreased through 2017, increased to 18.2% in 2021, and has decreased to 9.0% in 2022.

There was a significant volume of note (non-performing mortgage) sales from claim Fiscal Year 2003 through claim Fiscal Year 2005. From claim Fiscal Year 2007 to claim Fiscal Year 2012, there were significantly fewer note sales. By 2014, however, the percentage of note sales rose above 27%. In these cases, the expenses of foreclosure procedures and subsequent house sales are avoided by FHA. Note sales are discretionary and highly unpredictable. We do not model note sales as a continuing program.

FHA changed its servicing guide in 2013 to allow foreclosure without conveyance. This consists of a Third-Party Sale (TPS) during the foreclosure auction. A third party, instead of FHA, acquires the property directly from the foreclosure auction. This process allows FHA to avoid the process and expenses of property disposition after conveyance including any associated holding costs. TPSs have increased significantly since 2012, accounting for 66.5% of claims in 2022.

Table 61: Percentage of Claim Termination Types by Fiscal Claim Year

Claim Year	Conveyance (REO)	Note Sales	Third Party Sales (TPS)	Pre-Foreclosure Sales (PFS)
1999	94.86%	0.11%	0.00%	5.02%
2000	95.06%	0.09%	0.00%	4.85%
2001	95.03%	0.01%	0.00%	4.97%
2002	94.33%	0.00%	0.00%	5.66%
2003	86.74%	8.34%	0.00%	4.92%
2004	85.57%	8.41%	0.00%	6.02%
2005	83.29%	9.79%	0.00%	6.91%
2006	89.37%	2.83%	0.00%	7.80%
2007	92.80%	0.00%	0.00%	7.20%
2008	93.06%	0.00%	0.10%	6.84%
2009	90.06%	0.00%	0.01%	9.93%
2010	84.46%	0.31%	0.00%	15.22%
2011	76.29%	1.17%	0.02%	22.51%
2012	71.24%	1.32%	3.59%	23.86%
2013	56.72%	17.66%	6.87%	18.75%
2014	42.68%	27.29%	15.40%	14.63%
2015	54.25%	16.27%	18.25%	11.22%
2016	49.52%	ll.51%	29.30%	9.66%
2017	38.10%	6.23%	47.00%	8.66%
2018	34.34%	0.11%	56.38%	9.17%
2019	30.63%	0.13%	61.08%	8.15%
2020	36.26%	0.01%	53.65%	10.07%
2021	25.01%	0.50%	56.33%	18.15%
2022	24.55%	0.00%	66.51%	8.95%

Table 62 shows the average net loss for the combined foreclosure (REO and TPS) and PFS claims by claim Fiscal Year for 1991 to 2022. The average net loss increased from 1991 to 2012, reaching a high of almost $129,000 in Fiscal Year 2012. Since 2012, the average net loss had been decreasing, and for Fiscal Year 2022 sits at just under $65,000.

Table 62: Historical Average Net Loss

Claim Year	Average Net Loss
1991	61,095
1992	62,389
1993	65,614
1994	68,850
1995	71,118
1996	73,864
1997	77,434
1998	81,185
1999	84,226
2000	85,883
2001	87,069
2002	88,206
2003	91,208
2004	93,004
200S	94,310
2006	97,606
2007	101,710
2008	110,001
2009	118,373
2010	127,977
2011	128,834
2012	128,884
2013	124,555
2014	112,674
2015	115,459
2016	107,401
2017	95,020
2018	86,930
2019	80,120
2020	84,494
2021	70,988
2022	64,807

Loss Mitigation Expenses

FHA initiated a loss mitigation program in 1996 to provide opportunities for borrowers in financial difficulties to retain homeownership. Loss mitigation also reduces foreclosure costs. In the standard process, the mortgagees provide default counseling for borrowers who are behind in their

payments and offer appropriate loss mitigation options to prevent borrowers from losing their homes. In 2009, FHA started the HAMP program as a new loss mitigation option, and the program represented increasing percentages of loss mitigation assistance through the years. In 2016, Mortgage Modification as a standalone option was eliminated and combined into HAMP.

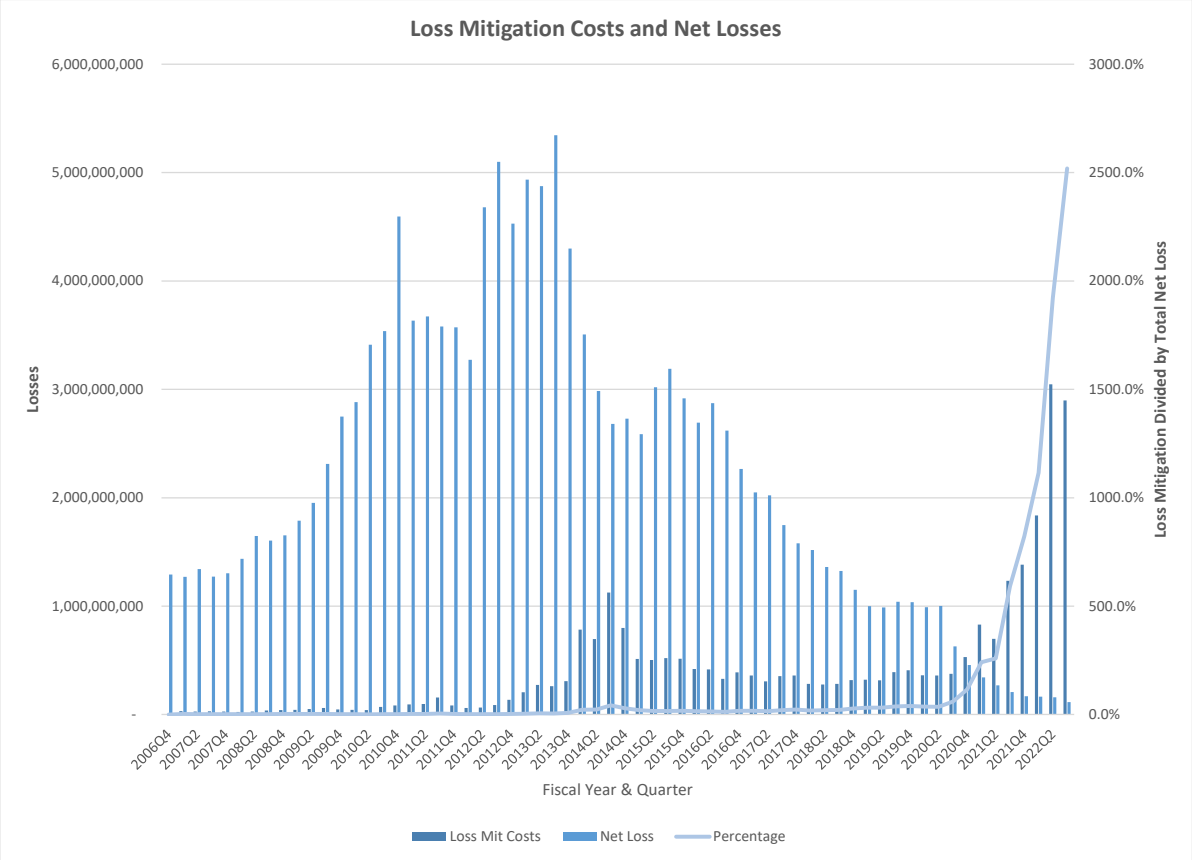
The loss mitigation program includes Forbearance and HAMP, which has Loan Modification and Partial Claim options. A Special Forbearance is a written repayment agreement between the mortgagee, acting on behalf of FHA, and the borrower that contains a plan to reinstate a mortgage. A Loan Modification modifies the contractual terms of the mortgage permanently, such as lowering the interest rate, or increasing the mortgage term. Under the partial claim option, a mortgagee will advance funds on behalf of a mortgagor in an amount necessary to reinstate a delinquent mortgage. The borrowers are required to sign a promissory note and a subordinated mortgage payable to FHA of the amount advanced.

Figure 47 shows the ratio of loss mitigation costs to overall net losses. Loan mitigation cases increased significantly from Fiscal Year 2007 to Fiscal Year 2014. There were just under 80,000 loss mitigation claims in Fiscal Year 2007 which grew to over 180,000 cases in Fiscal Year 2014. The amount FHA paid in these cases and curtailments was $116 million in Fiscal Year 2007, which increased to $3.41 billion in Fiscal Year 2014. From 2014 to 2018, loss mitigation payments decreased to $1.16 billion, but then increased in 2019 and 2020.

For Fiscal Year 2022, loss mitigation payments in total have been over 17 times higher than the total REO, TPS and PFS claim payments. This is due to the COVID forbearance rules that were implemented on March 1, 2020. All foreclosure proceedings had been halted until September 30, 2021, no new foreclosure proceedings could begin until September 30, 2021, and no foreclosure evictions could begin until September 30, 2021. Therefore, the non-loss mitigation claims had been delayed until normal foreclosure and claim processes resumed. Although foreclosure proceedings are starting again, loss mitigation is still increasing significantly relative to REO payments.

Loss mitigation payments made by FHA include administrative fees, costs of title searches and recording fees, and subordinated mortgage note amounts.

Figure 47: Loss Mitigation Expense



Net Loss Severity Model Specification

As described above, there are several components of the total loss amount, and each component is influenced by several factors. Foregone interest depends on the interest rate on the mortgage and on the length of the default-to-claim lag. Foreclosure expenses can vary depending on whether a judicial foreclosure process is used that can lengthen the time of the foreclosure process. Repair expenses may be a function of the financial condition of the borrowers, which we proxy by credit scores. Sale prices are influenced by the house price appreciation since origination and by the prevailing local housing market conditions during the default and property disposition periods. Several components of the net loss amount involve expenses that are fixed across foreclosed properties. Hence, mortgages with lower values are more likely to realize higher net losses as a percentage of the sales amount, as the amount of the recovery will be smaller relative to higher value homes.

As shown in Table 61, the distribution between REO/TPS (foreclosure) and PFS was relatively stable through Fiscal Year 2009. Beginning in Fiscal Year 2010, there were widespread house price declines and a higher volume of defaults. As a result, the foreclosure claim process had been lengthened and foreclosure claims were delayed, while the PFS process has remained relatively stable. From Fiscal Year 2008 to 2012, the PFS share increased significantly. Since Fiscal Year

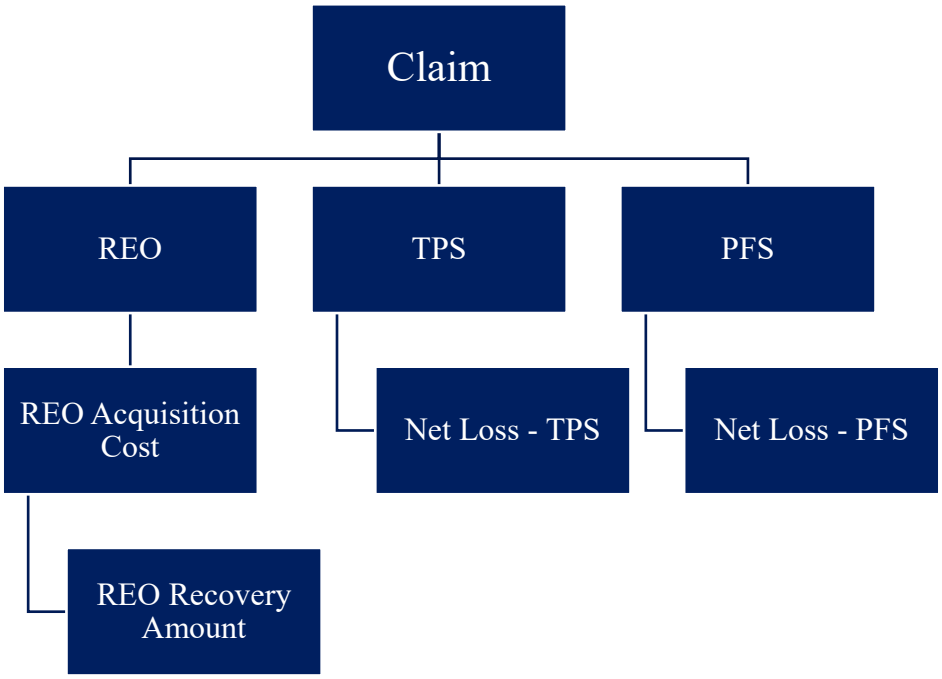
2012, the PFS share has declined. Moreover, the proceeds recovered from REO and PFS sales differ significantly.

To achieve more accurate estimates of net loss severities, we adopted a three-stage model:

1. Model to predict the development of an REO, TPS or PFS claims
2. Model of REO acquisition cost and TPS and PFS net loss
3. Model of recovery amount conditional on claim being a foreclosure REO claim

The net loss severity model follows the flowchart in Figure 48.

Figure 48: Net Loss Severity Model Structure



First, we estimate the probability that a claim is settled by the REO, TPS, or PFS process. To model the first-stage choice event, we used a multinomial logistic model approach to estimate the probability of the claim settlement type.

Second, we estimate the REO Acquisition Amount, TPS net loss and PFS net loss as a function of all the same explanatory factors used in the multinomial model. The gross loss severity distribution is smooth and continuous with a long right tail. Thus, we use a GLM approach with a Gamma error structure and a log link function to develop the gross loss severity models. The Gamma structure is used for each loss severity model (REO, TPS, PFS). For REO claims, a recovery model estimating sales proceeds net of the Capital Income Expenses is built using a similar framework.

In addition to the loss severity models described above, we also developed a set of models to project loss mitigation costs. Implemented in 1996, the loss mitigation program was designed to

help financially stressed borrowers stay in their homes. Loss mitigation costs can be incurred from modifying the terms of the mortgage, allowing a borrower to refinance into a new mortgage and writing off a portion of the unpaid principal (partial claim), or a forbearance, which is a written agreement with the borrower which includes a plan to reinstate the mortgage. The loss mitigation cost is modeled using a GLM with a Gamma error structure.

Thus, the estimated net loss to the MMI is the expected value of net loss of the different claim types:

$$Net\ Loss = Probability\ of\ REO * (GrossLoss_{REO} - Recovery) + Probablity\ of\ TPS * NetLoss_{TPS} + Probablity\ of\ PFS * NetLoss_{PFS} + Probability\ of\ Loss\ Mitigation * Net\ Loss\ Mitigation\ Cost$$

Estimation Sample

The sample used to estimate the loss severity model consists of mortgage level data from the FHA single-family data warehouse. The available data covers the period from the first quarter of Fiscal Year 1975 to the end of Fiscal Year 2022. In total, there are over 2.8 million claims in the FHA database.

The models were built using a traditional train/validate approach. A random sample of the data is used to train the models, and the remaining data is used to validate and refine the model parameters and to determine inclusion and exclusion of explanatory variables.

Explanatory Variables

Multiple categories of explanatory variables were used.

- Fixed initial mortgage characteristics: ARM adjustment period, mortgage product, interest rate, initial mortgage size, spread at origination
- Fixed initial borrower characteristics: down payment assistance, first time home buyer, credit score
- Property characteristics: the number of living units, initial home values
- Dynamic variables based on mortgage information: prior default indicator, prior mortgage modification, LTV ratio, interest rate spread, TEI, age of mortgage
- Dynamic variables derived by combining mortgage information and external economic data: spread, spread at origination
- Dynamic macroeconomic variables: 10-year average unemployment rate, change in the unemployment rate, prior year unemployment rate, HPI, state unemployment rate relative to countrywide unemployment rate, CMT rates, state unemployment rate
- Geographic variables: judicial state, collateral state

Most of the explanatory variables used in the loss severity model are the same as those used in the mortgage status transition models. The additional variables used in the loss severity models are defined below.

- Product: loan product type. This variable is incorporated as a categorical variable.
- Balance: outstanding mortgage balance. This variable is incorporated as a variate.
- Deltatm3: change in three-month CMT rate from policy inception to current. This variable is incorporated as a grouped categorical variable.
- Arm_ind: ARM product type indicator. This variable is incorporated as a grouped categorical variable.

Model Parameters[83, 84]

Loss Mitigation Binomial Model

The model parameters for the binomial model to estimate whether a claim is a loss mitigation (HAMP) claim are in Table 63.

Table 63: Loss Mitigation Binomial Model Parameters

Variable	ClassVal0	Description	Description Detail	Response	Estimate	StdErr	WaldChiSq	ProbChiSq
Intercept				HAMP	-0.2953	0.5904	0.2501	0.617
SVSBOI_pw1		Small Business Optimism Index	median(0,SBOI-80,95-80)	HAMP	-0.0099	0.0118	0.7047	0.4012
SVSBOI_pw2		Small Business Optimism Index	median(0,SBOI-95,110-95)	HAMP	-0.0332	0.0014	584.9869	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	HAMP	0.2471	0.0386	40.9521	<.0001
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	HAMP	0.2050	0.0627	10.6696	0.0011
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	HAMP	-1.1584	0.0471	605.4431	<.0001
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	HAMP	-1.1715	0.0944	154.0854	<.0001
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	HAMP	-0.1558	0.0277	31.7194	<.0001
SVloansize_raw_grp		Variate version of loansize_raw	min(loansize/1000,600)	HAMP	0.0023	0.0001	1746.5490	<.0001
SMpriordef	L01	Categorical of prior defaults	prior_default_count = 1	HAMP	-0.1220	0.0132	85.3961	<.0001
SMpriordef	L02	Categorical of prior defaults	prior_default_count = 2	HAMP	-0.2263	0.0149	231.2941	<.0001
SMpriordef	L03	Categorical of prior defaults	prior_default_count >= 3	HAMP	-0.3833	0.0147	679.6445	<.0001
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	HAMP	0.0563	0.0117	23.1476	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt = 2	HAMP	0.1468	0.0175	70.3237	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt >= 3	HAMP	0.2331	0.0236	97.2105	<.0001
SVpriordef_pw1		Variate piecewise version of prior defaults	median(0,prior_default_cnt - 12,3)	HAMP	-0.1066	0.0304	12.3249	0.0004
SVpriormod_pw1		Variate piecewise version of prior_mod_cnt	median(0,prior_mod_cnt-3,15-3)	HAMP	-0.0704	0.0176	16.0656	<.0001

[83] For categorical variables, only non-base levels are listed.
[84] The tables' footnotes are consistent among the tables. They are listed at the end of the section.

Variable	ClassVal0	Description	Description Detail	Response	Estimate	StdErr	WaldChiSq	ProbChiSq
SMseason	L01	Categorical of season	season = "winter"	HAMP	-0.1148	0.0125	83.9283	<.0001
SMseason	L02	Categorical of season	season = "spring"	HAMP	-0.1294	0.0120	117.1445	<.0001
SMseason	L03	Categorical of season	season = "summer"	HAMP	-0.1617	0.0119	184.1194	<.0001
SMperiodnbr_LML	L01_04	Categorical of period number	1 <= period_number <= 4	HAMP	-3.4091	0.2141	253.4311	<.0001
SMperiodnbr_LML	L05	Categorical of period number	period_number = 5	HAMP	-2.0258	0.1141	315.0585	<.0001
SMperiodnbr_LML	L06	Categorical of period number	period_number = 6	HAMP	-1.0420	0.0652	255.6238	<.0001
SMperiodnbr_LML	L07	Categorical of period number	period_number = 7	HAMP	-0.2200	0.0347	40.0890	<.0001
SVperiodnbr_pw1		Variate piecewise version of period number	median(0,period_number-8,40-8)	HAMP	-0.0374	0.0006	3502.0674	<.0001
SVperiodnbr_pw2		Variate piecewise version of period number	median(0,period_number-40,53-40)	HAMP	-0.0166	0.0018	82.6887	<.0001
SVperiodnbr_pw3		Variate piecewise version of period number	median(0,period_number-53,68-53)	HAMP	-0.0077	0.0023	11.6292	0.0006
SVperiodnbr_pw4		Variate piecewise version of period number	median(0,period_number-68,108-68)	HAMP	-0.0094	0.0017	29.5646	<.0001
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	HAMP	-0.0304	0.0088	12.0229	0.0005
SMRatioTmpTei	L00	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	HAMP	1.2153	0.0459	702.4815	<.0001
SVratiotmptei_pw1		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-0,24-0)	HAMP	0.0374	0.0018	419.7951	<.0001
SVratiotmptei_pw2		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-24,36-24)	HAMP	0.0793	0.0013	3741.8041	<.0001
SVratiotmptei_pw3		Variate piecewise version of front end ratio	max(0,ratio_tmp_tei-36)	HAMP	0.0215	0.0024	79.0933	<.0001
SVsato_pw1		Spread at origination	min(sato+0.1,0)	HAMP	-0.0887	0.0221	16.0984	<.0001
SVsato_pw2		Spread at origination	median(0,sato+0.1,0.7+0.1)	HAMP	-0.1892	0.0173	119.1176	<.0001
SVsato_pw3		Spread at origination	max(0,sato-0.7)	HAMP	-0.1542	0.0308	25.0038	<.0001
SVhpa2yb_pw1		Variate piecewise of hpa2y_blended_r1	min(hpa2y_blended_r,85)	HAMP	-0.0035	0.0068	0.2699	0.6034
SVhpa2yb_pw2		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-85,95-85)	HAMP	-0.0187	0.0082	5.1638	0.0231
SVhpa2yb_pw3		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-95,113-95)	HAMP	-0.0106	0.0016	44.4216	<.0001
SVhpa2yb_pw4		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-113,120-113)	HAMP	0.0151	0.0024	39.6783	<.0001
SVhpa2yb_pw5		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended_r-120)	HAMP	-0.0034	0.0019	3.2467	0.0716
SMdurdefepi	L02	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	HAMP	0.3405	0.0146	542.8688	<.0001
SMdurdefepi	L03	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	HAMP	0.4408	0.0154	823.2207	<.0001
SMdurdefepi	L04	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	HAMP	0.4603	0.0164	787.0352	<.0001
SMdurdefepi	L05	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	HAMP	0.4954	0.0178	770.6015	<.0001
SMdurdefepi	L06	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	HAMP	0.5865	0.0196	893.9635	<.0001
SMdurdefepi	L07	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	HAMP	0.5626	0.0217	672.1683	<.0001
SMdurdefepi	L08	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	HAMP	0.5850	0.0243	581.3584	<.0001
SMdurdefepi	L09	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	HAMP	0.6288	0.0272	535.2605	<.0001
SMdurdefepi	L10	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	HAMP	0.7137	0.0309	533.7758	<.0001

Variable	ClassVal0	Description	Description Detail	Response	Estimate	StdErr	WaldChiSq	ProbChiSq
SMdurdefepi	L11	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 11	HAMP	0.7010	0.0246	812.7819	<.0001
SVdurdefepi_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	HAMP	0.0115	0.0028	16.8581	<.0001
SVdurdefepi_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	HAMP	0.0304	0.0120	6.4467	0.0111
SMDeltaTm3	L01	Categorical of DeltaTm3Init_r2 (change in 3-month Treasury rate from policy inception to current)	DeltaTm3Init_r > 600	HAMP	-0.1133	0.0120	88.7529	<.0001
SMcredit	L01	Credit Score	credit_score = 0	HAMP	0.0490	0.0326	2.2635	0.1325
SMcredit	L02	Credit Score	credit_score<500	HAMP	-0.0173	0.0739	0.0545	0.8154
SVcredit_pw1		Variate piecewise of Credit Score	median(0,credit_score-500,625-500)	HAMP	-0.0023	0.0003	72.8107	<.0001
SVcredit_pw2		Variate piecewise of Credit Score	median(0,credit_score-625,680-625)	HAMP	0.0021	0.0003	48.1280	<.0001
SVcredit_pw3		Variate piecewise of Credit Score	max(0,credit_score - 680)	HAMP	0.0007	0.0003	3.9542	0.0468
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	HAMP	0.5377	0.0131	1689.1679	<.0001

Loss Mitigation HAMP Severity Model

The model parameters for the HAMP claim severity model are shown in Table 64.

Table 64: Loss Mitigation HAMP Severity Model Parameters

Variable	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
Intercept				PRE	6.0485	0.0561	<.0001
SVbalance_i_log		Variate version of log transformed outstanding balance at start of quarter	log(balance_i/1000)	PRE	0.9488	0.0034	<.0001
SVCCI_pw1		Consumer Confidence Index	median(0,CCI-30,91)	PRE	-0.0095	0.0008	<.0001
SVCCI_pw2		Consumer Confidence Index	median(0,CCI-91,142-91)	PRE	0.0099	0.0006	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	PRE	0.0580	0.0137	<.0001
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	PRE	-0.0283	0.0245	0.2477
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	PRE	0.2721	0.0260	<.0001
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	PRE	0.3498	0.0521	<.0001
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	PRE	-0.0653	0.0115	<.0001
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	PRE	-0.1021	0.0048	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt = 2	PRE	-0.0951	0.0076	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt >= 3	PRE	-0.0871	0.0110	<.0001
SVpriormod_pw1		Variate piecewise version of prior_mod_cnt	median(0,prior_mod_cnt-3,15-3)	PRE	0.0036	0.0095	0.7066

Variable	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	PRE	0.0487	0.0037	<.0001
SMRatioTmpTei	L00	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	PRE	0.2444	0.0223	<.0001
SVratiotmptei_pw1		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-0,24-0)	PRE	0.0019	0.0009	0.0444
SVratiotmptei_pw2		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-24,36-24)	PRE	0.0112	0.0006	<.0001
SVratiotmptei_pw3		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-36,50-36)	PRE	0.0113	0.0009	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	PRE	-0.0453	0.0055	<.0001
Covid_ID	Y	Indicator Covid period (Jan 2020+)	period ge 202001	PRE	0.0344	0.0051	<.0001

Third Party Sale Claims Logistic Model

The model parameters for the binomial model to predict the TPS claim type are shown in Table 65.

Table 65: TPS Claim Binomial Model Parameters

Variable	ClassVal0	Description	Description Detail	Response	Estimate	StdErr	WaldChiSq	ProbChiSq	_ESTTYPE_
Intercept				TPS	-6.9019	0.1097	3955.4126	<.0001	MLE
SVbalance_i		Outstanding balance at start of quarter		TPS	-0.0090	0.0006	216.1424	<.0001	MLE
SVCCI_2_pw1		Consumer Confidence Index	median(0,CCI-60,142-60)	TPS	0.0444	0.0007	4593.5452	<.0001	MLE
SVSBOI_pw1		Small Business Optimism Index	median(0,SBOI-80,95-80)	TPS	0.0596	0.0055	117.6517	<.0001	MLE
SVSBOI_pw2		Small Business Optimism Index	median(0,SBOI-95,110-95)	TPS	-0.0107	0.0024	19.0912	<.0001	MLE
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	TPS	0.2955	0.0376	61.6902	<.0001	MLE
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	TPS	0.2866	0.0524	29.8727	<.0001	MLE
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	TPS	-0.2935	0.0488	36.1173	<.0001	MLE
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	TPS	0.1399	0.0955	2.1456	0.143	MLE
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	TPS	0.2000	0.0190	110.5232	<.0001	MLE
SVloansize_raw_grp		Variate version of loansize_raw	min(loansize/1000,600)	TPS	0.0098	0.0006	309.4099	<.0001	MLE
SMseason	L01	Categorical of season	season = "winter"	TPS	-0.0237	0.0132	3.2225	0.0726	MLE
SMseason	L02	Categorical of season	season = "spring"	TPS	0.1722	0.0131	173.9815	<.0001	MLE
SMseason	L03	Categorical of season	season = "summer"	TPS	0.0179	0.0127	1.9980	0.1575	MLE
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	TPS	-0.0237	0.0095	6.2507	0.0124	MLE
SMdpa_govt	LGovt	Categorical of down payment assistance, government level indicator	dpa = "govt"	TPS	-0.0786	0.0313	6.2872	0.0122	MLE

Variable	ClassVal0	Description	Description Detail	Response	Estimate	StdErr	WaldChiSq	ProbChiSq	_ESTTYPE_
SMdpa_nprof	LNPro	Categorical of down payment assistance, non-profit level indicator	dpa = "nonprof"	TPS	0.1605	0.0156	105.3588	<.0001	MLE
SMdpa_rel	LRela	Categorical of down payment assistance, non-profit level indicator	dpa = "relative"	TPS	0.0581	0.0145	16.1086	<.0001	MLE
SVsato_pw1		Spread at origination	min(sato-0.1,0)	TPS	0.1901	0.0221	74.2072	<.0001	MLE
SVsato_pw2alt		Spread at origination	max(0,sato-.1)	TPS	-0.0434	0.0122	12.5983	0.0004	MLE
SVhpa2yb_pw1alt		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-79,100-79)	TPS	0.1468	0.0047	981.3582	<.0001	MLE
SVhpa2yb_pw2alt		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-100,115-100)	TPS	0.0802	0.0012	4173.9193	<.0001	MLE
SVhpa2yb_pw3alt		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended-115)	TPS	0.0082	0.0013	40.4092	<.0001	MLE
SMycslope	L01	Categorical of yield curve slope	dpa = "relative"	TPS	0.1391	0.0187	55.1005	<.0001	MLE
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	frst_tm_by = "Y"	TPS	-0.1272	0.0131	94.5730	<.0001	MLE
SMDeltaTY10	L01	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	TPS	0.0834	0.0117	51.2108	<.0001	MLE
SMDeltaTY10	L02	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 130	TPS	0.0542	0.0254	4.5581	0.0328	MLE
SMDeltaTm3	L01	Categorical of DeltaTm3Init_r3 (change in 3-month Treasury rate from policy inception to current)	DeltaTm3Init_r > 600	TPS	0.0813	0.0157	26.9695	<.0001	MLE
SMicredit_grp1	L450	Categorical of credit	0<credit_score<=450	TPS	-0.3171	0.1537	4.2550	0.0391	MLE
SMicredit_grp2	L500	Categorical of credit	450<credit_score<=500	TPS	-0.1587	0.0663	5.7186	0.0168	MLE
SMicredit_grp3	L600	Categorical of credit	500<credit_score<=600	TPS	-0.1688	0.0176	92.3610	<.0001	MLE
SMicredit_grp4	L630	Categorical of credit	600<credit_score<=630	TPS	-0.0868	0.0174	24.7981	<.0001	MLE
SMicredit_grp5alt	L720	Categorical of credit	630<credit_score<=720	TPS	0.0094	0.0152	0.3808	0.5372	MLE
SMicredit_grp6alt	L850	Categorical of credit	720<credit_score	TPS	0.0445	0.0224	3.9407	0.0471	MLE
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	TPS	-0.7280	0.0197	1363.0924	<.0001	MLE

Pre-Foreclosure Sale Claims Logistic Model

The model parameters for the binomial model to predict the PFS claim type are shown in Table 66.

Table 66: PFS Claim Binomial Model Parameters

Variable	ClassVal0	Description	Description Detail	Response	DF	Estimate	StdErr	ProbChiSq
Intercept				PRE	1	-4.0960	0.1461	<.0001
SVbalance_i		Outstanding balance at start of quarter		PRE	1	-0.0090	0.0009	<.0001
SVCCI_pw1		Consumer Confidence Index	median(0,CCI-30,91)	PRE	1	-0.0271	0.0008	<.0001
SVCCI_pw2		Consumer Confidence Index	median(0,CCI-91,142-91)	PRE	1	0.0255	0.0017	<.0001

Variable	ClassVal0	Description	Description Detail	Response	DF	Estimate	StdErr	ProbChiSq
SVSBOI_pw1		Small Business Optimism Index	median(0,SBOI-80,95-80)	PRE	1	0.1152	0.0038	<.0001
SVSBOI_pw2		Small Business Optimism Index	median(0,SBOI-95,110-95)	PRE	1	0.0319	0.0045	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	PRE	1	-0.0547	0.0304	0.0725
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	PRE	1	0.3451	0.0400	<.0001
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	PRE	1	-0.6235	0.0617	<.0001
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	PRE	1	-0.2586	0.1170	0.0271
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	PRE	1	0.3685	0.0182	<.0001
SVloansize_raw_grp		Variate version of loansize_raw	min(loansize/1000,600)	PRE	1	0.0156	0.0008	<.0001
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	PRE	1	0.1260	0.0135	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt = 2	PRE	1	0.3572	0.0248	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt >= 3	PRE	1	0.6643	0.0408	<.0001
SVpriormod_pw1		Variate piecewise version of prior_mod_cnt	median(0,prior_mod_cnt-3,15-3)	PRE	1	0.2201	0.0425	<.0001
SMseason	L01	Categorical of season	season = "winter"	PRE	1	-0.0750	0.0127	<.0001
SMseason	L02	Categorical of season	season = "spring"	PRE	1	0.0566	0.0124	<.0001
SMseason	L03	Categorical of season	season = "summer"	PRE	1	-0.0082	0.0123	0.5067
SMperiodnbr_clm	L01_04	Categorical of period number	1 <= period_number <= 4	PRE	1	1.4323	0.0697	<.0001
SMperiodnbr_clm	L05	Categorical of period number	period_number = 5	PRE	1	0.7706	0.0478	<.0001
SMperiodnbr_clm	L06	Categorical of period number	period_number = 6	PRE	1	0.4094	0.0358	<.0001
SMperiodnbr_clm	L07	Categorical of period number	period_number = 7	PRE	1	0.2609	0.0303	<.0001
SVperiodnbr_pw1		Variate piecewise version of period number	median(0,period_number-8,40-8)	PRE	1	-0.0458	0.0009	<.0001
SVperiodnbr_pw2		Variate piecewise version of period number	median(0,period_number-40,53-40)	PRE	1	0.0055	0.0028	0.0538
SVperiodnbr_pw3		Variate piecewise version of period number	median(0,period_number-53,68-53)	PRE	1	-0.0293	0.0049	<.0001
SVperiodnbr_pw4		Variate piecewise version of period number	median(0,period_number-68,108-68)	PRE	1	-0.0220	0.0052	<.0001
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	PRE	1	0.1712	0.0095	<.0001
SVhpa2yb_pw1		Variate piecewise of hpa2y_blended_r1	min(hpa2y_blended_r,85)	PRE	1	0.0206	0.0018	<.0001
SVhpa2yb_pw2		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-85,95-85)	PRE	1	-0.0101	0.0021	<.0001
SVhpa2yb_pw3		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-95,113-95)	PRE	1	0.0151	0.0013	<.0001
SVhpa2yb_pw4		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-113,120-113)	PRE	1	0.0707	0.0030	<.0001
SVhpa2yb_pw5		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended_r-120)	PRE	1	0.0167	0.0017	<.0001
SMycslope	L01	Categorical of yield curve slope	1<=ycslope<=2	PRE	1	0.1400	0.0336	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	frst_tm_by = "Y"	PRE	1	-0.0326	0.0111	0.0033
SMDeltaTY10	L01	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	PRE	1	0.2564	0.0115	<.0001
SMDeltaTY10	L02	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 130	PRE	1	0.0008	0.0330	0.9812
SMDeltaTm3	L01	Categorical of DeltaTm3Init_r3 (change in 3-month Treasury rate from policy inception to current)	DeltaTm3Init_r > 600	PRE	1	-0.0433	0.0269	0.1079

Variable	ClassVal0	Description	Description Detail	Response	DF	Estimate	StdErr	ProbChiSq
SMicredit_grp1	L450	Categorical of credit	0<credit_score<=450	PRE	1	-0.3434	0.1411	0.015
SMicredit_grp2	L500	Categorical of credit	450<credit_score<=500	PRE	1	-0.4628	0.0630	<.0001
SMicredit_grp3	L600	Categorical of credit	500<credit_score<=600	PRE	1	-0.3187	0.0183	<.0001
SMicredit_grp4	L630	Categorical of credit	600<credit_score<=630	PRE	1	-0.1292	0.0186	<.0001
SMicredit_grp5	L680	Categorical of credit	630<credit_score<=680	PRE	1	0.0840	0.0170	<.0001
SMicredit_grp6	L720	Categorical of credit	680<credit_score<=720	PRE	1	0.3624	0.0200	<.0001
SMicredit_grp7	L745	Categorical of credit	720<credit_score<=745	PRE	1	0.5226	0.0270	<.0001
SMicredit_grp8	L800	Categorical of credit	745<credit_score<=800	PRE	1	0.7435	0.0254	<.0001
SMicredit_grp9	L850	Categorical of credit	800<credit_score	PRE	1	0.6325	0.0776	<.0001
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	PRE	1	-0.3884	0.0293	<.0001

Conveyance Severity Model

The model parameters for the Conveyance severity model are shown in Table 67.

Table 67: Conveyance Severity Model Parameters

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
Intercept				Conveyance	9.1327	0.0532	<.0001
SVbalance_i_log		Variate version of log transformed outstanding balance at start of quarter	log(balance_i/1000)	Conveyance	0.3231	0.0013	<.0001
SVCCI_pw1		Consumer Confidence Index	median(0,CCI-30,91)	Conveyance	0.0006	0.0000	<.0001
SVCCI_pw2		Consumer Confidence Index	median(0,CCI-91,142-91)	Conveyance	-0.0005	0.0000	<.0001
SVSBOI_pw1		Small Business Optimism Index	median(0,SBOI-80,95-80)	Conveyance	-0.0022	0.0001	<.0001
SVSBOI_pw2		Small Business Optimism Index	median(0,SBOI-95,110-95)	Conveyance	0.0012	0.0000	<.0001
SVcredit_subsidy_cohort		Credit Subsidy Cohort	SVcredit_subsidy_cohort = credit_subsidy_cohort	Conveyance	-0.0003	0.0000	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	Conveyance	0.0102	0.0005	<.0001
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	Conveyance	0.0091	0.0012	<.0001
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	Conveyance	-0.0253	0.0009	<.0001
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	Conveyance	-0.0279	0.0019	<.0001
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	Conveyance	-0.0055	0.0006	<.0001
SVloansize_raw_grp		Variate version of loansize_raw	min(loansize/1000,600)	Conveyance	0.0288	0.0001	<.0001
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 0	Conveyance	0.0502	0.0005	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	Conveyance	0.1067	0.0009	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt = 2	Conveyance	0.1660	0.0015	<.0001
SVpriormod_pw1		Variate piecewise version of prior_mod_cnt	median(0,prior_mod_cnt-3,15-3)	Conveyance	0.0438	0.0017	<.0001
SMcredit	L01	Credit Score	SMcredit = "L01"	Conveyance	0.0113	0.0009	<.0001
SMcredit	L02	Credit Score	SMcredit = "L02"	Conveyance	0.0051	0.0020	0.0109
SVcredit_pw1		Variate piecewise of Credit Score	median(0,credit_score-500,625-500)	Conveyance	0.0000	0.0000	0.0012
SVcredit_pw2		Variate piecewise of Credit Score	median(0,credit_score-625,680-625)	Conveyance	0.0000	0.0000	<.0001
SMseason	L01	Categorical of season	season = "winter"	Conveyance	0.0008	0.0003	0.0046
SMseason	L02	Categorical of season	season = "spring"	Conveyance	-0.0017	0.0003	<.0001

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
SMseason	L03	Categorical of season	season = "summer"	Conveyance	-0.0015	0.0003	<.0001
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	Conveyance	0.0461	0.0002	<.0001
SMRatioTmpTei	L00	Categorical of ratio_tmp_tei (front-end ratio)	ratio_tmp_tei=0	Conveyance	0.0083	0.0008	<.0001
SVratiotmptei_pw1		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-0,24-0)	Conveyance	0.0003	0.0000	<.0001
SVratiotmptei_pw2		Variate piecewise version of front end ratio	median(0,ratio tmp tei-24,36-24)	Conveyance	0.0005	0.0000	<.0001
SVratiotmptei_pw3		Variate piecewise version of front end ratio	median(0,ratio_tmp_tei-36,50-36)	Conveyance	-0.0004	0.0001	<.0001
SVsato_pw1		Variate piecewise of sato (spread at origination)	min(sato+0.1,0)	Conveyance	-0.0009	0.0002	<.0001
SVsato_pw2		Variate piecewise of sato (spread at origination)	median(0,sato+0.1,0.7+0.1)	Conveyance	0.0268	0.0004	<.0001
SVsato_pw3		Variate piecewise of sato (spread at origination)	max(0,sato-0.7)	Conveyance	-0.0044	0.0001	<.0001
SVhpa2yb_pw1		Variate piecewise of hpa2y_blended_r1	min(hpa2y_blended_r,85)	Conveyance	-0.0002	0.0000	<.0001
SVhpa2yb_pw2		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-85,95-85)	Conveyance	-0.0005	0.0001	<.0001
SVhpa2yb_pw3		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-95,113-95)	Conveyance	-0.0014	0.0000	<.0001
SVhpa2yb_pw4		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y blended r-113,120-113)	Conveyance	0.0033	0.0001	<.0001
SVhpa2yb_pw5		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended_r-120)	Conveyance	0.0003	0.0001	<.0001
SMycslope	L01	Categorical of yield curve slope	Categorical of yield curve slope	Conveyance	0.0067	0.0003	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	Conveyance	-0.0047	0.0004	<.0001
SMdurdefepi	L02	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	Conveyance	-0.0255	0.0004	<.0001
SMdurdefepi	L03	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	Conveyance	-0.0099	0.0004	<.0001
SMdurdefepi	L04	Categorical of dur def episode (duration of default episode)	dur_def_episode = 4	Conveyance	0.0059	0.0004	<.0001
SMdurdefepi	L05	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	Conveyance	0.0220	0.0005	<.0001
SMdurdefepi	L06	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	Conveyance	0.0359	0.0005	<.0001
SMdurdefepi	L07	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	Conveyance	0.0482	0.0005	<.0001
SMdurdefepi	L08	Categorical of dur def episode (duration of default episode)	dur_def_episode = 8	Conveyance	0.0587	0.0006	<.0001
SMdurdefepi	L09	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	Conveyance	0.0693	0.0006	<.0001
SMdurdefepi	L10	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	Conveyance	0.0789	0.0007	<.0001
SMdurdefepi	L11	Categorical of dur def episode (duration of default episode)	dur_def_episode >= 11	Conveyance	0.0827	0.0005	<.0001
SVdurdefepi_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur def episode-10,30-10)	Conveyance	0.0066	0.0001	<.0001
SVdurdefepi_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	Conveyance	0.0052	0.0002	<.0001
SMDeltaTY10	L01	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	Conveyance	0.0004	0.0004	0.3032
SMDeltaTY10	L02	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 130	Conveyance	0.0036	0.0008	<.0001

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
SMloansize	L01	Categorical loansize_raw	loansize_raw<32000	Conveyance	-0.0296	0.0007	<.0001
SVloanraw_pw1		Variate piecewise of loansize_raw	median(0,loansize_raw-32000,70000-32000)	Conveyance	0.0000	0.0000	<.0001
SVloanraw_pw2		Variate piecewise of loansize_raw	median(0,loansize_raw-70000,98000-70000)	Conveyance	0.0000	0.0000	<.0001
SVloanraw_pw3		Variate piecewise of loansize_raw	median(0,loansize_raw-98000,180000-98000)	Conveyance	0.0000	0.0000	<.0001
SVloanraw_pw4		Variate piecewise of loansize_raw	median(0,loansize_raw-180000,500000-180000)	Conveyance	0.0000	0.0000	<.0001
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	Conveyance	-0.0213	0.0012	<.0001

Conveyance Recovery Severity Model

The model parameters for the Conveyance Recovery severity model are shown in Table 68.

Table 68: Conveyance Recovery Severity Model Parameters

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
Intercept				Conveyance Recovery	8.2339	0.0275	<.0001
SVbalance_i_log		Variate version of log transformed outstanding balance at start of quarter	log(balance_i/1000)	Conveyance Recovery	0.2826	0.0069	<.0001
SVCCI_pw1		Consumer Confidence Index	median(0,CCI-30,91)	Conveyance Recovery	-0.0010	0.0001	<.0001
SVCCI_pw2		Consumer Confidence Index	median(0,CCI-91,142-91)	Conveyance Recovery	0.0006	0.0001	<.0001
SVSBOI_pw1		Small Business Optimism Index	median(0,SBOI-80,95-80)	Conveyance Recovery	0.0116	0.0005	<.0001
SVSBOI_pw2		Small Business Optimism Index	median(0,SBOI-95,110-95)	Conveyance Recovery	0.0204	0.0003	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	Conveyance Recovery	-0.0889	0.0028	<.0001
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	Conveyance Recovery	-0.0324	0.0063	<.0001
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	Conveyance Recovery	0.0220	0.0060	0.0002
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	Conveyance Recovery	0.2186	0.0105	<.0001
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	Conveyance Recovery	0.0325	0.0028	<.0001
SVloansize_raw_grp		Variate version of loansize_raw	min(loansize/1000,600)	Conveyance Recovery	0.0164	0.0006	<.0001
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	Conveyance Recovery	-0.0392	0.0025	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt = 2	Conveyance Recovery	-0.0263	0.0047	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt >= 3	Conveyance Recovery	-0.0064	0.0082	0.4323
SVpriormod_pw1		Variate piecewise version of prior_mod_cnt	median(0,prior_mod_cnt-3,15-3)	Conveyance Recovery	0.0256	0.0093	0.0059
SMseason	L01	Categorical of season	season = "winter"	Conveyance Recovery	0.0247	0.0016	<.0001
SMseason	L02	Categorical of season	season = "spring"	Conveyance Recovery	0.0163	0.0016	<.0001
SMseason	L03	Categorical of season	season = "summer"	Conveyance Recovery	-0.0026	0.0016	0.1151
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	Conveyance Recovery	-0.0730	0.0013	<.0001
SMdpa_govt	LGovt	Categorical of down payment assistance, government level indicator	dpa = "govt"	Conveyance Recovery	-0.0980	0.0044	<.0001
SMdpa_nprof	LNPro	Categorical of down payment assistance, non-profit level indicator	dpa = "nonprof"	Conveyance Recovery	-0.1579	0.0021	<.0001
SVsato_pw1		Spread at origination	min(sato+0.1,0)	Conveyance Recovery	-0.0288	0.0014	<.0001
SVsato_pw2		Spread at origination	median(0,sato+0.1,0.7+0.1)	Conveyance Recovery	-0.1233	0.0024	<.0001

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
SVsato_pw3		Spread at origination	max(0,sato-0.7)	Conveyance Recovery	-0.0091	0.0039	0.0194
SVhpa2yb_pw1		Variate piecewise of hpa2y_blended_r1	min(hpa2y_blended_r,85)	Conveyance Recovery	-0.0054	0.0000	<.0001
SVhpa2yb_pw2		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-85,95-85)	Conveyance Recovery	0.0273	0.0003	<.0001
SVhpa2yb_pw3		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-95,113-95)	Conveyance Recovery	0.0149	0.0002	<.0001
SVhpa2yb_pw4		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-113,120-113)	Conveyance Recovery	0.0095	0.0004	<.0001
SVhpa2yb_pw5		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended_r-120)	Conveyance Recovery	0.0102	0.0003	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	Conveyance Recovery	-0.1968	0.0022	<.0001
SMdurdefepi	L02	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	Conveyance Recovery	0.0140	0.0033	<.0001
SMdurdefepi	L03	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	Conveyance Recovery	0.0095	0.0032	0.003
SMdurdefepi	L04	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	Conveyance Recovery	-0.0048	0.0032	0.1339
SMdurdefepi	L05	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	Conveyance Recovery	-0.0194	0.0033	<.0001
SMdurdefepi	L06	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	Conveyance Recovery	-0.0277	0.0034	<.0001
SMdurdefepi	L07	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	Conveyance Recovery	-0.0341	0.0036	<.0001
SMdurdefepi	L08	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	Conveyance Recovery	-0.0317	0.0038	<.0001
SMdurdefepi	L09	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	Conveyance Recovery	-0.0324	0.0039	<.0001
SMdurdefepi	L10	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	Conveyance Recovery	-0.0333	0.0042	<.0001
SMdurdefepi	L11	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 11	Conveyance Recovery	-0.0380	0.0036	<.0001
SVdurdefepi_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	Conveyance Recovery	0.0020	0.0003	<.0001
SVdurdefepi_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	Conveyance Recovery	0.0116	0.0011	<.0001
SMDeltaTY10	L01	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	Conveyance Recovery	-0.1229	0.0019	<.0001
SMDeltaTY10	L02	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 130	Conveyance Recovery	-0.0089	0.0068	0.1945
SMDeltaTm3	L01	Categorical of DeltaTm3Init_r3 (change in 3-month Treasury rate from policy inception to current)	DeltaTm3Init_r > 600	Conveyance Recovery	-0.0609	0.0044	<.0001
SMcredit	L01	Credit Score	credit_score = 0	Conveyance Recovery	0.1818	0.0047	<.0001
SMcredit	L02	Credit Score	credit_score<500	Conveyance Recovery	0.0063	0.0108	0.5608
SVcredit_pw1		Variate piecewise of Credit Score	median(0,credit_score-500,625-500)	Conveyance Recovery	0.0000	0.0000	0.6883
SVcredit_pw2		Variate piecewise of Credit Score	median(0,credit_score-625,680-625)	Conveyance Recovery	0.0005	0.0001	<.0001
SMloansize	L01	Categorical loansize_raw	loansize_raw<32000	Conveyance Recovery	-0.2375	0.0050	<.0001
SVloanraw_pw1		Loan amount	median(0,loansize_raw-32000,70000-32000)	Conveyance Recovery	0.0000	0.0000	<.0001
SVloanraw_pw2		Loan amount	median(0,loansize_raw-70000,98000-70000)	Conveyance Recovery	0.0000	0.0000	<.0001

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
SVloanraw_pw3		Loan amount	median(0,loansize_raw-98000,180000-98000)	Conveyance Recovery	0.0000	0.0000	<.0001
SVloanraw_pw4		Loan amount	median(0,loansize_raw-180000,500000-180000)	Conveyance Recovery	0.0000	0.0000	<.0001
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	Conveyance Recovery	-0.1835	0.0068	<.0001

Third Party Sales Severity Model

The model parameters for the TPS severity model are shown in Table 69.

Table 69: TPS Severity Model Parameters

Parameter	Level1	Description	Description Detail	Response	Estimate	StdErr	ProbChiSq
Intercept				TPS	10.7204	0.0669	<.0001
SVbalance_i_log		Variate version of log transformed outstanding balance at start of quarter	log(balance_i/1000)	TPS	0.6240	0.0038	<.0001
SMBOI	L00	Categorical of Business Optimism Index	sboi <= 104	TPS	0.1607	0.0076	<.0001
SVSBOI_alt		Small Business Optimism Index	MEDIAN(0,sboi-89,108.18-89)	TPS	-0.0237	0.0008	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	TPS	0.0824	0.0164	<.0001
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	TPS	0.0778	0.0251	0.0019
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	TPS	0.0136	0.0221	0.5378
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	TPS	-0.0195	0.0447	0.662
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	TPS	0.0060	0.0112	0.5922
SMpriormod	L01	Categorical of Prior Loan Modifications	prior_mod_cnt = 1	TPS	0.0901	0.0055	<.0001
SMpriormod	L02	Categorical of Prior Loan Modifications	prior_mod_cnt =2	TPS	0.2037	0.0089	<.0001
SMpriormod	L03	Categorical of Prior Loan Modifications	prior_mod_cnt >= 3	TPS	0.3221	0.0113	<.0001
SMseason	L01	Categorical of season	season = "winter"	TPS	-0.0070	0.0060	0.243
SMseason	L02	Categorical of season	season = "spring"	TPS	-0.0224	0.0059	0.0001
SMseason	L03	Categorical of season	season = "summer"	TPS	-0.0031	0.0059	0.5991
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	TPS	0.2489	0.0045	<.0001
SMRatioTmpTei_alt	L00	Categorical of ratio tmp tei (front-end ratio)	ratio_tmp_tei = 0	TPS	-0.0296	0.0128	0.0202
ratio_tmp_tei		Variate version of front end ratio	ratio_tmp_tei	TPS	-0.0027	0.0003	<.0001
SVratiotmptei_pw1alt		Variate piecewise version of front end ratio	median(0,ratio tmp tei-50,148.3-50)	TPS	0.0064	0.0015	<.0001
Vsato		Variate of sato (spread at origination)	sato	TPS	0.0679	0.0042	<.0001
SMhpa2y_blended_r	L00	Categorical of hpa2y_blended_r1	hpa2y_blended = 0	TPS	-3.0374	0.0662	<.0001
SVhpa2yb_pw1alt		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r,115)	TPS	-0.0277	0.0006	<.0001
SVhpa2yb_pw2alt		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-115,162-115)	TPS	-0.0061	0.0006	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	TPS	0.1561	0.0057	<.0001
dur_def_episode		variate of dur def episode (duration of default episode)	dur_def_episode	TPS	0.0289	0.0003	<.0001
SMdurdefepi_alt	L01	Categorical of rfnc_ind (refinanced loan indicator)	dur_dep_episode = 1	TPS	0.1122	0.0108	<.0001
SVdurdefepi_pw1alt		variate piecewise of dur def episode (duration of default episode)	median(0,dur_def_episode-40,50-40)	TPS	-0.0643	0.0050	<.0001
SMDeltaTm3	L01	Categorical of DeltaTm3Init_r2 (change in 3-month Treasury rate from policy inception to current)	DeltaTm3Init_r > 600	TPS	-0.1568	0.0058	<.0001
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	TPS	0.1304	0.0075	<.0001

Pre-Foreclosure Sale Severity Model[85]

The model parameters for the PFS severity model are shown in Table 70.

Table 70: PFS Severity Model

Parameter	Level1	Description	Description Detail	Response	DF	Estimate	StdErr	ProbChiSq
Intercept				Pre	1	6.7314	0.0543	<.0001
SVbalance_i_log		Variate version of log transformed outstanding balance at start of quarter	log(balance_i/1000)	Pre	1	0.7910	0.0039	<.0001
SMproduct	ARM	Categorical of product type	adjustable rate mortgage	Pre	1	-0.0088	0.0084	0.2972
SMproduct	ARMSR	Categorical of product type	adjustable rate mortgage - streamline refinance	Pre	1	0.1412	0.0134	<.0001
SMproduct	FRM15	Categorical of product type	15 year fixed rate mortgage	Pre	1	0.0145	0.0254	0.5678
SMproduct	FRM15SR	Categorical of product type	15 year fixed rate mortgage - streamline refinance	Pre	1	0.1296	0.0452	0.0041
SMproduct	FRM30SR	Categorical of product type	30 year fixed rate mortgage - streamline refinance	Pre	1	0.1845	0.0066	<.0001
SMseason	L01	Categorical of season	season = "winter"	Pre	1	0.0122	0.0049	0.0137
SMseason	L02	Categorical of season	season = "spring"	Pre	1	-0.0199	0.0047	<.0001
SMseason	L03	Categorical of season	season = "summer"	Pre	1	-0.0093	0.0048	0.0519
SMjudicial	L01	Categorical of judicial (judicial state)	judicial = 1	Pre	1	0.0369	0.0037	<.0001
SMdpa_govt	LGovt	Categorical of down payment assistance, government level indicator	dpa = "govt"	Pre	1	0.0560	0.0143	<.0001
SMdpa_nprof	LNPro	Categorical of down payment assistance, non-profit level indicator	dpa = "nonprof"	Pre	1	0.1382	0.0056	<.0001
SVhpa2yb_pw1		Variate piecewise of hpa2y_blended_r1	min(hpa2y_blended_r,85)	Pre	1	0.0004	0.0006	0.512
SVhpa2yb_pw2		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-85,95-85)	Pre	1	-0.0271	0.0008	<.0001
SVhpa2yb_pw3		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-95,113-95)	Pre	1	-0.0159	0.0004	<.0001
SVhpa2yb_pw4		Variate piecewise of hpa2y_blended_r1	median(0,hpa2y_blended_r-113,120-113)	Pre	1	0.0113	0.0011	<.0001
SVhpa2yb_pw5		Variate piecewise of hpa2y_blended_r1	max(0,hpa2y_blended_r-120)	Pre	1	0.0007	0.0006	0.2863
SMycslope	L01	Categorical of yield curve slope	Categorical of yield curve slope	Pre	1	-0.1918	0.0049	<.0001
SMfrst_tm_by	1	Categorical of frst_tm_by (first-time buyer)	frst_tm_by = "Y"	Pre	1	0.0657	0.0052	<.0001
SMrfncind	LY	Categorical of rfnc_ind (refinanced loan indicator)	rfnc_ind <> "N"	Pre	1	0.2273	0.0063	<.0001
SMdurdefepi	L02	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 2	Pre	1	0.1117	0.0054	<.0001
SMdurdefepi	L03	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 3	Pre	1	0.1932	0.0057	<.0001

Parameter	Level1	Description	Description Detail	Response	DF	Estimate	StdErr	ProbChiSq
SMdurdefepi	L04	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 4	Pre	1	0.2682	0.0063	<.0001
SMdurdefepi	L05	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 5	Pre	1	0.3332	0.0071	<.0001
SMdurdefepi	L06	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 6	Pre	1	0.4042	0.0081	<.0001
SMdurdefepi	L07	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 7	Pre	1	0.4538	0.0090	<.0001
SMdurdefepi	L08	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 8	Pre	1	0.4898	0.0101	<.0001
SMdurdefepi	L09	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 9	Pre	1	0.5430	0.0114	<.0001
SMdurdefepi	L10	Categorical of dur_def_episode (duration of default episode)	dur_def_episode = 10	Pre	1	0.5934	0.0126	<.0001
SMdurdefepi	L11	Categorical of dur_def_episode (duration of default episode)	dur_def_episode >= 11	Pre	1	0.6189	0.0102	<.0001
SVdurdefepi_pw1		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-10,30-10)	Pre	1	0.0263	0.0014	<.0001
SVdurdefepi_pw2		Variate piecewise of dur_def_episode (duration of default episode)	median(0,dur_def_episode-30,40-30)	Pre	1	0.0166	0.0078	0.0329
SMDeltaTY10	L01	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r < 53	Pre	1	0.2681	0.0047	<.0001
SMDeltaTY10	L02	Categorical of DeltaTy10Init_r2 (change in 10-year Treasury rate from policy inception to current)	DeltaTy10Init_r > 130	Pre	1	-0.0588	0.0121	<.0001
SMcredit	L01	Credit Score	credit_score = 0	Pre	1	-0.2441	0.0125	<.0001
SMcredit	L02	Credit Score	credit_score<500	Pre	1	0.0042	0.0296	0.8871
SVcredit_pw1		Variate piecewise of Credit Score	median(0,credit_score-500,625-500)	Pre	1	-0.0007	0.0001	<.0001
SVcredit_pw2		Variate piecewise of Credit Score	median(0,credit_score-625,680-625)	Pre	1	-0.0008	0.0001	<.0001
Covid_ID	N	Indicator Covid period (Jan 2020+)	period lt 202001	Pre	1	0.3219	0.0116	<.0001

cx_time[1] = time since last condition D
DeltaTy10Init_r[2] = round(DeltaTy10Init*100,1)
DeltaTy1Init_r[3] = round(DeltaTy1Init*100,1)
DeltaUEInit_r[4] = round(100*DeltaUEInit,1)
deltauepr3_r[5] = round(delta_ue_sa_st*100,1)
hpa2y_blended_r[6] = round(hpa2y_blended*100,1); HPA2Y = 2 year house price appreciation
ltv_i_r[7] = round(ltv_i*100,1)
ue_blended_r[8] = round(ue_blended*100,1)
ycslope_r[9] = round(ycslope*100,1)
ue_sa_st_r[10] = round(ue_sa_st*100,1)
prior3_ue_r[11] = round(prior3_ue_sa_st*100,1) state unemployment 3rd prior quarter

DeltaTm3Init_r[12] = Round(DeltaTm3Init*100,1)
refi_incent2_r[13] = round(100*int_rt/frm30_rate,1); int_rt = loan interest rate; frm30_rate = current frm30 rate

Model Validation

Model validation was accomplished by applying the models developed using the training set to the validation dataset. The application of the models to the validation data produces the probability of each type of claim settlement type and a predicted net loss. The actual target variable is then compared to the predicted target variable to ensure the model fits the claim settlement process and net loss process without over-fitting the actual data.

Specifically, for the loss settlement models, for the final loss settlement type we calculate the predicted probability of the settlement type. The actual settlement type is 1 for the final type of claim and 0 for all other claim types. The probability of each claim type for each record in the validation dataset is derived from the model parameters. The sum of all predicted claim type probabilities is 1 for each record.

For the net loss severity models, we calculate a predicted net loss. We also summarize the actual net loss for each claim. The predicted loss severity for each record in the validation dataset is derived from the model parameters.

Decile charts are then created for each final claim type selection and each net loss. All records are sorted, or ranked, in ascending order by the predicted value. Ten equal-sized decile groups are created with 10% of the records in each group. The sum of the actual probability and the sum of the predicted probability for each claim type within each decile is calculated for the claim type models. The sum of the actual net loss and the sum of the predicted net loss within each decile is calculated for the loss severity models. The actual and predicted numbers are then compared for consistency. The objective of a model is to have a significant spread in predicted values while maintaining a close relationship between the resulting actual and predicted values.

Loss Mitigation Model

The validation charts for the loss mitigation models are shown in Figures 49 and 50.

Figure 49: Loss Mitigation Binomial Model Validation

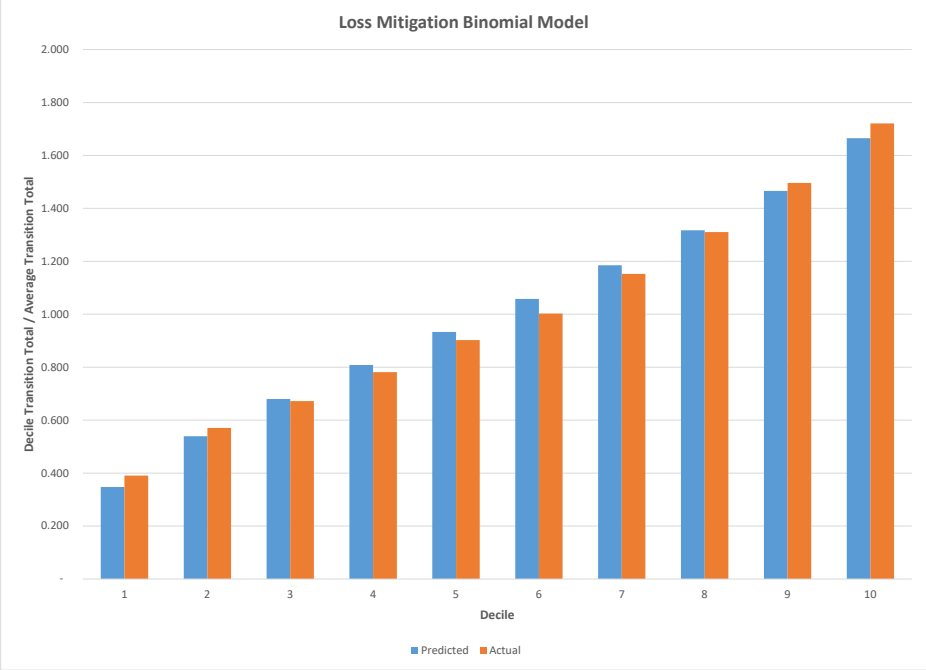
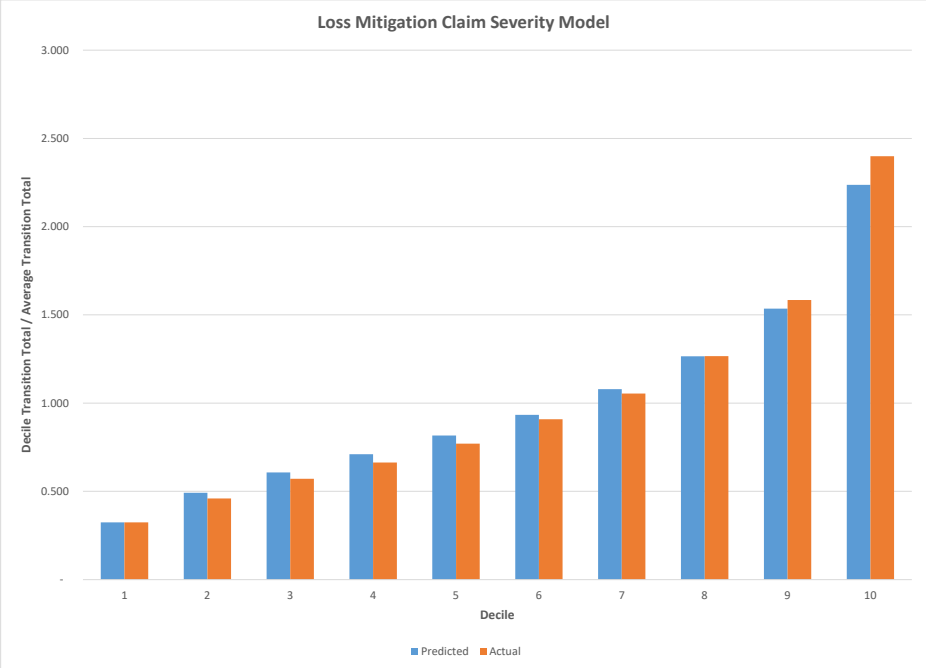


Figure 50: Loss Mitigation Claim Severity Model Validation



Claim Type Model

The validation charts for the Claim Type models are shown in Figures 51, 52, and 53.

Figure 51: Conveyance Claim Type Model Validation Chart

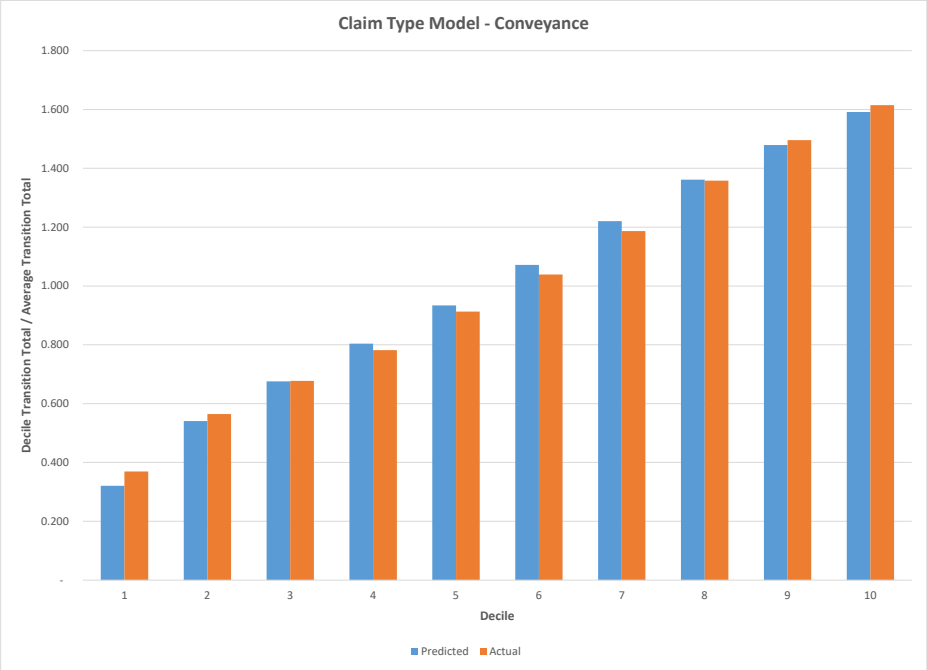


Figure 52: TPS Claim Type Model Validation Chart

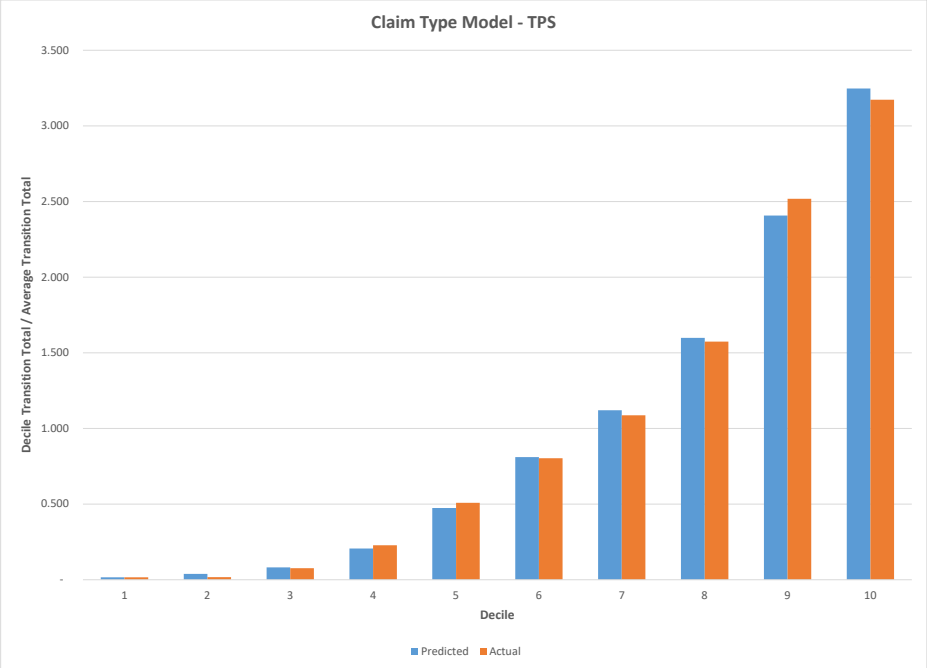
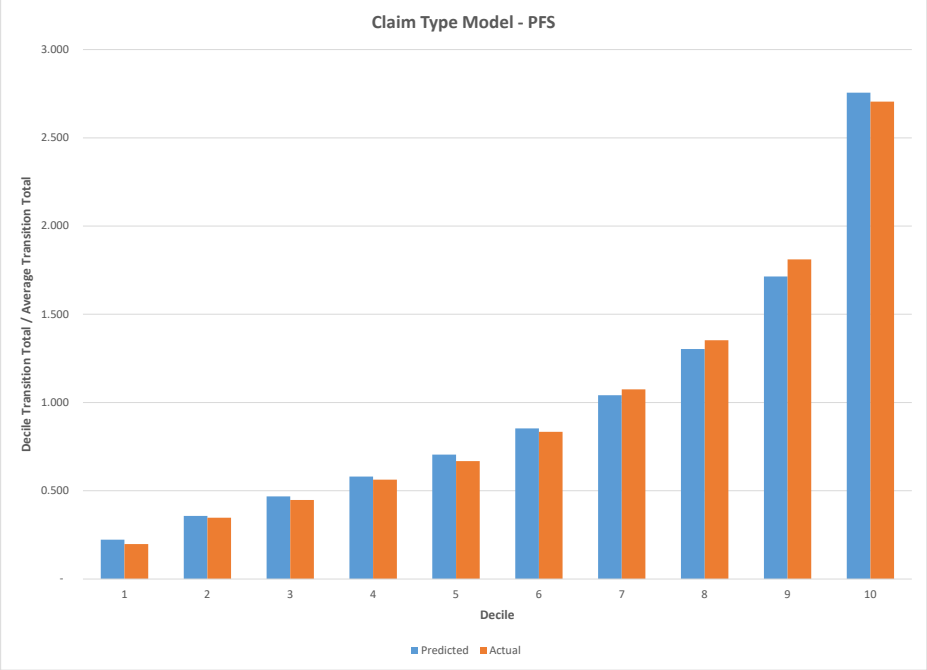


Figure 53: PFS Claim Type Model Validation Chart



Claim Type Severity Models

The validation charts for the Claim Type Severity models are shown in Figures 54, 55, 56, and 57.

Figure 54: Conveyance Loss Severity Model Validation

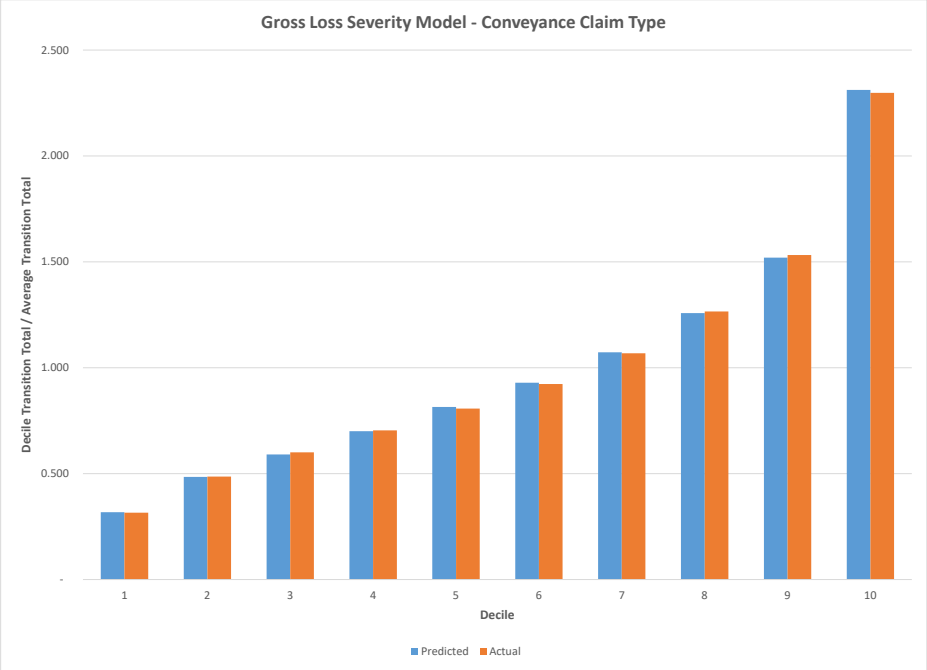


Figure 55: Conveyance Recovery Loss Severity Model Validation

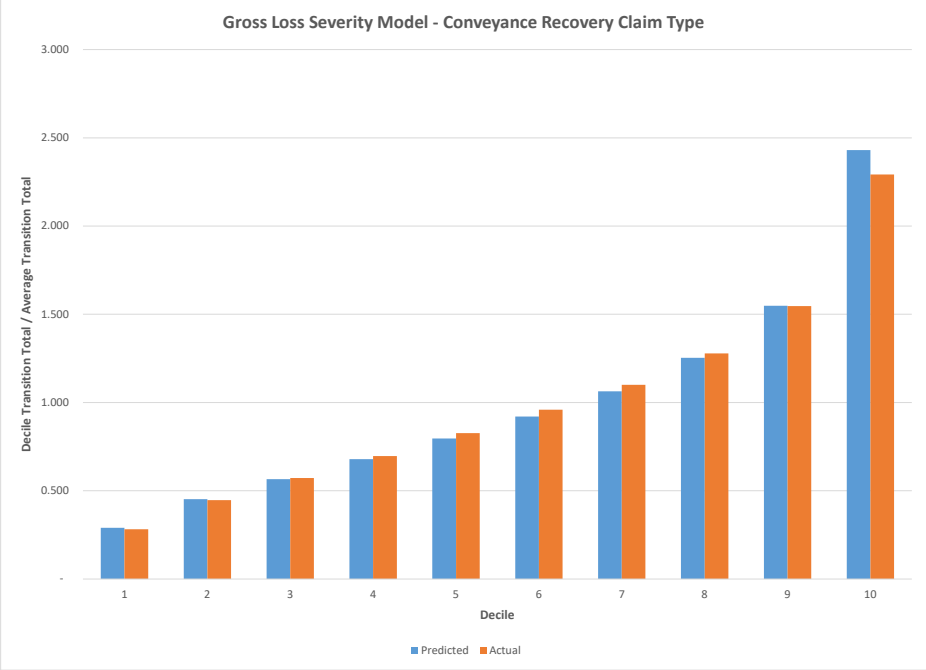


Figure 56: PFS Loss Severity Model Validation

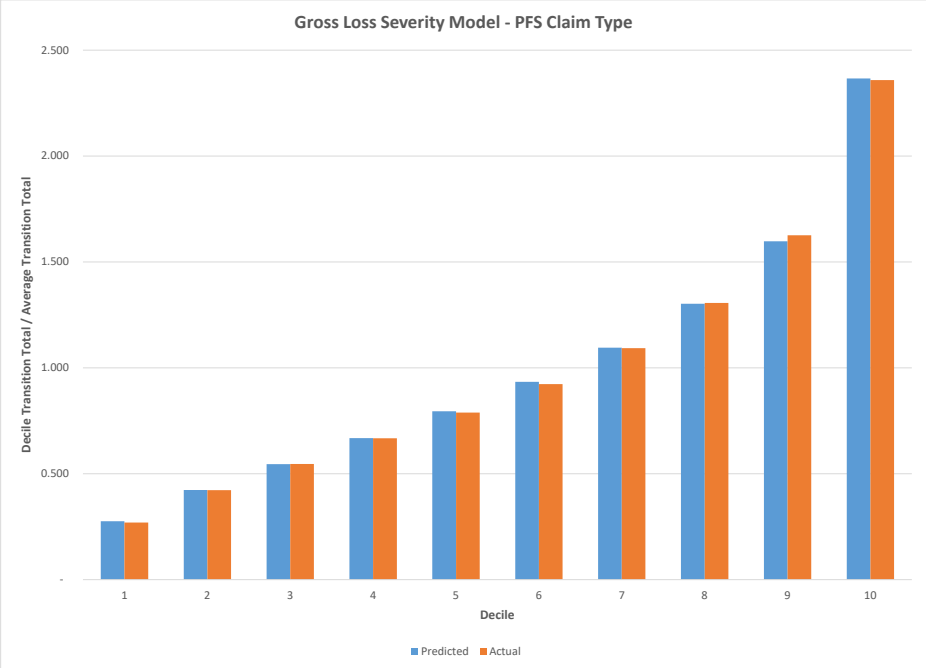
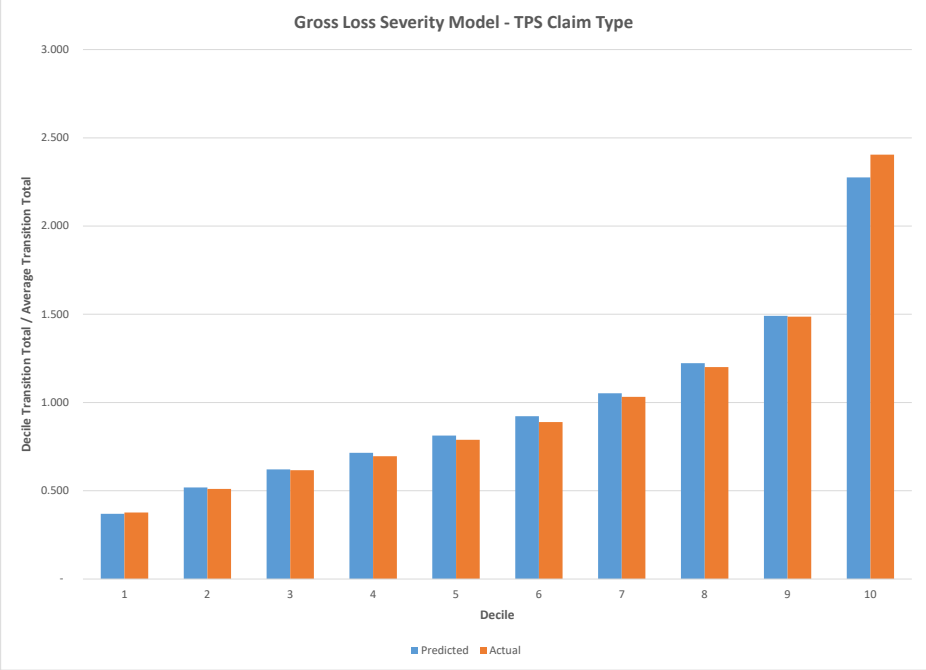


Figure 57: TPS Loss Severity Model Validation



Appendix D: Economic Scenarios

To measure the possible variation in MMI's Cash Flow NPV on the existing portfolio, we developed a baseline projection using OMB Economic Assumptions and projections for ten additional deterministic economic scenarios from Moody's. For this analysis, we used the Moody's October 2022 forecast of the U.S. economy. For purposes of our analysis, the components of Moody's forecast include:

- HPI at the MSA, state, regional and national levels
- One-year CMT rate
- Three-year CMT rate
- Five-year CMT rate
- 10-year CMT rate
- 30-year CMT rate
- Commitment rate on 30-year fixed-rate mortgages
- Unemployment rates at the MSA, state, regional and national levels
- GDP

Alternative Scenarios

To assess the effect of alternative economic scenarios on the Cash Flow NPV, ten alternative scenarios from Moody's were used. The ten Moody's scenarios are:

- Baseline
- Alternative 0 – Upside (4th Percentile)
- Alternative 1 – Upside (10th Percentile)
- Alternative 2 – Downside (75th Percentile)
- Alternative 3 – Downside (90th Percentile)
- Alternative 4 – Downside (96th Percentile)
- Slower Trend Growth
- Stagflation
- Next-Cycle Recession
- Low Oil Price

The Moody's projections provide a range of better-than-expected economic assumptions and worse than expected economic assumptions. This range of assumptions produces a range of Cash Flow NPV projections.

Graphical Depiction of the Scenarios

Figure 58 shows the future movements of the HPI under the baseline and the alternative economic scenarios. In the Baseline scenario, the HPI increases throughout the entire projection period. The

rate of decreases from 9.1% to about 0.0% in the second quarter of 2023, and then increases to about 4.0% per year by 2028 and remains at this level for the remainder of the projection period.

Figure 58: Paths of the Future National House Price Index in Different Scenarios

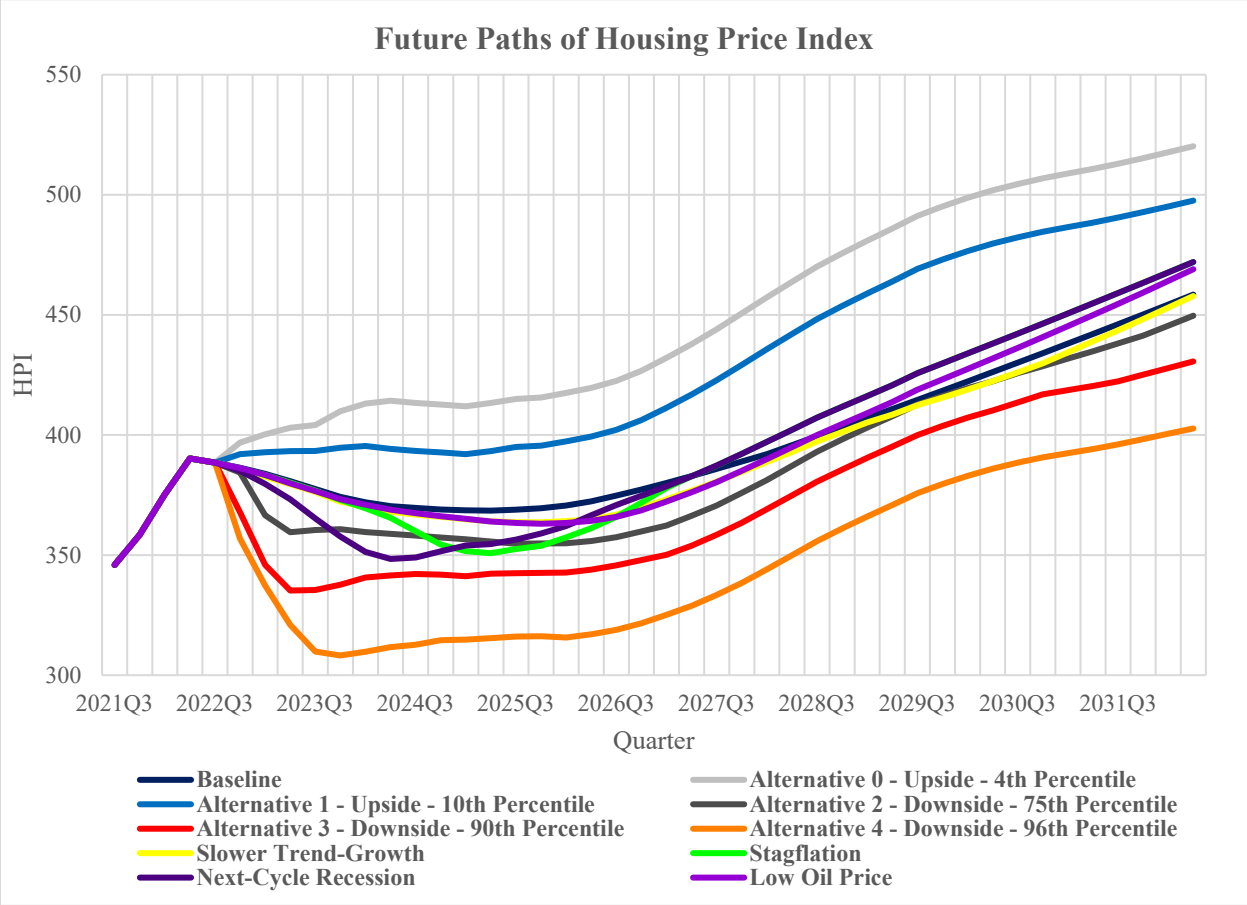


Figure 59 shows the forecasted mortgage rate of 30-year fixed-rate mortgages for the ten Moody's scenarios. For the Moody's Baseline Scenario, the mortgage interest rate remains flat through the second quarter of 2024, increases through the second quarter of 2026, and then levels off at 5.6%.

Figure 59: Paths of the Future Mortgage Rate

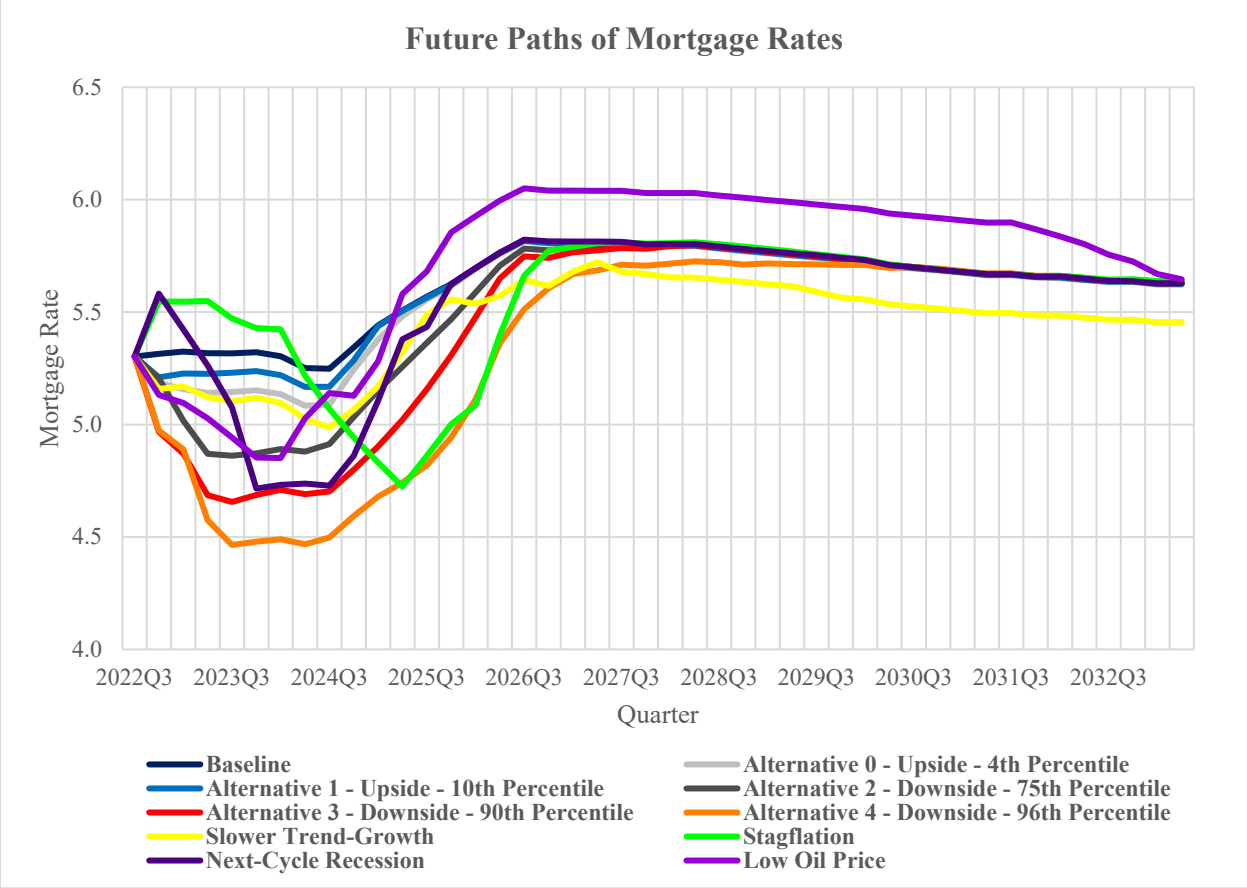
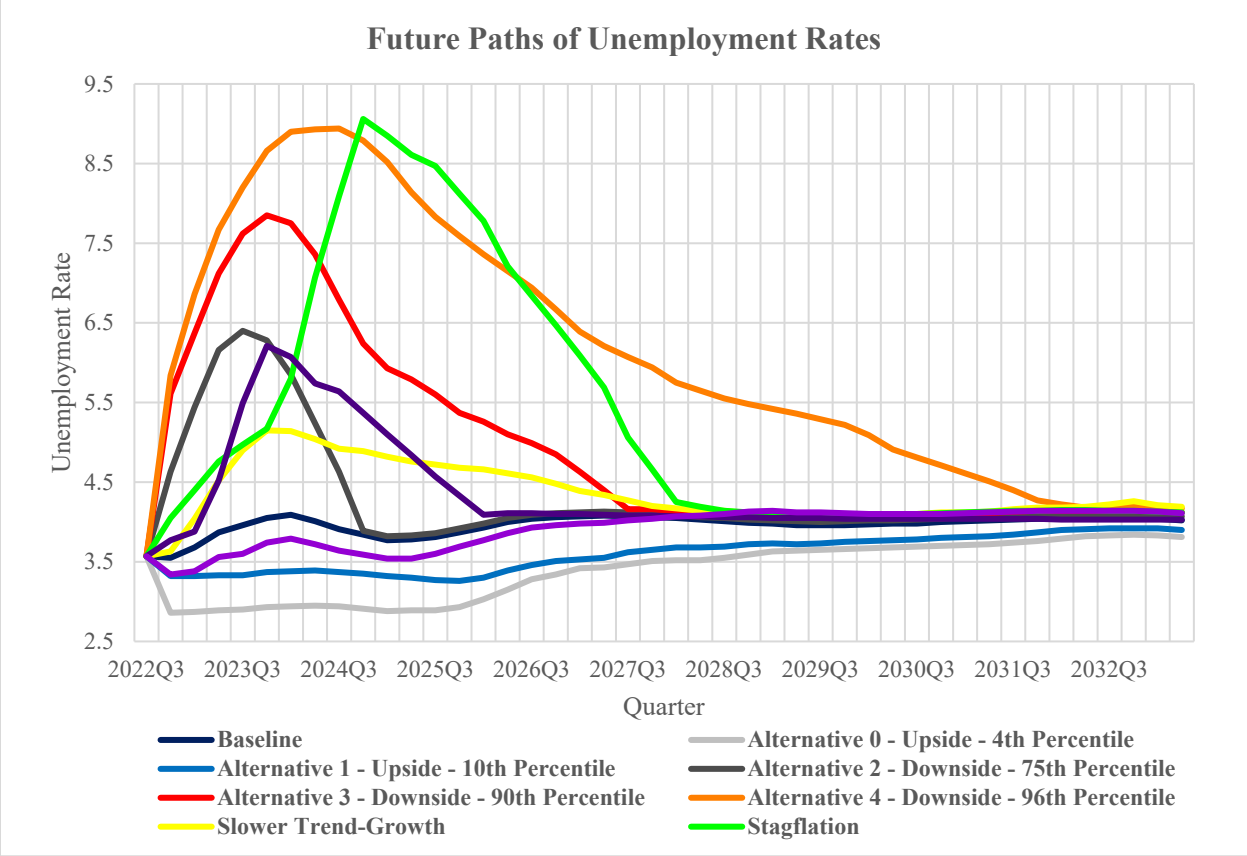


Figure 60 shows the forecasted unemployment rate under alternative economic scenarios. Under the Moody's Baseline forecast, the unemployment rate is projected to decrease through 2022 to approximately 3.5%, and then increases to 4.1% at the end of 2026. The rate then remains steady at that level for the remainder of the projection period.

Figure 60: Paths of Future National Unemployment Rate



Stochastic Simulation

This section describes the stochastic models fitted to generate the economic variables simulations used in the projection of Cash Flow NPV. The economic variables modeled herein as stochastic for computing expected present values include:

- Three-month CMT rates
- Six-month CMT rates
- 10-year CMT rates
- 1-year CMT rates
- 30-year CMT rates
- 30-year FRM rates
- FHFA National Purchase Only House Price Index (HPI-PO)
- Unemployment Rates
- Gross Domestic Product (GDP)
- Small Business Normalized Optimism Index (NOI)
- Consumer Confidence Index (CCI)
- London Interbank Offered Rates (LIBOR)
- Secured Overnight Financing Rates (SOFR)

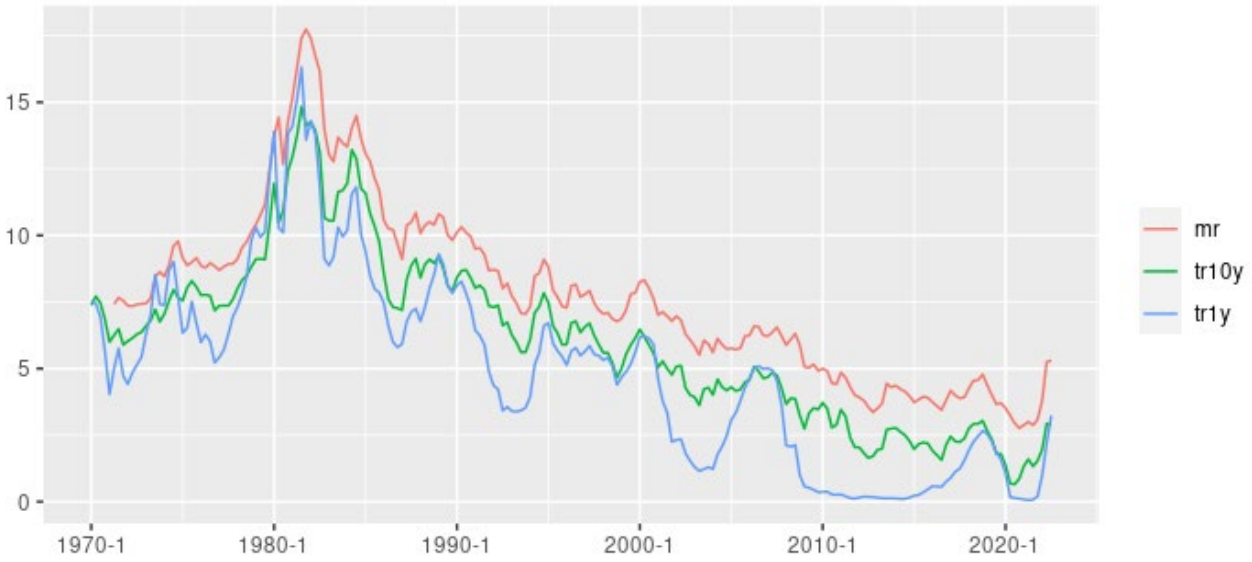
Historical Data

A. Interest Rates

Figures 61 and 62 shows historical interest rates since 1971. This graph illustrates the variability of interest rates over time and the consistent spread between rates. Shown are the one-year CMT rate (tr1y), 10-year CMT rate (tr10y) and the 30-year FRM rate (mr).

High inflation rates caused by the global oil crisis in the late 1970's was the major factor for the historically high level in early 1980's. The Federal Reserve shifted its monetary policy from managing interest rates to managing the money supply to influence interest rates after this period. The one-year CMT rate was around 5% in calendar year 1971 and increased steadily to its peak of 16.31% in the third quarter of calendar year 1981. After that, it followed a decreasing trend and reached a low of 0.10% in second quarter of calendar year 2014. Since then, rates had started a slow upward trend up until recently where there is a sharp downward trend reaching a historic low of 0.06% in the second quarter of 2021, a result of the COVID-19 pandemic before turning up since that time. We see the beginning of the Federal Reserve tightening in the most recent quarter where the one-year rate has increased to a little over 2%.

Figure 61: Historical Interest Rates (%)



Multiple short-term rates were included in these simulations, including three-, six- and 12-month CMT rates, SOFR, and LIBOR. Figure 62 illustrates the close relationship between these rates with the most volatility in LIBOR.

Figure 62: Historical Shorter-Term Interest Rates (%)

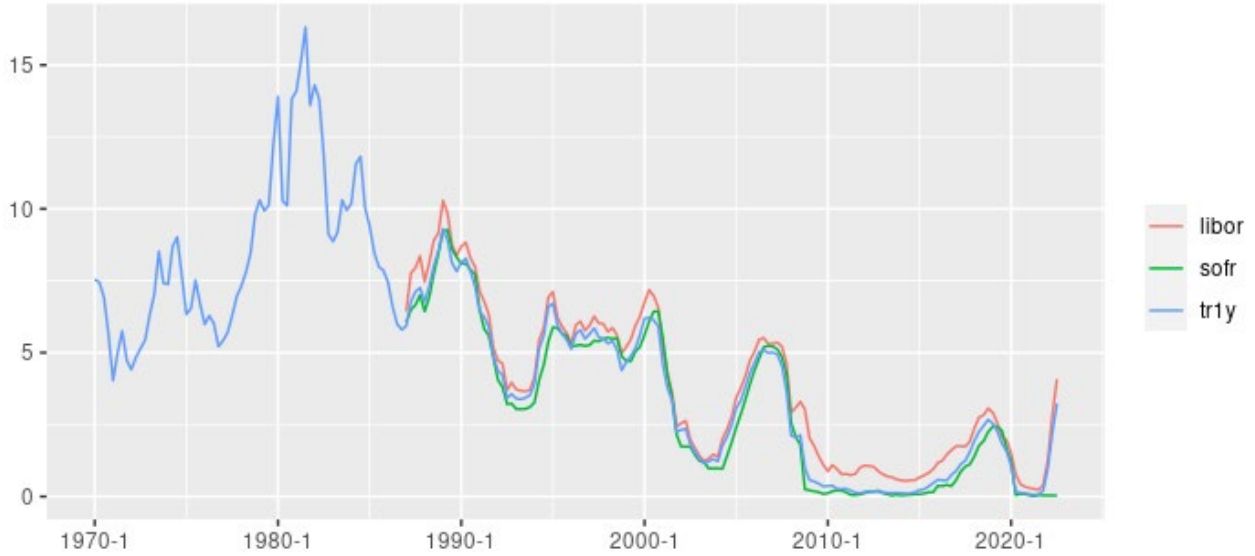
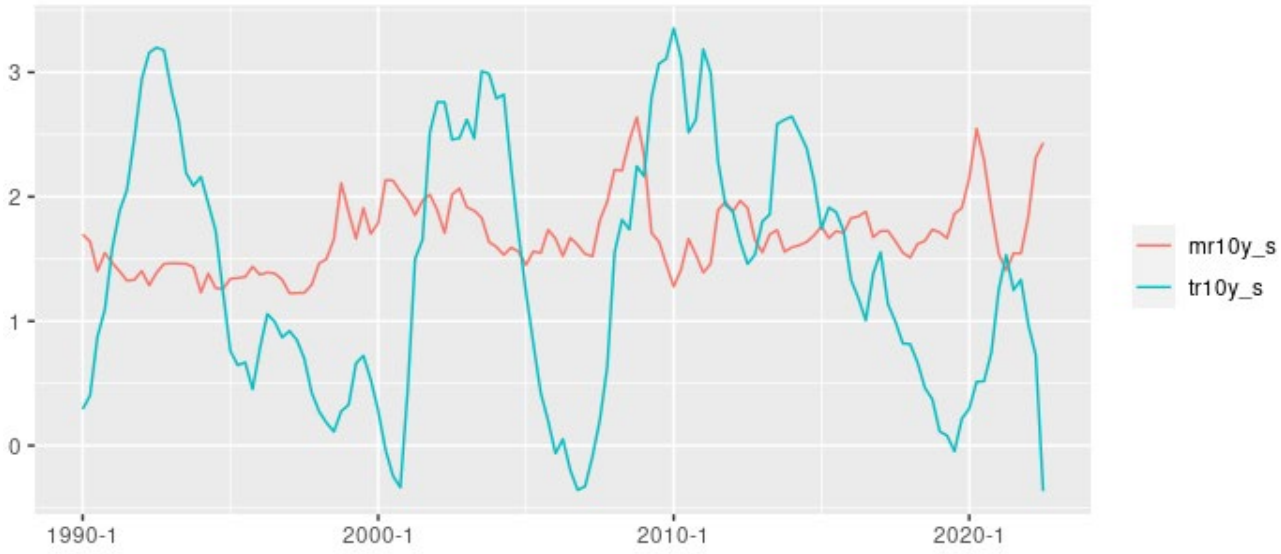


Figure 63 shows historical interest rate spreads, including the spread between 10-year and one-year CMT rates (tr10y_s) and the spread between the 30-year FRM rate and the 10-year CMT rate (mr10y_s). Both spreads are primarily positive with long cycles. Lower, negative spreads typically correspond with economic downturns, such as the downturn that occurred during the late 1970's through the early 1980's. Also note, the spread of the mortgage rate over the 10-year CMT rate is always positive, reflecting the premium for credit risk. Both spreads turn sharply in the last four quarters.

Figure 63: Historical Interest Rate Spreads (%)



B. House Price Appreciation Rates

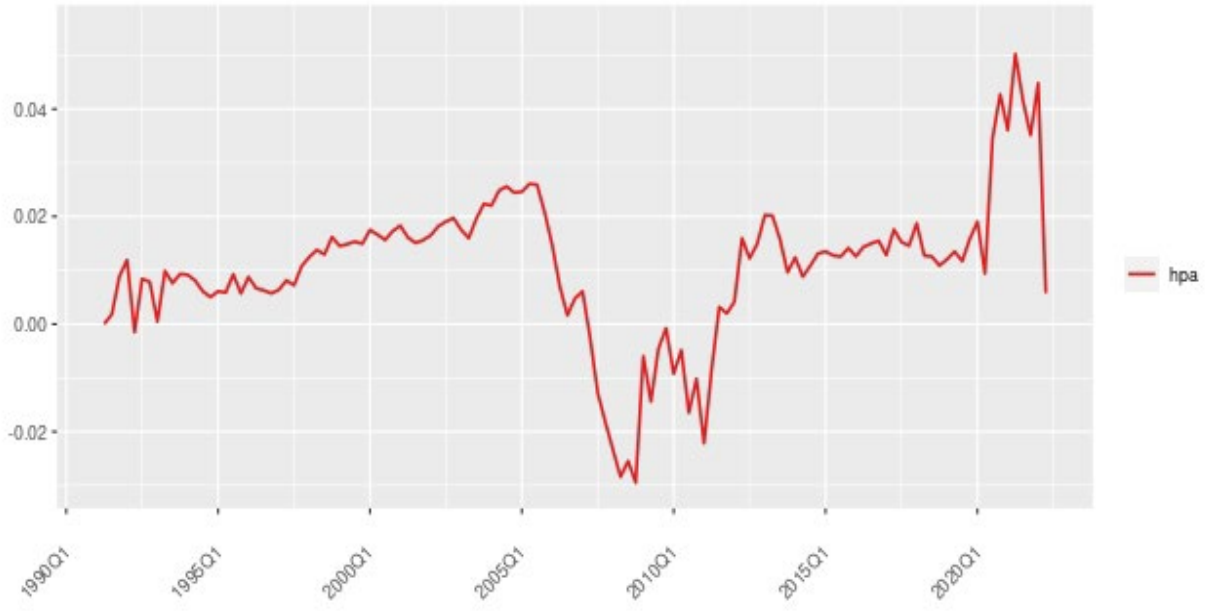
The national house price appreciation rate (HPA) is derived from the FHFA repeat sales house price indexes (HPIs) of purchase-only (PO) transactions. The PO HPI provides a reliable measure of housing market conditions since it is based on repeat sales at market prices and does not use any appraised values.

The HPA series being modeled is defined as:

$$HPA_t = \ln\left(\frac{HPI_t}{HPI_{t-1}}\right) \qquad (1)$$

Figure 64 shows the national quarterly HPA from the first quarter of calendar year 1991 to the third quarter of calendar year 2022. The long-term average quarterly HPA is approximately 0.87% (3.30% annual rate).

Figure 64: Historical National HPI and Quarterly HPA



The HPI increased steadily before 2004, and the quarterly appreciation rate was around 1.14%. Then house prices rose sharply starting in 2004. The average quarterly home-price appreciation rate was 1.88% during the subprime mortgage expansion period from 2004 to 2006 and reached its peak of 2.59% in the second quarter of 2005. After 2006, the average growth rate of house prices became negative until 2011, when appreciation returns to a positive value. The appreciation rate generally increased until approximately the end of 2012, where it dipped before increasing at a gradual rate until approximately 2018. Following a slight dip in 2018, there was a period of almost eight quarters with a nearly flat appreciation rate, which was interrupted by the first two quarters of the COVID-19 shutdowns. This period showed a decrease, followed by historic home appreciation not seen since the sub-prime bubble. Low inventory, low interest rates, prohibitively high construction costs, and more remote work options were all contributing factors to this recent

home appreciation. In the latest quarter, increases in interest rates, increasing inventory and affordability challenges have led to a significant slowdown in HPA.

Table 71 shows the quarterly HPA by selected historical time-periods.

Table 71: Average Quarterly HPA by Time Span

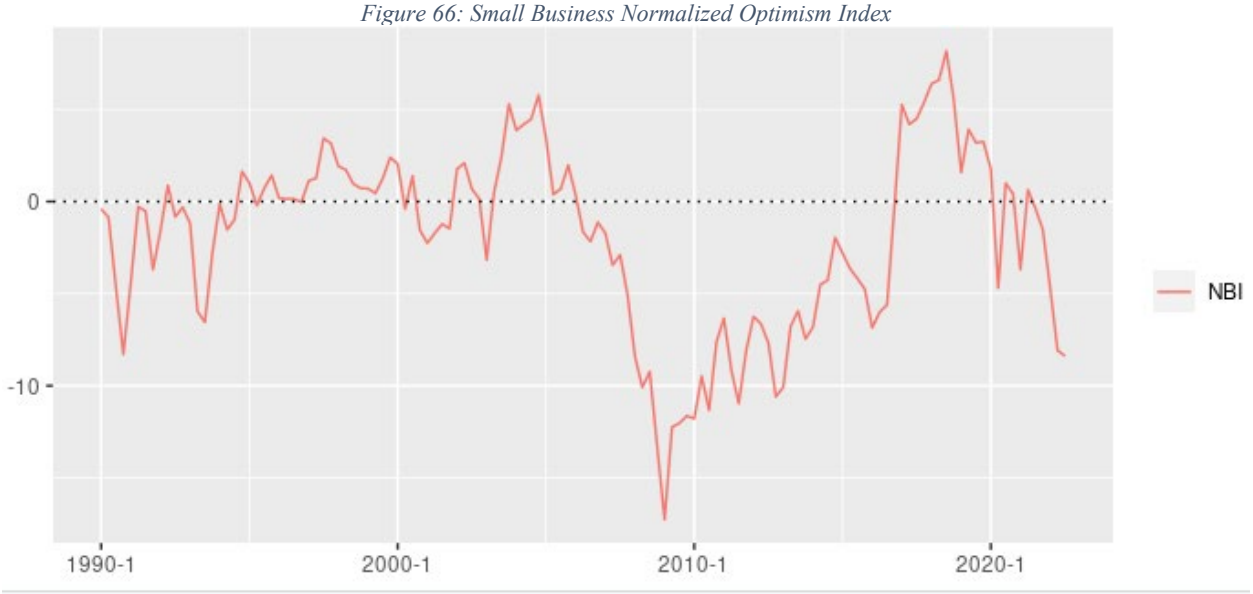
Period	Average Quarterly HPA
1991 – 2003	1.13%
2004 – 2006	1.84%
2007 – 2010	-1.25%
2011 – 2019	1.13%
2020-2022-Q3	3.28%

C. Confidence Indices

The Small Business NOI and CCI are confidence indices based on surveys conducted throughout the year by The Conference Board. These indexes are designed to provide a relative measure of how optimistic or pessimistic consumers and small business are regarding their expected financial situation. Both indices are based around 100 points where indicators above 100 signal relative optimism for the future of the economy, values below 100, relative pessimism. Figure 65 and Figure 66 show historical CCI and NOI, with noted sharp drops in confidence associated to the 2008 mortgage crisis and the beginning of the COVID-19 shutdowns. Since the second quarter of 2020 during the COVID-19 shutdown, the CCI has improved to a level of modest optimism as of the third quarter of 2022. During the same period the NOI has bounced up and down with the most recent quarter staying firmly in negative territory.

Figure 65: Consumer Confidence Index

Figure 66: Small Business Normalized Optimism Index

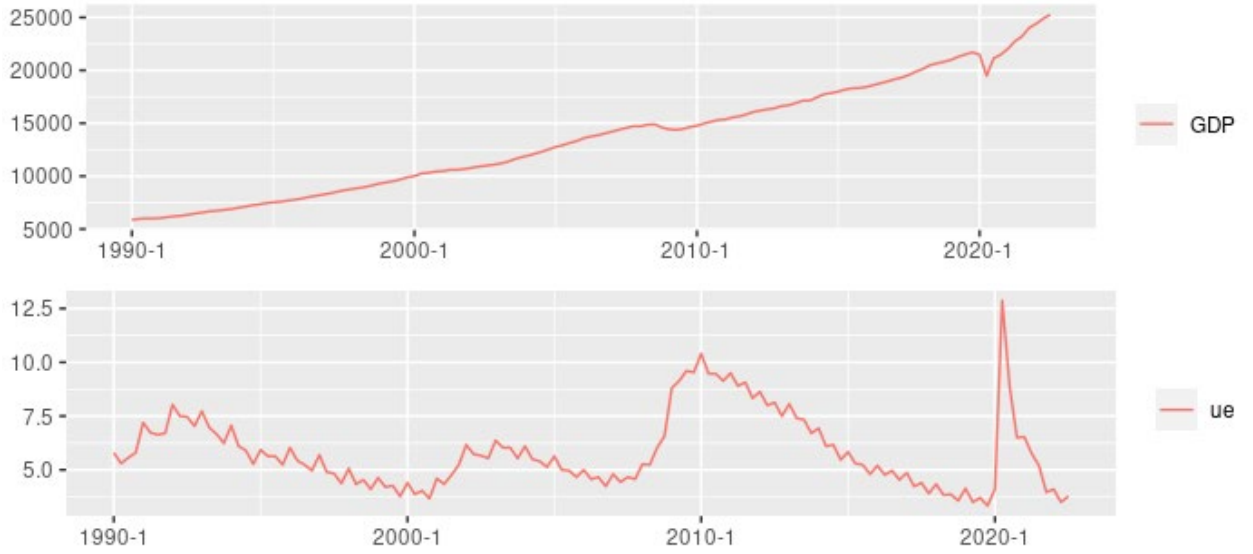


Modeling Method

In financial econometrics and management understanding, predicting the dependence in the co-movements of these series is important when simulating a set of economic factors. This is illustrated in Figure 61, where interest rates track closely.

Long periods of high unemployment will lead to lower GDP. In Figure 67, we can see two obvious examples of this following the mortgage crisis in 2008 and again with the recent COVID-19 pandemic. The most recent quarters illustrate how lockdown restrictions lessened, unemployment dropped, and GDP again begins to increase.

Figure 67: Unemployment vs. GDP



Volatilities will also move together across these series. High levels of economic instability and uncertainty will lead to volatility in these measures, affecting all economic indicators. A modeling method that accounts for these factors will lead to models that are more relevant.

Recognizing and accounting for these features through a multivariate model should lead to more accurate empirical models than working with separate univariate models.

For these reasons a multivariate General Auto Regressive Conditional Heteroscedasticity (GARCH) modeling approach was chosen.

Univariate GARCH models are typically specified as GARCH(*p,q)* where p is the auto regressive (AR) component of ${\sigma_t}^2$, and q is the auto regressive component of the error term. Multivariate GARCH models are defined similarly to a standard GARCH model, where the univariate term is replaced with a vector of terms. Mezrich (1995) and Shephard (1996) provide a more detailed explanation of these models.

There are several implementations of multivariate GARCH models. One such implementation, Dynamic Conditional Correlation (DCC) estimators, have the flexibility of univariate GARCH but avoid the complexity of conventional multivariate GARCH algorithms. Engle and Sheppard (2000) detail descriptions and examples of using a DCC models for time series analysis.

The 'rmgarch' package implemented with the Cran-R project was specifically used for this modeling effort, developed by Ghalanos (2019), and based off the methods described by Engle (2000).

Data Transformation

The algorithms required to calculate maximum likelihood estimates in these families of models are prone to non-convergence. Variable scale, stationarity of the variables, and covariance within the variable vector set are often the underlying issue when dealing with non-convergence in these complex matrix calculations. Data transformation was performed on these variables to provide a more robust and consistent estimate.

Dickey-Fuller stationarity tests were performed on all variables. GDP and HPA test as non-stationary. As a result, first difference transformations were applied to all variables to provide stationarity. Further scaling was required for index variables (*Ind*) using a log transformation:

$$Ind_{trans} = \ln(Ind + \sqrt{Ind^2 + 1}) \qquad (1)$$

Table 72 below provides a description of each variable transformation.

Model Specifications

Each variable is provided a univariate type specification, in a standard (p,q) format where p,q for the ARMA (mean) specification describes the number of autoregressive and moving average lags to include in the model, and (p,q) for the GARCH specification correspond to the autoregressive components and heteroskedastic components (auto regressive component of error term) respectively. See Table 72 for each variable specification.

Table 72: Model Variable Transformations and specifications

Variable	Variable Transformation	ARMA(p,q)	GARCH(p,q)	Distribution
SOFR	First difference	(0,1)	(1,1)	Normal
LIBOR	First difference	(0,1)	(1,1)	Normal
3-MONTH	First difference	(0,1)	(1,1)	Normal
6-MONTH	First difference	(0,1)	(1,1)	Normal
1-YEAR	First difference	(1,0)	(1,1)	Normal
10-YEAR	First difference	(1,0)	(1,1)	Normal
30-YEAR	First difference	(1,0)	(1,1)	Normal
30-YEAR FRM	First difference	(1,0)	(1,1)	Normal
UNEMPLOYMENT	First difference	(0,0)	(1,1)	Normal
GDP	First difference, log function transformation	(1,1)	(1,1)	Skewed generalized error
HPI	First difference, log function transformation	(1,1)	(1,0)	Normal
NOI	First difference	(0,0)	(0,1)	Normal
CCI	First difference	(0,0)	(0,1)	Normal

When fitting a DCC model, the dynamic correlation is fitted with an autoregressive parameter that is applied across all variables. This was set with a (p,q) value of (1,1), describing the correlation across all variables as one autoregressive and one moving average period. These parameters are then used in calculating the correlation matrix.

Table 73 provides all parameter estimates, where "mu" is the mean, "ar" represent the auto regressive and "ma" represent the moving average of the mean model.

Parameters "omega", "alpha" and "beta" are the mean, autoregressive, and heteroskedastic parameters of the variance model.

Parameters "skew" and "shape" are estimates to account for specified skewed distributions (GDP and HPI).

Table 73: Parameter Estimates

VARIABLE	ESTIMATE	VARIABLE	ESTIMATE
TR1YR.MU	0.0239	TR1YR.BETA1	0.6877
TR1YR.MA1	0.7271	TR3M.MU	-0.3182
TR1YR.OMEGA	0.0005	TR3M.AR1	0.8823
TR1YR.ALPHA1	0.3113	TR3M.OMEGA	0.0011

VARIABLE	ESTIMATE
TR3M.ALPHA1	0.2095
TR3M.BETA1	0.7895
TR6M.MU	-0.4814
TR6M.AR1	0.9854
TR6M.OMEGA	0.0009
TR6M.ALPHA1	0.5172
TR6M.BETA1	0.4818
TR10YR.MU	0.0242
TR10YR.AR1	0.7296
TR10YR.OMEGA	0.0004
TR10YR.ALPHA1	0.3124
TR10YR.BETA1	0.6866
TR30YR.MU	-0.3056
TR30YR.AR1	0.8069
TR30YR.OMEGA	0.0012
TR30YR.ALPHA1	0.2192
TR30YR.BETA1	0.7798
MR.MU	-0.4773
MR.AR1	0.9850
MR.OMEGA	0.0010
MR.ALPHA1	0.5304
MR.BETA1	0.4686
UE.OMEGA	1.7921
UE.ALPHA1	0.9782
UE.BETA1	0.0445
GDP.MU	0.1865
GDP.AR1	0.4311
GDP.MA1	2.0152
GDP.OMEGA	0.9865

VARIABLE	ESTIMATE
GDP.ALPHA1	0.0709
GDP.BETA1	0.3218
GDP.SKEW	0.1940
GDP.SHAPE	3.1386
HPI.MU	0.9766
HPI.AR1	0.0530
HPI.OMEGA1	0.4205
HPI.ALPHA1	0.1515
NOI.MU	0.0059
NOI.AR1	0.0000
NOI.OMEGA	0.9990
NOI.ALPHA1	5.5226
NOI.BETA1	0.0583
CCI.MU	0.2006
CCI.AR1	0.0083
CCI.OMEGA	0.0764
CCI.ALPHA1	0.8998
CCI.BETA1	0.7695
LIBOR.MU	0.4515
LIBOR.AR1	1.0713
LIBOR.OMEGA	0.5064
LIBOR.ALPHA1	0.8105
LIBOR.BETA1	0.5077
SOFR.MU	0.0055
SOFR.AR1	0.0393
SOFR.OMEGA	0.7433
SOFR.ALPHA1	0.1324
SOFR.BETA1	0.7117

COVID-19 Pandemic Considerations

The impact from the COVID-19 pandemic is noticeable and dramatic when analyzing these economic indicators. Dramatic, historic, and rapid changes to these economic measures provided additional challenges when fitting these models and produced simulated results that were skewed and assumed to misrepresent historical data.

Because of the historic nature of this event, and its impact on the economy, it is unknown what the long-term impacts of this pandemic will have on the economy. Numerous research articles have been produced to estimate or predict these long-term impacts (Chudik, 2020; Malliet, 2020).

Based on this research and an analysis of historical data, a randomized impact of the pandemic was applied.

As a result, two models were estimated, one basing estimates on pre-pandemic variables, and the second including the pandemic data. A continued impact of eighteen months to five years (six to twenty quarters) was applied randomly as a diminishing linear weight. The two model simulations were then combined using this weighting factor, where COVID-19 simulations were given the most weight, and then we slowly decreased the COVID-19 impacts to the simulations over the randomized period until the COVID-19 simulations were given no weight.

Simulation Generation

Model fit was performed through an iterative process, varying parameter specifications for both ARMA and GARCH model components.

Distributions were determined using standard distribution fitting techniques, including QQ-plots and Kolmogorov-Smirnov tests.

Further parameter selection and distribution adjustments were made based on comparative analysis of simulations to historical series, providing the most reasonable estimates and simulations possible.

One hundred simulations were generated for each of the economic variables. These variables were fully transformed back to the common form and scale as the original un-transformed versions.

Interest Rate Simulations

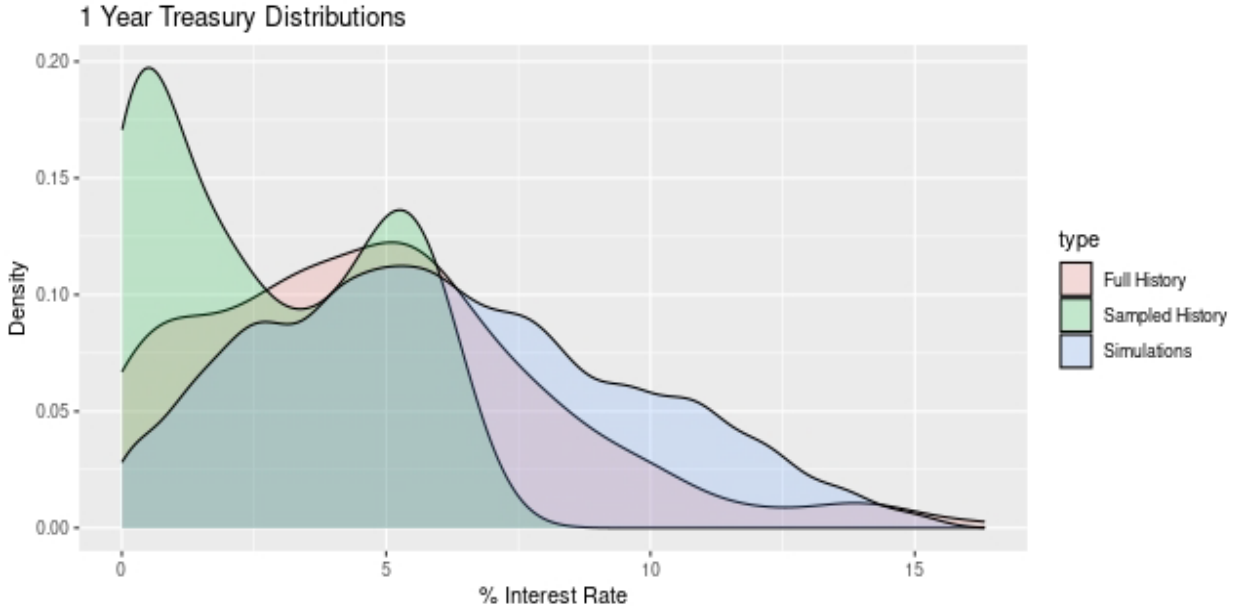
Table 74 shows the summary statistics of the historical one-year Treasury rates for two different periods as well as the simulated series. We can see that in the last 50 or more years, interest rates have had a much broader range as compared to the last 25 years.

Table 74: Statistics for the 1-Year Treasury Rates

Statistics	Since 1953	Since 1991	Simulations
95-PERCENTILE	10.28%	6.08%	13.08%
90-PERCENTILE	8.88%	5.66%	11.80%
50-PERCENTILE	4.44%	2.25%	7.07%
25-PERCENTILE	2.17%	0.46%	4.66%
10-PERCENTILE	0.35%	0.14%	2.81%
5-PERCENTILE	0.15%	0.12%	1.76%
MEAN	4.64%	2.69%	7.17%
MAX	16.31%	6.71%	16.40%
MIN	0.06%	0.06%	0.01%
VARIANCE	10.95%	4.74%	11.28%

Figure 68 shows density distributions, comparing the distribution of the historical CMT rates, historic sample used for simulations, and the distributions of all the simulations.

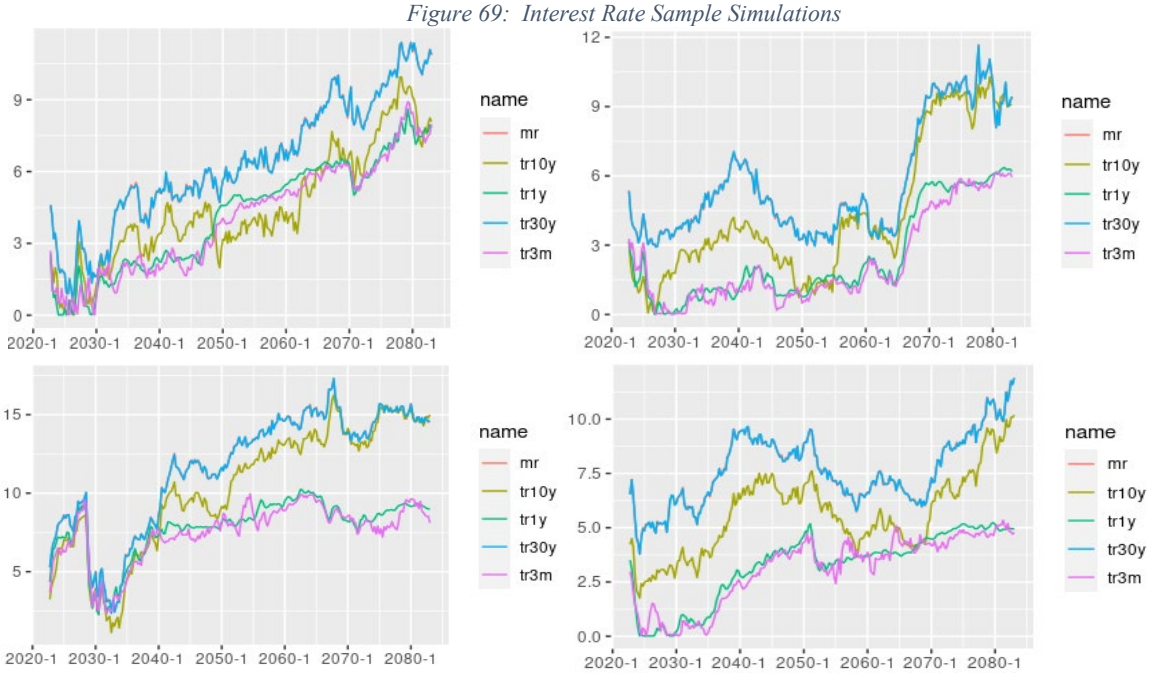
Figure 68: 1 Year Treasury Rate Densities, Historical and Simulations



To avoid negative interest rates, a lower bound of 0.01 percent was applied to all the simulated future interest rates.

Figure 69 graphs four of the one-hundred simulations, illustrating the co-movements and correlations between these variables and how the multivariate modeling method accounts for these interdependencies.

Figure 69: Interest Rate Sample Simulations



House Price Appreciation Rate (HPA)

A. National HPA

The national HPA is calculated by first estimating and simulating HPI. From the HPI simulation, these simulations are then transformed using formula (1) to simulate HPA.

Table 75 provides comparison of simulated HPI average trends and the historical sample trends.

The analysis shows a significant spread between the series when comparing the largest and smallest quarter over quarter changes, but when simulated quarterly changes are averaged across all series, they are very close to the historical quarterly changes used in model fitting.

Table 75: HPI Simulation Statistics

	Simulated Series			Historical
	MAX QOQ	MIN QOQ	MEAN QOQ	QOQ
HPI	7.7%	-7.7%	0.5%	1.1%

B. Geographic Dispersion

The MSA-level HPA forecasts were based on Moody's forecast of local and the national HPA forecasts. Specifically, at each time *t*, there is a dispersion ratio of HPAs between the i^{th} MSA or State level and the national forecast:

$$Disp_{i,t}^{Base} = HPA_{i,t}^{Base} / HPA_{national,t}^{Base} \qquad (6)$$

This dispersion forecast under Moody's base case was preserved for all local house price forecasts under individual future economic paths. That is, for economic path *j*, the HPA of the i^{th} MSA at time t was computed as:

$$HPA_{i,t}^{j} = HPA_{national,t}^{j} * Disp_{i,t}^{Base} \qquad (7)$$

This approach retains the relative current housing market cycle among different geographic locations, and it allows us to capture the geographical concentration of FHA's current endorsement portfolio. This approach is also consistent with Moody's logic in creating local market HPA forecasts relative to the national HPA forecast under alternative economic scenario forecasts.[86]

We understand this approach is equivalent to assuming perfect correlation of dispersions among different locations across simulated national HPA paths, which creates systematic house price

[86] The dispersion of each MSA remains constant among all alternative Moody's forecast scenarios.

decreases during economic downturns and vice versa during booms. Due to Jensen's Inequality, this tends to generate a more conservative estimate of claim losses of the Fund.

Unemployment Rate

A. National Unemployment Rate

Table 76 provides statistics comparing series samples of unemployment rates to the simulated series.

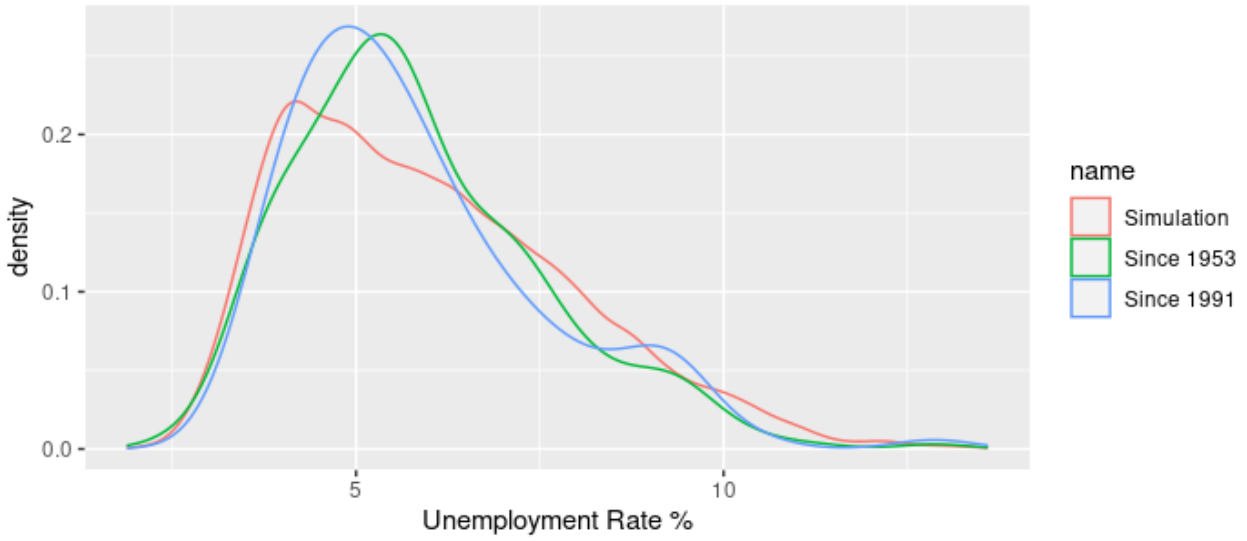
Table 76: Unemployment Historical and Simulation Statistics

Statistics	Since 1953	Since 1991	Simulations
95-Percentile	9.13%	9.37%	9.68%
90-Percentile	8.18%	8.70%	8.75%
50-Percentile	5.57%	5.43%	5.69%
25-Percentile	4.65%	4.57%	4.41%
10-Percentile	3.83%	4.01%	3.74%
5-Percentile	3.60%	3.77%	3.42%
Mean	5.85%	5.86%	5.99%
Max	12.87%	12.87%	13.58%
Min	2.57%	3.33%	1.89%
Variance	2.89%	3.10%	3.82%

Based on historical statistics, the national unemployment rate limits were set at 20% maximum and a 2% minimum.

Figure 70 is a density plot comparison of the historical series and simulated sets.

Figure 70: Unemployment Rate Densities Historical and Simulations



B. Geographic Dispersion

Following the same logic that we applied to the MSA-level HPA forecasts, we first obtained the dispersion of unemployment rates between the i[th] MSA or State level and the national level from Moody's July base-case forecast at each time t:

$$Disp_{i,t}^{Base} = ue_{i,t}^{Base} / ue_{national,t}^{Base} \quad (9)$$

This dispersion forecast was preserved for all local unemployment rate forecasts under each individual future economic path. That is, for economic path j, the unemployment rate of the i[th] MSA at time t was computed as:

$$ue_{i,t}^{j} = ue_{national,t}^{j} * Disp_{i,t}^{Base} \quad (10)$$

For the simulation, we capped the unemployment rate at the local level at 30% with a floor at 1%.

Gross Domestic Product

Table 77 provides statistics comparing the historical GDP series trend to simulated trends. The analysis shows a fairly small spread between the series when comparing the largest and smallest quarter over quarter changes, and when simulated quarterly changes are averaged across all series they are very close to the historical GDP quarterly changes used in model fitting.

Table 77: GDP Simulation Statistics

	Simulated Series			Historical
	MAX QOQ	MIN QOQ	MEAN QOQ	QOQ
GDP	11.0%	-23.6%	0.5%	1.1%

Small Business Normalized Optimism Index/ Consumer Confidence Index

The Small Business NOI and CCI are based on a 100-point scale, where values under 100 represent less confidence in the economy, values over 100 indicate an increase in confidence.

Table 78: Confidence Indices Statistics

	Historical NOI	Simulated NOI	Historical CCI	Simulated CCI
MAX	108.18	173.42	142.12	200.00
MIN	82.74	20.00	29.87	10.00
MEAN	98.06	91.63	95.16	111.13

Table 78 provides comparisons of range and means for both indices and the corresponding simulate data showing that the simulations provide reasonable ranges compared to historical data.

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Appendix E: Cash Flow Analysis

Introduction

The calculation of the Cash Flow NPV of the MMI involves the estimation of the present value of future cash flows generated by the existing portfolio. The analysis requires the projection of future prepayment and claim incidences, and severity and cash flow items associated with each type of outcome. The Cash Flow NPV represents future revenue and expenses associated with the existing book of mortgage guarantees. This appendix describes the components of these cash flow calculations.

To develop the estimated Cash Flow NPV, our model incorporates projections of mortgage performance and information about the existing portfolio composition to project the MMI's various cash flow sources. The cash flow projection model uses projections from predictive models as discussed in Appendix B: Transition Models (Transition Models), Appendix C: Loss Severity Models (Loss Severity Models), and the economic scenarios described in Appendix D: Economic Scenarios. We developed predictive models for conditional transition probabilities for individual mortgages depending on several mortgage and economic characteristics. From these models and using detailed mortgage-level characteristics, we estimated the various transition probabilities and then generated respective cash flows for individual mortgages.

Based on the mortgage termination rates projected by the predictive models, individual components of cash flows are projected into the future. These cash flows are discounted to present value based on the single discount rate provided by the OMB. Based on the specific characteristics of the mortgage, the probability of each transition is calculated. Then, a random number between 0 and 1 is generated, and based on this random draw a mortgage transition is determined. The projection process continues for each mortgage until the mortgage ends by prepayment, claim or reaches maturity.

The cash flow components are shown in the following table:

Table 79: Cash Flow Components

Cash Inflows	Cash Outflows
Upfront MIP	Net Claim Payments
Annual MIP	Loss Mitigation Expenses
Interest Income	Refunded Upfront Premiums

These cash flows were projected quarterly for individual mortgages and then aggregated by product type and origination year. Below, we discuss the development of each of these cash flows.

Cash Flow Components

The components of cash flow are discussed below.

MIP

The primary source of MMI revenue is insurance premiums. If the MMI's mortgage insurance is priced to meet the expected liabilities, the MIP collected, and interest earned on the MIP will cover all costs associated with mortgages insured by the MMI under a normal or expected economic environment. The MIP structure and the premium rates have changed over the period under evaluation. Details of MIP changes are as follows:

- For mortgages originated prior to September 1, 1983, the MIP was collected monthly at an annualized rate of 0.50% of the outstanding principal balance for the period. To align this change with fiscal quarters, we assumed that this annual MIP policy was in effect through September 30, 1983.
- Between September 1, 1983 and June 30, 1991, the MIP was charged only upon mortgage origination and was based on a percentage of the original mortgage amount at the time of origination. This amount was 3.80% for 30-year mortgages and 2.40% for 15-year mortgages.
- Effective July 1, 1991, NAHA implemented a new MIP structure. An upfront MIP of 3.80% was charged for all product types except for 15-year non-SR mortgages, for which the upfront MIP was set at 2.00%. An annual MIP of 0.50% per year on the outstanding balance was also implemented. The annual MIP would cease at different years of maturity depending on the initial LTV of the mortgage.
- On October 1, 1992, the upfront MIP for 30-year mortgages was reduced from 3.80% to 3.00%. The annual MIP for 30-year mortgages was extended for a longer time period, while for 15-year mortgages it was lowered to 0.25% for a shorter time period or completely waived if the initial LTV ratio was less than 90%.
- As of April 17, 1994, FHA lowered the upfront MIP rate on 30-year mortgages from 3.00% to 2.25%. To align this change with fiscal quarters, we applied this policy change on April 1, 1994.
- Starting from October 1, 1996, FHA lowered the upfront MIP rate on 30-year mortgages for first-time homebuyers who received homeowner counseling from 2.25% to 2.00%. This rate was further reduced to 1.75% for mortgages originated on or after September 22, 1997. This favorable treatment for borrowers with homeownership counseling was terminated shortly thereafter.
- Effective January 1, 2001, FHA lowered the upfront MIP rate for all mortgages to 1.50%. The annual MIP would be discontinued as soon as the current LTV ratio of the mortgage was below 78% according to the home price as of the mortgage origination date. The annual MIP was required to be paid for a minimum of five years for 30-year mortgages.

- Effective October 1, 2008, FHA charged an upfront premium rate of 1.75% for home purchase and full-credit qualifying refinances; and 1.50% for all types of streamline refinance mortgages. A varying annual MIP, collected monthly, was charged based on the initial LTV ratio and maturity of the mortgage.
- Effective April 1, 2010, FHA changed the upfront MIP to 2.25% for all mortgages executed after April 1, 2010.
- Effective October 4, 2010, FHA lowered the upfront MIP of all mortgages to 1.0%. The annual MIP for mortgages with 30-year terms was increased to 0.85% for LTV ratios up to 95 percent and to 0.90% for LTV ratios greater than 95%. For mortgages with 15-year terms, an annual MIP of 0.25% was set for LTV ratios greater than 90%. To align this change with fiscal quarters, we started applying this policy change on October 1, 2010.
- Effective April 18, 2011, the annual MIP for mortgages with 30-year terms was increased to 1.10% for LTV ratios up to 95% and to 1.15% for LTV ratios greater than 95%. For mortgages with 15-year terms, the annual MIP was increased to 0.25% for LTV ratios up to 90% and to 0.50% for LTV ratios greater than 90%. To align this change with fiscal quarters, we started applying this policy change on April 1, 2011.
- Effective April 9, 2012, FHA increased the upfront MIP of all mortgages to 1.75%. The annual MIP for mortgages with 30-years terms was increased to 1.20% for LTV ratios up to 95%, and to 1.25% for LTV ratios greater than 95%. For mortgages with 15-year terms, the annual MIP was increased to 0.35% for LTV ratios up to 90%, and to 0.60% for LTV ratios greater than 90%. To align this change with fiscal quarters, we started applying this policy change on April 1, 2012.
- Effective June 11, 2012, the annual MIP for mortgages with 30-year terms and base mortgage amounts above $625,500 was increased to 1.45% for LTV ratios up to 95%, and to 1.50% for LTV ratios greater than 95%. For mortgages with 15-year terms, and base mortgage amount above $625,500, the annual MIP was increased to 0.60% for LTV ratios up to 90%, and to 0.85% for LTV ratios greater than 90%. Also, effective June 11, 2012, for all single family forward SR mortgages which are refinancing existing FHA mortgages that were endorsed on or before May 31, 2009, the upfront MIP decreased to 0.01% of the base mortgage amount, and the annual MIP was set at 0.55%, regardless of the base mortgage amount. To align this change with fiscal quarters, we started applying this policy change on July 1, 2012.
- Effective April 1, 2013, the annual MIP for mortgages with 30-year terms and base mortgage amounts below $625,500 was increased to 1.30% for LTV ratios up to 95%, and to 1.35% for LTV ratios greater than 95%. The annual MIP for mortgages with 30-year terms and base mortgage amounts above $625,500 was increased to 1.50% for LTV ratios up to 95%, and to 1.55% for LTV ratios greater than 95%. For mortgages with 15-year terms and base mortgage amounts below $625,500, the annual MIP was increased to 0.45%

for LTV ratios up to 90%, and to 0.70% percent for LTV ratios greater than 90%. For mortgages with 15-year terms and base mortgage amounts above $625,500, the annual MIP was increased to 0.70% for LTV ratios up to 90%, and to 0.95% for LTV ratios greater than 90%. This increase was effective for all forward mortgages except single family forward SR transactions that refinance existing FHA mortgages that were endorsed on or before May 31, 2009.

- Effective June 3, 2013, the annual MIP rates for mortgages with an LTV of less than or equal to 78% and with terms of up to 15 years was 0.45%. The new payment period for annual MIP for mortgages with case numbers assigned on or after June 3, 2013 and with an LTV up to 90% was 11 years, and the annual MIP applied for the life of the mortgage for LTVs greater than 90%. To align this change with fiscal quarters, we started applying these policy changes on July 1, 2013.
- Effective January 26, 2015, the annual MIP rates for mortgages with a term greater than 15-years have been reduced by 50 basis points. To align this change with fiscal quarters, we applied these policy changes on January 1, 2015.

Upfront MIP

The upfront MIP is assumed to be fully paid at the mortgage origination date and the amount is calculated as follows:

*Upfront MIP = Origination Mortgage Amount * Upfront MIP Rate*

In practice, FHA allows qualified homeowners to finance the upfront MIP so that the upfront MIP does not add to the borrower's equity burden at the beginning of the contract. Instead, the borrower can add the upfront MIP to the original mortgage balance, in essence paying the upfront MIP on the same schedule as their principal balance. The annual MIP is charged based on the unpaid principal balance excluding the financed upfront MIP. Almost all borrowers finance their upfront MIP in this fashion. However, the LTV including refinanced upfront MIP cannot exceed 96.5%.

Annual Premium

The annual MIP is calculated as follows:

*Monthly MIP = UPB (excluding any upfront MIP) * Annual MIP Rate / 12*

The MIP is collected on a monthly basis. For purposes of the simulation, the monthly MIP is aggregated by quarter, and this quarterly premium is used to discount MIP for the simulation.

Refunded MIP

FHA first introduced the upfront MIP refund program in 1983. It specified that FHA would refund a portion of the upfront MIP when a household prepaid its mortgage. The upfront MIP was

"earned" over the life of the mortgage. Upon prepayment, an approximation of the unearned upfront MIP is returned to the borrower. Therefore, the amount of the refund depends on the time from origination to when the mortgage is prepaid. For modeling purposes, the refund payments are calculated as follows:

*Refund Payments = Original UPB * Upfront MIP Rate* Refund Rate*

Refund payments at each quarter are calculated based on the number of mortgages prepaid in that quarter and the origination date of the mortgage. In the past, borrowers always received the upfront MIP refund when they prepaid their mortgages before the maturity of the mortgage contract. In 2000, FHA changed its policy so that borrowers would obtain refunds only if they prepaid within the first five years of their mortgage contracts. The most recent policy change at the end of 2004 eliminated refunds for early prepayments of any mortgages endorsed after that date, except for those borrowers who refinanced into a new FHA mortgage within three years following the original endorsement date.

Losses Associated with Claims

The MMI's largest expense component comes in the form of payments arising from claims. FHA pays the claim to the lender after a lender files a claim. This claim expense can be either a loss mitigation expense or a traditional claim. If it is a traditional claim, in most cases, FHA takes possession of the foreclosed property and sells the property to partially recover the loss. This claim is called a conveyance (REO).

Based on this practice, claim cash flows can be decomposed into two components:

1. Cash outflow of the claim payment at the claim date including expenses incurred, and
2. Cash inflow of any net proceeds received in selling the conveyed property at the property disposition date.

We have estimated the net loss as discussed in Appendix C separately for loss mitigation, PFS, TPS and REO claim types. Based on the specific characteristics of the mortgage, the net loss for each claim is calculated. Then, a random number between 0 and 1 is generated, and based on this random draw the predicted net loss is determined.

Net Present Value

Once all the above future cash flow components are estimated, their present value is computed by discounting them at an appropriate rate. The discount factors applied were provided by FHA and reflect the OMB discount factors and the expected timing of future cash flows. The rates are constant and vary by mortgage cohort year. The discount factors reflect the most recent Treasury yield curve, which captures the federal government's cost of capital in raising funds. These factors reflect the capital market's expectation of the consolidated interest risk of U.S. Treasury securities. Our simulations aggregated each future year's cash flows by quarter and treat the cash flows as being received at the end of the quarter.

Appendix F: Review of HUD Analysis of Economic Net Worth, Comparison of HUD and RMA Models, and Assessment of Vulnerabilities

Appendix F presents a high-level review of HUD models developed to project Economic Net Worth, compares the models developed by HUD with the models developed by RMA, and assesses the vulnerabilities of the models developed as well as developing potential areas of future research to address these vulnerabilities.

Deliverable 4 of the Actuarial Report states:

> ***To promote transparency of the Studies' assessments, the Studies should identify methodological vulnerabilities that may occur in its actuarial models or in HUD's analyses of Economic Net Worth. This discussion should evaluate the scope and scale of such vulnerabilities in creating possible forecast risk and suggest possible lines of research in these areas. The Studies shall assess and comment upon HUD's own models that estimate Economic Net Worth for methodological vulnerabilities and compare HUD's methodologies with those in the Studies.***

There are several different aspects of forecast risk that can arise in the projection of Economic Net Worth, including:

- Process risk — actual results varying from projected results due to variability in the mortgage insurance process.
- Parameter risk — uncertainty related to the parameters selected for a given model.
- Specification risk — uncertainty related to the type of model that is selected for a forecast.

The following discussion comments on these various types of forecast risk.

Forward Budget Model Commentary

Summit-Milliman (S-M) has developed a series of models consisting of the Single Family (Forward) Budget Model Schema that are used to forecast cash flows for the Forward mortgages in the FHA portfolio. The following discusses strengths and potential vulnerabilities of these models, as well as identifies potential areas for further research.

Model Schema

The Loan Performance Models consist of a Stage 1 model for loans that have never been seriously delinquent and a Stage 2 model for loans that have experienced a 90-day delinquency. Both models are used to predict the likelihood of a given loan becoming seriously delinquent or prepaying. This is reasonable as the two sub-populations exhibit different future transition behaviors.

The Stage 1 model uses a series of binomial logistic regressions to estimate the probabilities for non-claim termination and serious delinquency, incorporating the assumption of Independent Irrelevant Alternatives (IIA). The IIA assumption states that adding or removing termination events does not impact the odds of the original termination event. This is a potential vulnerability of the models if this assumption is violated. However, to the extent this assumption holds, then the S-M approach is mathematically equivalent to a multinomial logistic model, which would be a reasonable approach given the number and type of outcomes being predicted.

S-M built two Stage 1 models, one for purchase loans and one for refinance loans, as they exhibit different prepayment rates. This also appears to be a reasonable assumption based on our independent analysis of purchase and refinance loans.

There are some potential vulnerabilities in the S-M modeling approach, which are acknowledged by S-M as well:

- The models were developed using a long period of data (1990-2021). For Stage 2 loss mitigation models, delinquencies from 2009 and subsequent were used. This may cause slower reflection of shorter-term trends. As RMA uses data from the beginning of the Forward Mortgage Guaranty program, this is a potential vulnerability in the RMA models as well.
- Only the Stage 2 model is used for a loan once it is 90 days delinquent, which can fail to fully reflect short-term changes if a loan quickly self-cures, for example.
- The historical data may not be reflective of future performance or of program changes. Again, these are potential shortcomings in the RMA models as well. See COVID-19 Adjustments section regarding S-M adjustments because of the pandemic.

One area of potential future research for these vulnerabilities is to refit the models on more recent data and evaluate the change in the model parameters. Also, the results of the model could be validated against more recent data to test how well the models reflect more recent experience. One approach that RMA has incorporated to account for this vulnerability is to include credit subsidy cohort and loan period as variables in the models. An additional research step would be to test the interaction of these time related elements with other independent variables in the models.

The Stage 2 Loan Performance Model was developed on a loan level basis. Due to different claim rates, S-M built two Stage 2 models depending on whether the loan received loss mitigation in the past or not. Once a loan enters a Stage 2 model it cannot revert to Stage 1. These models used multinomial logistic regression given the number and type of different potential outcomes.

S-M used a few approaches to validate their Stage 1 and Stage 2 Loss Performance Models, including out-of-sample actual vs. expected results, Receiver Operating Characteristic (ROC) curves, and comparison of claim rates for loans that did or did not receive loss mitigation. S-M also reviewed the variable significance levels for the models. All of these are reasonable

approaches. An additional approach to consider would be to use out of time data to validate the models, however if more recent data was left out of the initial model development, it would potentially increase the likelihood of shorter-term trends being missed.

The Loss Mitigation Models developed by S-M have two parts for Stage 2, one for loans with loss mitigation applied and one for loans without loss mitigation. This is done since the probabilities of claim vs. non-claim termination vary greatly depending on if a loan receives loss mitigation or not and is consistent with the S-M approach for Stage 2 Loan Performance Models. However, due to changes in government programs and frequency of mitigation usage over the years, S-M notes there may not be enough data to develop a reliable model to predict which delinquent loans will receive loss mitigation. Therefore, actuarial methods were used to project these rates. S-M selected a 39% loss mitigation rate (a one percentage point increase from the prior year) for the current models based on updated data and loans in forbearance during the COVID pandemic. While it is reasonable to use actuarial methods in this case, this does introduce an additional potential source of uncertainty in the results. Also, it is not clear what testing that S-M did to conclude there was not enough data to develop a loss mitigation prediction model. Future research could involve attempting to build models on the data that does exist and comparing the model results to recent actual results to determine if the accuracy is sufficient.

The Loss Severity Models developed by S-M predict the disposition and severity of a loan loss from Stage 2 in two parts. The disposition estimation model utilizes a waterfall approach to predict the probability of a loan entering a specific disposition path (Pre-Foreclosure Sale [PFS], Single Family Loans Sales [SFLS], Claim Without Conveyance of Title [CWCOT], or Real Estate Owned [REO]). The loss severity model predicts the amount of loss given a default.

The model first uses binomial logistic regression to estimate the probability of a PFS vs. other type of disposition. Data from 1995 and forward was used. Due to lower data volume, historical data from January 1, 2019 to December 31, 2021 is then used to determine if a non-PFS is estimated to be either a SFLS or CWCOT. Finally, the conditional probability for REO is simply the remaining proportion of claims since it is the end of the process waterfall. Potential future research could be to test the two-year period for historical data to determine whether two years of data is sufficient, or to demonstrate how sensitive the results are to different lengths of time. Similarly, CWCOT severity, SFLS severity, and SFLS sales price are determined using this same two-year period. Future analysis should be considered to validate this length of time and its impact on results. RMA uses the entire data history to build models determining the likelihood of an REO or TPS claim.

These three models (Loan Performance, Loss Mitigation, and Loss Severity) combine to produce cash flows to then calculate Liability of Loan Guarantee (LLG) and Return on Assets.

S-M then estimates acquisition costs separately from Net Loss using Ordinary Least-Squares (OLS) regression. They also estimate sale ratio using linear regression, whereas previously the ratio was calculated from sales price. While these can be improvements in sophistication of the

modeling and results, this can also now add additional uncertainty from the additional model parameters.

With the FY 2021.1 model version, S-M introduced a 2.0% Quarterly Prepayment Rate Floor. While this could introduce some future variability in the results particularly considering the current economic conditions, S-M tested the selection using historical data to determine a reasonable floor, and tested results with different (including no) floors. This was also the result of S-M's discussion with FHA on a reasonable prepayment rate floor to use. For the FY2023.1 model version, due to COVID-19 impacts, S-M increased the rate to 3.5% to reflect the increase in pre-payment activity, however this increase was rescinded in the FY2024 model. See COVID-19 Adjustments section for more discussion.

S-M's process for selecting variables is reasonable. This process included performing exploratory data analyses and univariate analyses to better understand the data. Specifically, S-M reviewed how well a variable was populated, how the variable changes over time, and how well the variable relates to the target. S-M also considered collinearity between variables. Univariate regression analysis and backward selection stepwise regression were used, with a p-value threshold of 10% to determine which variable to include in the stepwise procedure. S-M also ran models across time to assess model stability. Splines were added to various models to improve performance, with the c-statistic measured to determine impact. Finally, when considering whether to include a variable in a model, S-M considered the intuitive relationship of the model variables and the predictive nature of the variable. As a result of this testing, S-M removed the Loan-to-Value field from the Stage 1 Refinance Non-Claim Termination (NCT) model and the 1-Year Unemployment Ratio from the Stage 2 No Loss Mitigation Models (NCT and Non-NCT) and the Stage 2 Loss Mitigation Models (Non-NCT). See the COVID-19 Adjustments section below for more discussion.

S-M notes that several variables such as credit score, borrower income, debt-to-income ratio, and loan-to-value ratio have an influence on mortgage performance yet are censored or have missing data in the datasets for various reasons. S-M made an explicit adjustment on the credit data to back-populate it to provide more predictive power.

S-M attempted to supplement the credit score data from additional sources. One source was a study completed by Fannie Mae, but upon review of the data that approach still resulted in a significant number of missing scores. Next, loan level data was then appended from a CoreLogic source. S-M compared aspects of this data to the existing scores for a time-period that overlapped between the CoreLogic and FHA data (2005-2013) and determined that it was reasonable to use based on the average credit scores by year for each of the datasets. Based on RMA's review of the summary statistics of the data, while this is not an unreasonable approach to take to supplement missing credit scores, some degree of caution should be exercised since there is a significant difference in the average credit scores between the two sources, with the CoreLogic source showing higher scores. To help account for this, S-M included an indicator for score source in the models, which is reasonable.

There are several additional potential areas for future research/testing of assumptions:

- The S-M report notes that most of FHA's endorsement volume is from post-2007 credit subsidy cohorts, and as a result, the data for the cohorts is not fully developed. The implicit assumption is that these younger cohorts will perform similarly to older cohorts. As more data is obtained over time, this assumption should be tested, and appropriate adjustments made if any differences in performance are seen.
- The methodology used for aiding in populating missing credit score values could potentially be used to better populate other key variables of interest for which a significant portion of the data is missing.
- The method for calculating partial claims and incentive payments have changed, as back-testing showed an underestimation of partial claim payments. The new method incorporates both historical partial claims and predicted partial claims. The sensitivity of the results to this change should continue to be explored given the variation that has been seen in this parameter over time.
- The results use a two-year lookback period for the Return on Properties calculation. While not necessarily unreasonable, further exploration of different lookback periods and support for the two-year selection would be a reasonable approach to validate the selection.

The following are some additional sources of potential vulnerabilities in the methodology:

- As noted in the report, the historical data used in model development was collected in a generally declining interest rate environment with the most recent data occurring in an increasing interest rate. This introduces a potential source of uncertainty in the results since the historical data is not necessarily reflective of loan performance in the future interest rate environment. S-M agrees with this as a source of potential vulnerability and their tests of the model indicate the forecasts of prepayment rates are lower than historical rates, especially among the most recent cohorts. This leaves the model's projections subject to the relative importance placed on both historical and recent data.
- Sensitivity tests performed on HPA, and interest rate factors assume independence of factors and so may impact the results that would actually be seen with multiple varying parameters.
- S-M selected 2012-2021 cohorts due to volume and availability of actual historical cash flows for performing back-testing of their model results. While this is not unreasonable, this could be a potential source of variability in results if different cohort years were selected.
- There are multiple models being used in combination, so there is the risk of error propagation across the multiple models.

COVID-19 Adjustments

S-M made several adjustments to models due to effects attributed to the COVID-19 pandemic:

- Increased the loss mitigation rate for future delinquencies from 38% to 39% based on data that shows delinquent loans during COVID that have used forbearance are more likely to also use loss mitigation.
- Revised the assumption that all loss mitigation events happen during the second quarter of a forecast period (FY2023.1) to reflect that all occur during the first quarter of a forecast period.
- Increased the Freddie Primary Mortgage Market Survey (PMMS) rate as of the evaluation date of the model from 3.5% to 5% to reflect rising interest rates.
- Reduced the three-month prepayment floor from 3.5% to 2.0% as planned when it was included in the FY2023.1 model version.
- Included a COVID-19 indicator variable in the Stage 1 Delinquency Models, Stage 2 Claim Models, and Stage 2 Loss Mitigation Models. This variable is set to a value of 1 between April 1, 2020 and December 31, 2021, and a value of 0 otherwise. It is planned to be turned off starting April 1, 2022.

None of these steps are unreasonable, but the last warrants further discussion.

The adoption of an indicator variable to capture the entirety of the effects of the COVID-19 pandemic is done due to the unique conditions for the housing market during the time-period, including eviction and foreclosure moratoriums. S-M notes the inclusion of this variable significantly improves their models. While this indicator can help account for short-term trends, there are concerns regarding the consistency and longer-term ramifications of this methodology.

S-M includes the COVID-19 indicator variable in all Stage 1 Delinquency Models and Stage 2 Claim Models due to "otherwise unexplained declines in claims and increased incentive to go delinquent during the pandemic, as well as reasonable magnitude statistical significance." It is also included in the Stage 2 NCT model due to "the policy effects on loss mitigation" and the intuitive direction in value. In contrast however, for the Stage 1 Purchase and Refinance Models, as well as the Stage 2 Loss Mitigation Models, the COVID-19 indicator is *not* included. The variable is still statistically significant but has an unintuitive directionality in those models and is therefore dropped from final models. This suggests that further refinement may be needed to appropriately specify the underlying mechanism of the pandemic that this indicator is attempting to capture.

The addition of the COVID-19 indicator in the Stage 2 Claim Models coincides with the removal of the 1-Year Unemployment Ratio as a predictive variable. In contrast, for the Stage 2 NCT Models, the Loss Mitigation model previously did not contain the 1-Year Unemployment Ratio,

but added the COVID-19 indicator, while No Loss Mitigation Model dropped the 1-Year Unemployment Ratio and did *not* add the COVID-19 indicator.

The COVID-19 indicator and 1-Year Unemployment Ratios theoretically should display a high degree of multicollinearity. While multicollinearity does not reduce the predictive power of the model, it does impact the validity of the results for any individual variable as well as which variables are redundant and should be removed. With multicollinearity, even small changes in the underlying data can lead to erratic behavior with respect to the model coefficients assigned to the individual variables.

The intention to end the indicator April 1, 2022, suggests the world pre-"COVID-19 Indicator" and post-"COVID-19 Indicator" are functionally similar. This neglects the fact that some trends from the COVID-19 pandemic will likely exhibit a long-tailed effect lasting well into the future. By failing to isolate the underlying mechanism that is causing the change in the outcome variable, future models will likely have to institute further similar short-term adjustments. Coupling this fact with the previous COVID-specific changes in model version FY2023.1 – specifically increasing the prepayment floor from 2% to 3.5% – increases model volatility and suggests that the model is improperly specified.

Finally, S-M considered including this term in the HECM models, but ultimately decided *against* inclusion. From a theoretical standpoint this is concerning and when coupled with the aforementioned concerns, it would seem that this is a significant area of opportunity for future research.

RMA Forward Budget Model Commentary

The following illustrates some of the similarities and differences in methodologies for the Forward budget models between the RMA analysis and that done by S-M for HUD.

The RMA models analyzed the forward book of loans based on separate products: 30-year FRM, 15-year FRM, refinances, and ARM. The S-M approach did not build models separately by product beyond the purchase loans vs. refinance loans for their Stage 1 model. Also, the RMA models were built on an individual loan level. S-M used individual loans for their Stage 1 and Stage 2 models.

Model Schema

The schema of the models is different between the S-M process and that of RMA. Both reflect models for Performing (Stage 1 or Current) vs. Non-Performing (Stage 2 or Default) loans. RMA further develops separate models based on product (FRM30, FRM15, ARM). The HUD models predict the likelihood of prepayment or delinquency from each of the Stage 1 or Stage 2 starting points. RMA's models reflect potential transition to multiple states.

- Transitions from Current mortgage: remain current, default/claim, prepay by SR, other prepayments, cure with mortgage modification, self-cure

- Transitions from Default mortgage: prepay, transition into a claim, self-cure, cure with mortgage modification, remain in default

Transition models for RMA are used to project how a loan will move to a different status. Loss Severity Models are used to project the amount of loss given a claim.

Regarding the modeling process, for this year's analysis RMA has continued to use multiple binomial models for the Forward transition models. RMA researched reverting to a multinomial model but found no significant differences in the resulting parameter estimates, and thus decided to continue the same process.

The main vulnerability in the models is the general vulnerability of developing predictive models: the extent to which historical patterns between target and projected results are indeed predictive. We have attempted to mitigate this potential vulnerability through a training and validation construct. For the Transition Models, we use 60% of the data to train the models and 40% of the data to validate the models. This is different than the split percentages used by S-M. For the Loss Severity Models, a train/validate approach also was used. RMA did not do any out of time sample validation.

RMA models were validated in general by comparing actual to predicted results in decile charts. This was done for both the transition models and loss severity models.

RMA applied random sampling for FRM30 SR Current transition model types to improve efficiency of the modeling process. This could be a potential source of variability if not truly random, and a future area of refinement could be to test to see if using different sampling percentages result in a difference in the model results. RMA used the full dataset for all other models.

For Loss Severity models, RMA built a multinomial logistic model to predict claim disposition—PFS, REO, or CWCOT. S-M also included the Single-Family Loan Sales (SFLS) as a type. RMA also built models to predict loss severity (using Generalized Linear Models with a Gamma error structure and a log link function) for each of PFS, REO, and CWCOT, as well as a model for recovery amounts if the claim is a foreclosure REO. S-M does not separately specify a recovery amount model. Finally, RMA also modeled loss mitigation costs.

S-M utilized data from Moody's in their loan projections. RMA used 10 economic scenarios from Moody's, and 100 random stochastic simulations of key economic variables to develop a range of Cash Flow NPV. Both S-M and RMA utilized Moody's data on a state- and MSA- level, when possible, to provide for a greater reflection of differences in home prices, etc. across the country.

Simulation

RMA ultimately utilized 100 random stochastic simulations to determine the range of Cash Flow NPV estimates. This compares to the S-M process which used 10,000 Monte Carlo simulations. RMA developed simulations of key economic variables as inputs into the Cash Flow NPV simulations, while the S-M process used 10,000 simulations of target variables (default rate, prepayment rate).

Appendix G: Summary of Historical and Projected Claim Rates, Non-Claim Termination Rates and Loss Severities

The following incremental annual summaries are shown by cohort for Fixed Rate 30, Fixed Rate 15, ARM products separately, and for all products combined in the attached PDFs.

1. **Conditional Claim Rate**: percentage of active Loans at the beginning of the evaluation year that end in claim during the evaluation year
2. **Cumulative Claim Rate**: cumulative claims as of evaluation year divided by active loans as of evaluation year 1
3. **Conditional Non-Claim Termination Rate**: percentage of active loans at the beginning of the evaluation year that end in termination by other than claim during the evaluation year
4. **Cumulative Non-Claim Termination Rate**: cumulative non-claim terminations as of evaluation year divided by active loans as of evaluation year 1
5. **Conditional Loss Rate**: claim cost net of recovery in each evaluation year divided by gross claim cost in each evaluation year
6. **Cumulative Loss Rate**: total losses net of recovery for each Fiscal Year as of the end of the evaluation year divided by total gross losses for each Fiscal Year as of the end of the evaluation year

Forward Triangle Exhibit FRM30 - 2022Q4.pdf

Forward Triangle Exhibit FRM15 - 2022Q4.pdf

Forward Triangle Exhibit ARM - 2022Q4.pdf

Forward Triangle Exhibit All Products Combined - 2022Q4.pdf