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November 15, 2018

The Honorable Brian D. Montgomery
Assistant Secretary for Housing – Federal Housing Commissioner
U.S. Department of Housing and Urban Development
451 Seventh Street, S.W., Room 9100
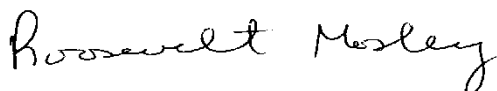Washington, D.C. 20410

Dear Mr. Montgomery:

Pinnacle Actuarial Resources, Inc. (Pinnacle) has completed the final report for the Fiscal Year 2018 Independent Actuarial Review of the Mutual Mortgage Insurance Fund Forward Loans. The attached report details our estimate of the Cash Flow Net Present Value for fiscal year 2018 as of September 30, 2018.
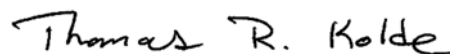
Roosevelt C. Mosley, Jr., FCAS, MAAA and Thomas R. Kolde, FCAS, MAAA are responsible for the content and conclusions set forth in the report. We are Fellows of the Casualty Actuarial Society and Members of the American Academy of Actuaries, and are qualified to render the actuarial opinion contained herein.

It has been a pleasure working with you and your team to complete this study. We are available for any questions or comments you have regarding the report and its conclusions.

Respectfully Submitted,

Roosevelt C. Mosley, Jr. FCAS, MAAA
Principal and Consulting Actuary

Thomas R. Kolde, FCAS, MAAA
Consulting Actuary

Commitment Beyond Numbers

Fiscal Year 2018 Independent Actuarial Review of the Mutual Mortgage Insurance Fund: Cash Flow Net Present Value from Forward Mortgage Insurance-In-Force

November 15, 2018

Commitment Beyond Numbers

Fiscal Year 2018 Independent Actuarial Review of the Mutual Mortgage Insurance Fund: Cash Flow NPV from Forward Mortgage Insurance-In-Force

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Summary of Findings

This report presents the results of Pinnacle Actuarial Resources, Inc.'s (Pinnacle's) independent actuarial review of the Cash Flow Net Present Value (NPV) associated with forward mortgages insured by the Mutual Mortgage Insurance Fund (MMIF) for fiscal year 2018. The Cash Flow NPV associated with Home Equity Conversion Mortgages (HECMs) are analyzed separately and are excluded from this report. In the remainder of this report, the term MMIF refers to forward mortgages and excludes HECMs.

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

Deliverable 1: Articulate the Actuary's conclusion regarding the reasonableness of the MMIF forward Cash Flow NPV as presented in FHA's Annual Report to Congress and the Actuary's best estimate and range of reasonable estimates, including estimates at the 90th, 95th and 99th percentiles of the adverse tail of the distribution, and the basis of the range which led to the Actuary's conclusion. The study also must compare the Actuary's conclusions to the corresponding amounts in FHA's Annual Report.

As of the end of Fiscal Year 2018, Pinnacle's Actuarial Central Estimate (ACE) of the MMIF forward Cash Flow NPV is $3.457 billion.

Pinnacle's ACE is based on the Economic Assumption for the 2019 Mid-Session Review from the Office of Management and Budget (OMB Economic Assumptions). Pinnacle 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 1.

Table 1: Range of Cash Flow NPV Outcomes Based on OMB & Moody's Scenarios

Economic Scenario	Fiscal Year 2018 Cash Flow NPV
Pinnacle ACE	3,456,740,665
Moody's Baseline	(2,536,331,860)
Moody's Exceptionally Strong Growth	1,048,676,746
Moody's Stronger Near-Term Rebound	(1,088,549,493)
Slower Near Term Growth	(5,168,845,520)
Moderate Recession	(11,864,467,808)
Protracted Slump	(16,401,568,826)
Below-Trend Long-Term Growth	(5,020,501,382)
Stagflation	(5,963,311,128)
Next Cycle Recession	(5,912,012,852)
Low Oil Price	(3,997,588,401)

The range of results based on the Moody's estimates is negative $16.402 billion to positive $1.049 billion.

In addition, Pinnacle has estimated a range of outcomes based on 100 randomly generated stochastic simulations of key economic variables. Based on these simulations, we estimate that the range of reasonable Cash Flow NPV estimates is negative $15.422 billion to positive $18.191 billion. This range is based on an 80%

likelihood that the ultimate Cash Flow NPV will fall within the lower and upper bound of the range.

The 90th, 95th and 99th percentiles of the stochastic simulations are shown below:

- 90th percentile: $18.191 billion
- 95th percentile: $21.192 billion
- 99th percentile: $24.030 billion

The Cash Flow NPV estimate provided by the Federal Housing Administration (FHA) to be used in the FHA's Annual Report to Congress is $1.372 billion. Based on Pinnacle's Actuarial Central Estimate 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.

Deliverable 2: Contain the Actuary's best estimate and range of reasonable estimates of the MMIF forward Cash Flow NPV by program and cohort beginning with the 1992 cohort and continuing through the most recent cohort.

Pinnacle's range of reasonable estimates of the Cash Flow NPV by cohort are shown below. The range of estimates are based on the stochastic simulation results.

Table 2: Range of Reasonable Cash Flow NPV Estimates - Forward Portfolio

Cohort	10th Percentile	90th Percentile	Pinnacle ACE
1992	-2,190,303	-1,871,824	-1,842,068
1993	-3,723,156	-2,544,923	-2,704,399
1994	-7,314,670	-4,414,143	-4,621,283
1995	-6,870,609	-4,854,653	-4,145,804
1996	-13,335,270	-6,928,280	-8,102,313
1997	-19,116,172	-9,967,625	-9,935,651
1998	-38,509,200	-18,414,115	-24,722,385
1999	-57,987,982	-24,017,799	-32,081,054
2000	-51,163,432	-19,032,102	-28,156,342
2001	-149,946,906	-83,566,882	-109,978,757
2002	-270,696,066	-142,631,900	-197,947,880
2003	-467,827,808	-237,107,569	-338,480,098
2004	-719,686,330	-349,301,530	-519,119,154
2005	-729,820,565	-313,884,465	-519,645,765
2006	-705,857,777	-320,491,756	-509,292,699
2007	-937,190,049	-424,011,991	-680,258,727
2008	-2,398,524,407	-1,049,305,125	-1,726,688,042
2009	-3,648,098,926	-1,664,129,554	-2,615,265,520
2010	-3,368,396,134	-1,248,535,085	-2,294,165,103
2011	-1,810,725,783	-592,093,042	-1,145,915,956
2012	-1,735,384,010	-181,070,052	-904,765,764
2013	-1,714,430,574	392,465,284	-548,186,578
2014	344,388,902	2,168,314,068	1,412,750,910
2015	-183,586,049	3,610,640,698	1,920,467,651
2016	-347,584,786	4,844,221,587	2,601,229,369
2017	835,535,303	6,543,915,228	4,202,456,195
2018	2,785,835,482	7,329,673,735	5,545,857,882
Total	-15,422,207,277	18,191,056,185	3,456,740,665

Deliverable 3: Reconcile the data used to prepare the Actuary's estimates with the data used by FHA to prepare its estimated MMIF liabilities for loan guaranty.

Section 5 shows the reconciliation of the data used by Pinnacle with the data used by FHA. Please see the sub-heading titled Data Reconciliation.

Deliverable 4: State clearly the assumptions and judgments on which the Actuary's estimates are based, the support for the assumptions and the sensitivity of the Actuary's estimates to alternative assumptions and judgments.

The assumptions and judgments on which the Cash Flow NPV estimates are based are summarized in Section 5 of this report. The sub-sections titled Specification of Mortgage Transition Models and Estimation Sample show the specifications and assumptions related to the transition models. The Loss Severity Model sub-section 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. Lastly, the Cash Flow Projections sub-section of Section 5 summarizes the assumptions associated with the cash flow analysis.

Deliverable 5: Narrative and technical components. The narrative component should provide sufficient detail to clearly explain to FHA and HUD management and auditors, OMB and Congressional offices the findings, recommendations and conclusions as well as their significance. The technical component must trace the analysis from the basic data and assumptions to the conclusions.

Sections 1 and 2 provide an explanation of the findings and discusses the significance of the findings. Also, Section 5 traces the analysis from data to conclusions.

Deliverable 6: Quantify in descending order of importance the underlying causes (changes in portfolio size, assumptions, economic conditions, methodology, loan performance, etc.) of change in the aggregate forward Cash Flow NPVs from September 30, 2017, as presented in the 2017 actuarial review, through September 30, 2018.

Table 9 provides a summary of the decomposition of changes in the Cash Flow NPV of the MMIF as of the end of fiscal year 2018 as compared to the Cash Flow NPV in the fiscal year 2017 report. The overall net change in the Cash Flow NPV is positive.

Table 3: Changes in Projected Cash Flow NPV

	Change in NPV	NPV - 9/30/18
Baseline FY2009-FY2017		1,892,909,014
Impact of assumption change	1,817,117,569	3,710,026,583
Impact of model change	-1,684,181,261	2,025,845,322
Impact of book change	-4,114,962,539	-2,089,117,217
FY1992-FY2017	-3,982,026,231	
FY2018	5,545,857,882	3,456,740,665
Cumulative Change	1,563,831,651	

A more detailed discussion of the sources of change is included in Section 2.

Deliverable 7: Comment thoroughly on trends indicating the presence or absence of risks and uncertainties that could result in material adverse changes in the condition of the Fund as measured by the forward Cash Flow NPVs.

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

Deliverable 8: Validation of interim and final claim rates, non-claim termination rates, and loss severities.

Appendix F 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 9: An appendix of all econometric estimations used to include variable definitions (including scale of units), equation specifications, and results including coefficients, goodness of fit measures and other evaluation statistics.

Appendix B shows the predictive model parameters and goodness of fit measures for the Transition models. Appendix C shows the parameters and goodness of fit measures for the Loss Severity models. See the Model Parameters and Model Validation sections.

Deliverable 10: Two-way tables by loan cohort and policy year of claim rates, non-claim termination rates, loss severities by major product type including a blend of actual and projected values for fiscal years 1975 to 2047 for forward mortgages.

Two-way tables by loan cohort and policy year of claim rates, non-claim termination rates, and loss severities are shown in Appendix F.

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) MMIF. 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 MMIF. One of them, HECMs, which are reverse mortgages, are analyzed separately and are excluded from this report. In the remainder of this report, the term MMIF refers to forward mortgages and excludes HECMs.

The primary purpose of this actuarial analysis is to estimate the Cash Flow NPV of the current book of business.

We have calculated a range of estimates using economic projections from the OMB Economic Assumptions for Fiscal Year 2019, ten economic projection scenarios from Moody's and a stochastic simulation approach to test variation around the base economic scenario.

Based on our analysis, we estimate that the Cash Flow NPV as of the end of fiscal year 2018 is $3.457 billion. We also estimate that the reasonable range of Cash Flow NPV is between negative $15.422 billion and positive $18.191 billion.

Impact of Economic Forecasts

The Cash Flow NPV of the MMIF 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 MMIF through the use of the following variables in our models:

- 30-year fixed-rate home mortgage effective rates
- 10-year Constant Maturity Treasury (CMT) rates
- 1-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 OMB Economic Assumptions.

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

1. Baseline
2. Exceptionally Strong Growth
3. Stronger Near-Term Rebound

4. Slower Near-Term Growth
5. Moderate Recession
6. Protracted Slump
7. Below-Trend Long-Term 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 MMIF under a range of economic environments.

We have also developed an estimate of the Cash Flow NPV using HUD data aggregated at the origination year level.

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 2018 Cash Flow NPV
Pinnacle ACE	3,456,740,665
Moody's Baseline	(2,536,331,860)
Moody's Exceptionally Strong Growth	1,048,676,746
Moody's Stronger Near-Term Rebound	(1,088,549,493)
Slower Near Term Growth	(5,168,845,520)
Moderate Recession	(11,864,467,808)
Protracted Slump	(16,401,568,826)
Below-Trend Long-Term Growth	(5,020,501,382)
Stagflation	(5,963,311,128)
Next Cycle Recession	(5,912,012,852)
Low Oil Price	(3,997,588,401)

We also randomly generated 100 stochastic simulations of key economic variables. Based on these simulations, we estimate that the range of reasonable Cash Flow NPV estimates is negative $15.422 billion to positive $18.191 billion. This range is based on an 80% likelihood that the ultimate Cash Flow NPV will fall within the lower and upper bound of the range.

Distribution and Use

This report is being provided to FHA for its use and the use of makers of public policy in evaluating the Cash Flow NPV of the MMIF. 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. Pinnacle 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 duty or liability by Pinnacle to the third party.

Our conclusions are predicated on a number of assumptions as to future conditions and events. These assumptions, which are documented in subsequent sections of the report, must be understood in order 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 Pinnacle 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 projections deviate significantly from these assumptions, the actual Cash Flow NPV projections may differ, perhaps significantly, from projected results.

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 using predictive modeling techniques, analyzing data from 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 40 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 MMIF.

Pinnacle 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 available statutes, regulations and administrative rules.

Section 1: Introduction

Scope

HUD and FHA have engaged Pinnacle to perform the annual independent actuarial study of the MMIF. 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 (ASOPs). This study provides an analysis of the financial position of MMIF as of September 30, 2018, using data through September 30, 2018.

The MMIF is a group of accounts of the federal government which records transactions associated with the FHA's guarantee programs for single family mortgages. Currently, the FHA insures approximately 7.94 million forward mortgages under the MMIF and 450,000 reverse mortgages under the HECM program.

Per 12 USC 1711-(f), the FHA must endeavor to ensure that the MMIF maintains a capital ratio of not less than 2.0%. The capital ratio is defined as the ratio of capital to the MMIF obligations on outstanding mortgages (IIF). Capital 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 MMIF.

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

1. Articulate the Actuary's conclusion regarding the reasonableness of the MMIF forward Cash Flow NPV as presented in FHA's Annual Report to Congress and the Actuary's best estimate and range of reasonable estimates, including estimates at the 90th, 95th and 99th percentiles of the adverse tail of the distribution, and the basis of the range which led to the Actuary's conclusion. The study also must compare the Actuary's conclusions to the corresponding amounts in FHA's Annual Report.

2. Contain the Actuary's best estimate and range of reasonable estimates of the MMIF forward Cash Flow NPV by program and cohort beginning with the 1992 cohort and continuing through the most recent cohort.

3. Reconcile the data used to prepare the Actuary's estimates with the data used by FHA to prepare its estimated MMIF liabilities for loan guaranty.

4. State clearly the assumptions and judgments on which the Actuary's estimates are based, the support for the assumptions and the sensitivity of the Actuary's estimates to alternative assumptions and judgments.

5. Contain narrative and technical components. The narrative component should provide sufficient detail to clearly explain to FHA and HUD management and auditors, OMB and Congressional offices the findings, recommendations and conclusions as well as their significance. The technical component must

trace the analysis from the basic data and assumptions to the conclusions.

6. Quantify in descending order of importance the underlying causes (changes in portfolio size, assumptions, economic conditions, methodology, loan performance, etc.) of change in the aggregate forward Cash Flow NPVs from September 30, 2017, as presented in the 2017 actuarial review, through September 30, 2018.

7. Comment thoroughly on trends indicating the presence or absence of risks and uncertainties that could result in material adverse changes in the condition of the Fund as measured by the forward Cash Flow NPVs.

8. Validation of interim and final claim rates, non-claim termination rates, and loss severities.

9. An appendix of all econometric estimations used to include variable definitions (including scale of units), equation specifications, and results including coefficients, goodness of fit measures and other evaluation statistics.

10. Two-way tables by loan cohort and policy year of claim rates, non-claim termination rates, loss severities by major product type including a blend of actual and projected values for fiscal years 1975 to 2047 for forward mortgages.

Background

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 for improving quality of life; build inclusive and sustainable communities free from discrimination, and transform the way HUD does business.[1]*

Congress created FHA in 1934. The FHA "provides mortgage insurance on loans made by FHA-approved lenders throughout the United States and its territories. FHA insures mortgages on single family and multifamily homes including manufactured homes and hospitals. It is the largest insurer of mortgages in the world, insuring over 34 million properties since its inception in 1934."[2] The mortgage insurance provided was done so through the establishment of the MMIF.

NAHA, enacted in 1990, introduced a minimum capital requirement for the MMIF[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

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[1] https://portal.hud.gov/hudportal/HUD?src=/about/mission
[2] https://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/fhahistory
[3] Public Law 101-625, 101st Congress, November 28, 1990, Section 332.

by NAHA as the ratio of capital to unamortized IIF. NAHA also implemented the requirement that an independent actuarial study of the MMIF be completed annually. 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 mortgage 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 be in 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 MMIF.

Mortgage Insurance Premiums

Adequate mortgage insurance premium (MIP) is key in maintaining the economic strength of the MMIF, 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 MMIF.

- 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.

- 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 MMIF, several changes were implemented. First, the upfront MIP was reduced by 75 basis points to 1.5%. Second, the upfront MIP refund schedule

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[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.
[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.

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 canceled.[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]

- 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

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[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.

[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.

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 assist 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 in 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 borrowers 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 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]

Homebuyer Counseling

Counseling for homebuyers was encouraged historically by FHA with the idea that if homebuyers were educated

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[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.
[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.

on issues of homeownership and mortgages, they would be less likely to default on the mortgage and would be more responsible homeowners. The history of mortgagee letters related to homebuyer counseling is outlined below;

- In 1993, a pilot of a counseling program for pre-purchase and pre-foreclosure situations was announced.[21]

- In 1996, after the pilot of the counseling program, the upfront MIP was decreased by 25 basis points for first-time homebuyers who complete homeownership counseling.[22] Just one year later in 1997, the upfront MIP was decreased by an additional 25 basis points for first-time homebuyers who complete homeownership counseling.[23] This discount was provided to recognize 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 being provided with workbooks without additional interaction or instruction. The guidelines of the homeownership counseling program were reiterated in this letter.[24]

- In 2000, in conjunction with an overall reduction in upfront MIP, the homeownership counseling discount was discontinued.[25]

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 Constant Maturity Treasury (CMT) rates. The interest rate at the beginning of the loan is typically lower than 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 of time (one year, three years, five years, etc.) and, after the fixed interest rate period, can change yearly. 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 ARM's have been higher than the default rates for fixed rate mortgages.

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[21] Mortgagee Letter 93-28, September 20, 1993: Prepurchase and Foreclosure Prevention Counseling Demonstration.
[22] 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.
[23] 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.
[24] Mortgagee Letter 98-1, January 2, 1998: Single Family Loan Production - Underwriting Adjustable Rate Mortgages, Interest Buydowns, Homeownership Counseling and Other Credit Policy Issues.
[25] Mortgagee Letter 2000-38, October 27, 2000: Single Family Loan Production - Further Reduction in Upfront Mortgage Insurance Premiums and Other Mortgage Insurance Premium Changes

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. 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. This was due to the fact that the payment shock associated with the termination of the buydown was causing default rates to increase to an unacceptable level.[26]

- In 2004, HUD expanded mortgage insurance availability to cover three-, five-, seven- and 10-year ARMs.[27]

- In 2007, the one-year London Interbank Offered Rate (LIBOR) was added as an acceptable index for ARMs.[28]

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;

- In 1995, HUD approved usage of AUSs. Mortgagees had to request permission to use these systems and receive approval from HUD.[29]

- In 1996, criteria were established for the approval by HUD of AUSs.[30]

In 1998, FHA approved Freddie Mac's Loan Prospector for underwriting FHA-insured mortgages, using a scorecard 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

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[26] Mortgagee Letter 98-1, January 2, 1998: Single Family Loan Production - Underwriting Adjustable Rate Mortgages, Interest Buydowns, Homeownership Counseling and Other Credit Policy Issues.
[27] Mortgagee Letter 2004-10, March 19, 2004: Adjustable Rate Mortgages.
[28] Mortgagee Letter 2007-13, October 12, 2007: Adjustable Rate Mortgages—Addition of LIBOR Index.
[29] Mortgagee Letter 95-7, January 27, 1995: Single Family Loan Production - Revised Underwriting Guidelines and Other Policy Issues.
[30] Mortgagee Letter 96-34, July 10, 1996: Single Family Loan Production - Automated Underwriting Systems.

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 from July 2008, all loans must be submitted through FHA's TOTAL scorecard. A new guidance issued in February 2011 prohibits the use of the TOTAL scorecard on streamline refinance transactions.

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 also limit the losses sustained by MMIF when a claim occurs. Over the years, FHA has issued a number of 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, pre-foreclosure sales, 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.[31]

- 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 also consolidated the provisions of the PFS program into one place. This letter also updated some provisions of the PFS to better address the mortgage crisis.[32]

- In 2010, the 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.[33]

- In 2011, the 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.[34]

- In 2012, FHA revised the Loss Mitigation Home Retention Options to reduce the claims against the MMIF 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

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[31] Mortgagee Letter 96-61, November 12, 1996: FHA Loss Mitigation Procedures - Special Instructions.
[32] Mortgagee Letter 2008-43, December 24, 2008: Pre-Foreclosure Sale (PFS) Program - Utilizing the PFS Loss Mitigation Option to Assist Families Facing Foreclosure.
[33] Mortgagee Letter 2010-23, August 6, 2010: FHA Refinance of Borrowers in Negative Equity Positions.
[34] Mortgagee Letter 2011-28, August 15, 2011: Trial Payment Plan for Loan Modifications and Partial Claims under Federal Housing Administration's Loss Mitigation Program.

can be included in the claim; and, eliminating the requirement that the existing mortgage be no more than 12 months past due.[35]

- 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) and the elimination of the financial hardship/deficit income PFS requirement for servicemen who have received a Permanent Change of Station order.[36]

- 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.[37]

- 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.[38]

- 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.[39]

- 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 procedures were implemented to help homeowners stay in their homes and reduce losses to FHA.[40]

- Later in 2018, FHA issued a mortgagee letter in response to continued elevated default rates and lower

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[35] Mortgagee Letter 2012-22, November 16, 2012: Revisions to FHA's Loss Mitigation Home Retention Options.
[36] Mortgagee Letter 2013-23, July 9, 2013: Updated Pre-Foreclosure Sale (PFS) and Deed in Lieu (DIL) of Foreclosure Requirements.
[37] Mortgagee Letter 2013-32, September 20, 2013: Update to FHA's Loss Mitigation Home Retention Options.
[38] Mortgagee Letter 2014-15, July 10, 2014: Updated Requirements for Pre-Foreclosure Sales (PFS) and Deeds in Lieu (DIL) of Foreclosure.
[39] Mortgagee Letter 2014-24, November 26, 2014: Increasing Use of FHA's Claims Without Conveyance of Title (CWCOT) Procedures.
[40] 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).

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.[41]

Current and Future Market Environment

In addition to the policies related to the MMIF, the default and claim rate and ultimately the Cash Flow NPV of the MMIF 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 MMIF 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 MMIF for mortgage insurance.

Interest Rates

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

Figure 1: 1-Year CMT Rate

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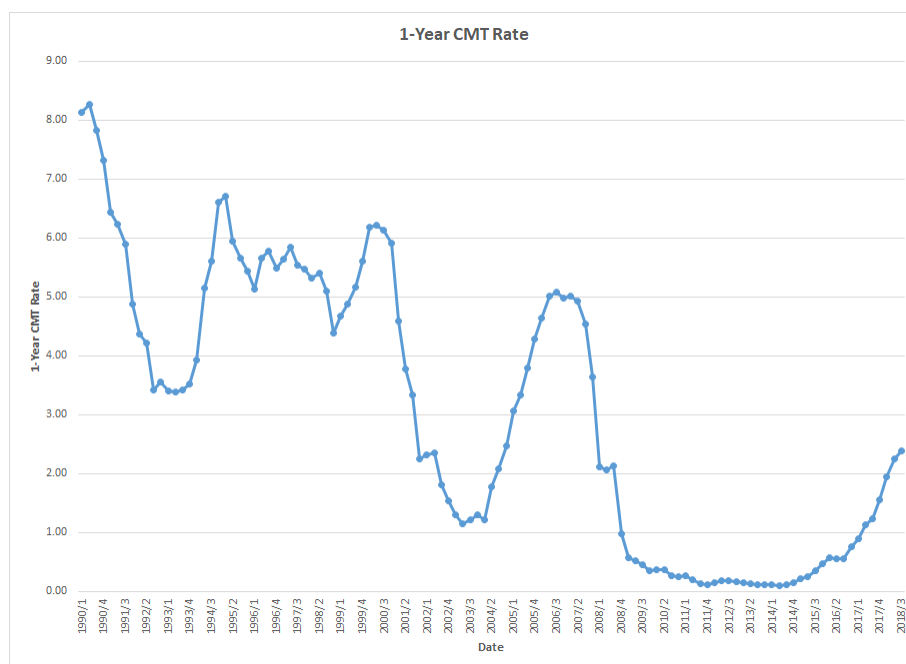
[41] Mortgagee Letter 2018-05, August 15, 2018: Updated Loss Mitigation for mortgagees servicing mortgage loans for borrowers with FHA-insured mortgages whose property and/or place of employment is located in the Presidentially-Declared Major Disaster Areas (PDMDAs) of Puerto Rico Hurricane Maria DR-4339 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).

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 fourth quarter of 2014. Since that time, the rate has increased to 2.4% in September 2018.

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

Figure 2: 10-Year CMT Rate
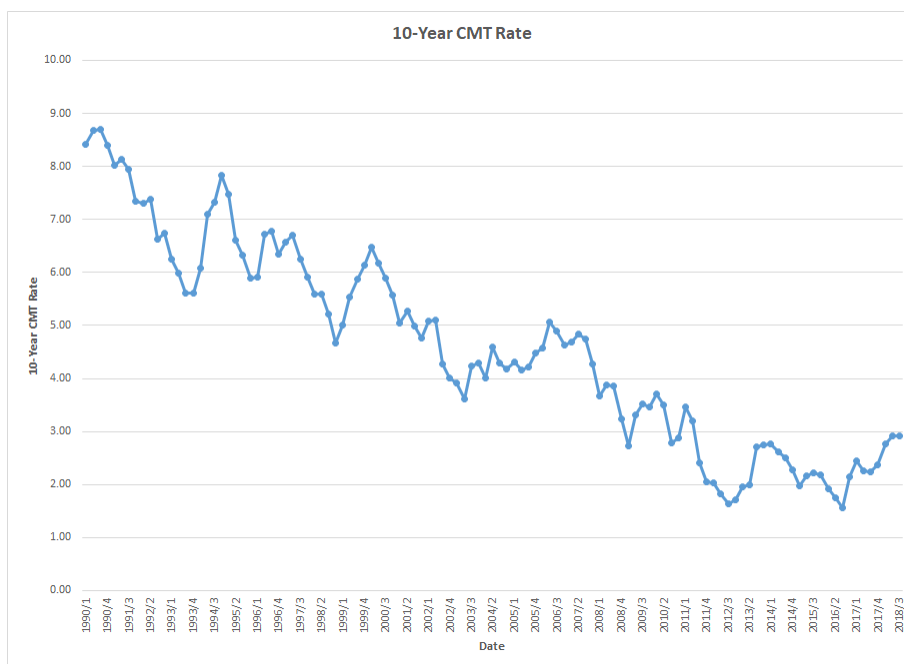
This shows a similar trend, although the changes are not as significant. In mid-2007, the 10-year CMT rate was nearly 5%. Since that time, the rate dropped to under 2% in 2012. Since that time, the rate has increased to almost 3.0% in September 2018.

For the purposes of projecting Cash Flow NPV, it is required that Pinnacle produce an estimate using the projection figures from the OMB. In addition to OMB projections, Pinnacle 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 projections from Moody's.

Figure 3: One-Year CMT Rate Projections
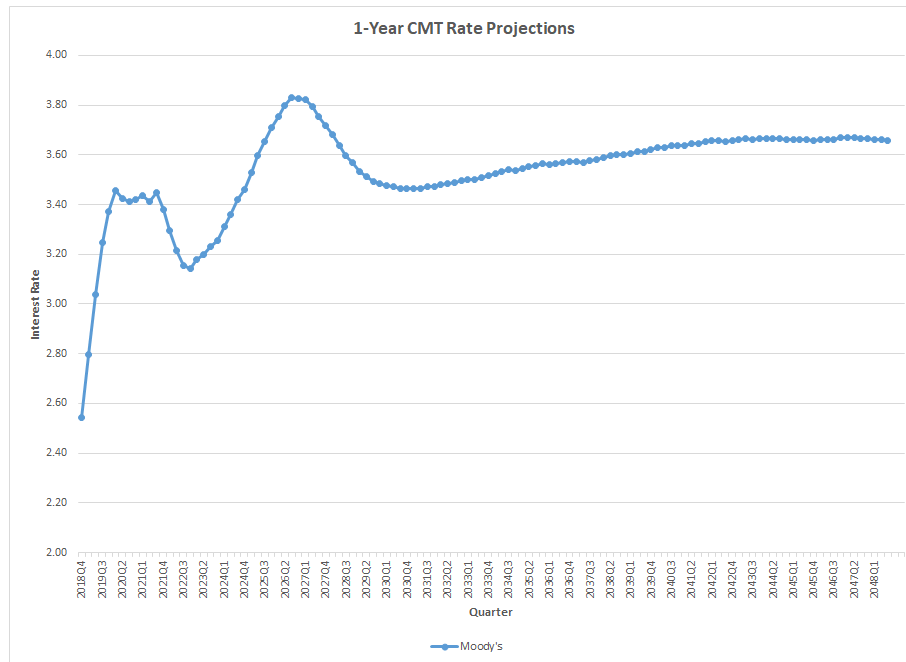
Moody's projections show increases in the one-year CMT rates. The rate increases to over 3.4% by 2019, and then decreases to about 3.1% in 2022. The rate then increases to 3.8% by 2026. After this, the rate decreases again and then gradually increases to almost 3.7%.

The 10-year CMT rate projections from Moody's are shown below.

Figure 4: 10-Year CMT Rate Projection
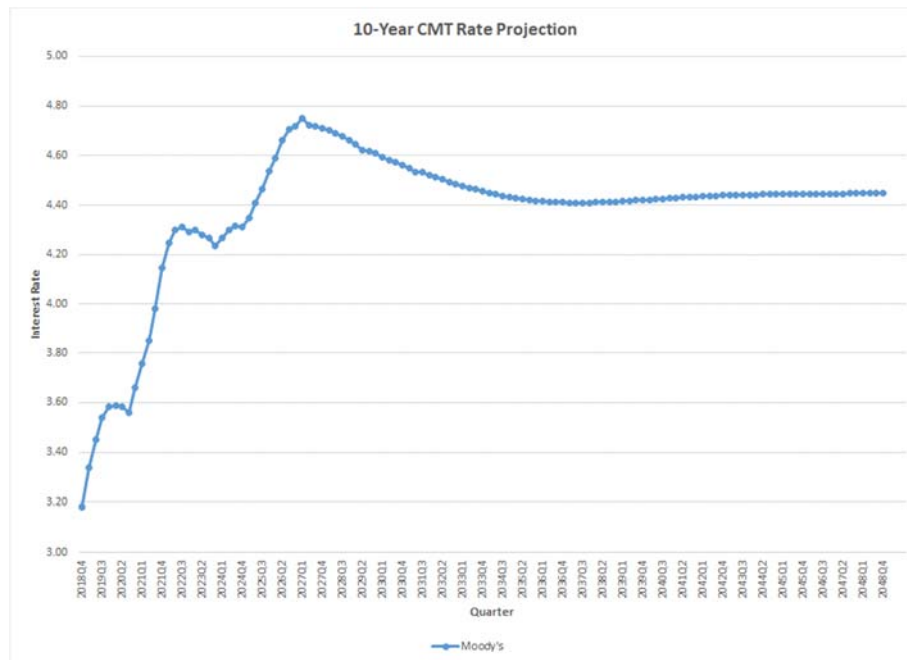
The interest rates increase gradually and then stabilize at 4.4% by 2036.

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. Moody's produces a home price index which projects home prices to 2047. Moody's also produces a forecast for local areas, including metropolitan areas and states.

The annual percentage change in the projected Federal Housing Finance Agency (FHFA) Purchase Only House Price Index by quarter is shown below for Moody's baseline projections.

Figure 5: FHFA Purchase Only House Price Index
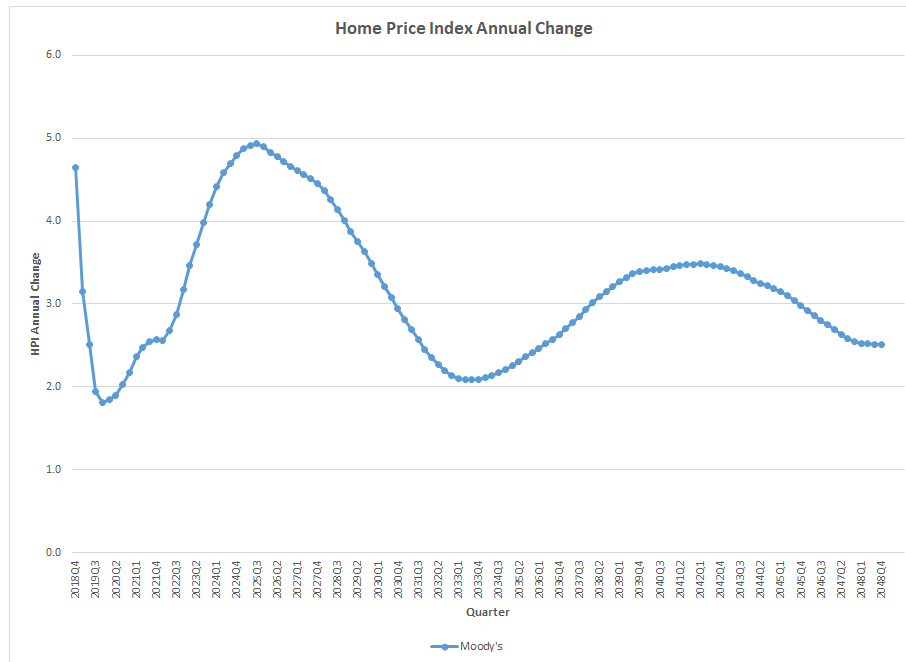
For Moody's projections, the index decreases from about 5% to 2% in 2019. The rate then increases sharply to just under 5% by 2025. The rate then decreases and stabilizes long-term near 3%.

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 MMIF. The historical unemployment rate is shown below.

Figure 6: Historical Unemployment Rate
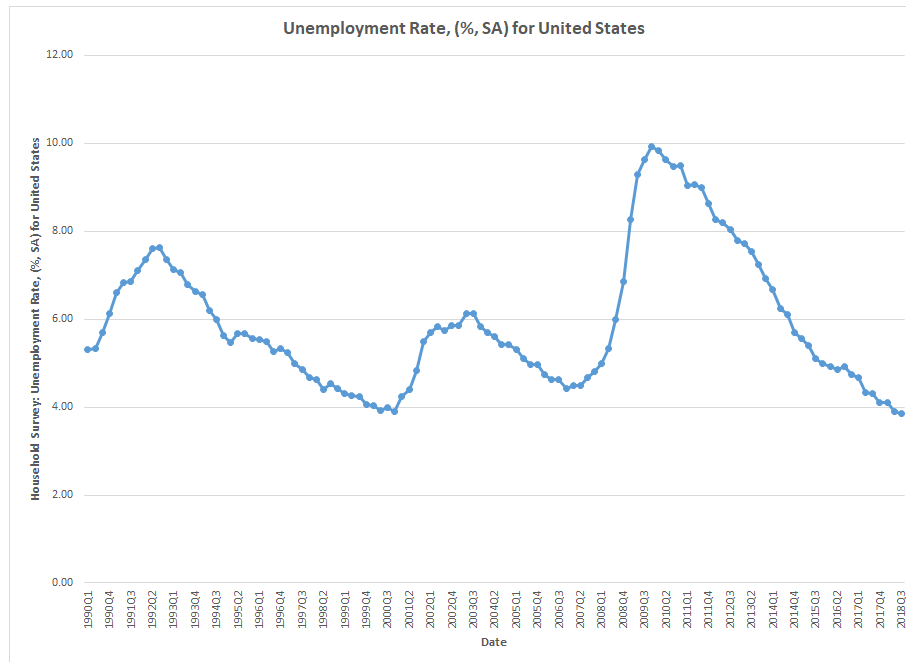
Beginning in 2008, as the economic downturn occurred, the seasonally adjusted unemployment rate nearly doubled from 5% to just under 10% by the end of 2009. Since 2009, the rate has decreased steadily to 3.9% in the third quarter of 2018.

The projected unemployment rates from Moody's are shown in Figure 7.

Figure 7: Unemployment Rate Projection
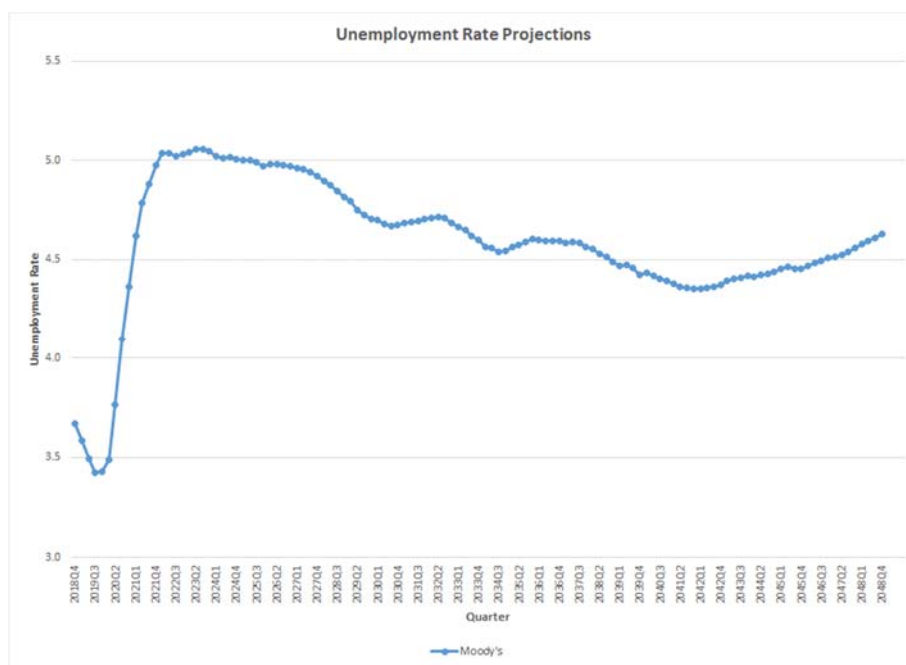
Moody's projections are cyclical over the next 10 years, oscillating between 4.4% and 5.0%. Subsequently, the long term unemployment rate settles at 4.4%.

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 MMIF. 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 an impact on the cash flow NPV of the MMIF.

Table 5: FHA Share of Home Sales

Calender Year	Volume of Home Sales ($ Billions)		
	FHA	Market	FHA Share (%)
2001	89	960	9.2%
2002	82	1,097	7.5%
2003	71	1,280	5.6%
2004	53	1,309	4.1%
2005	37	1,512	2.5%
2006	36	1,399	2.5%
2007	39	1,140	3.5%
2008	129	731	17.7%
2009	185	664	27.8%
2010	167	530	31.6%
2011	129	505	25.6%
2012	127	588	21.5%
2013	119	734	16.2%
2014	107	759	14.1%
2015	154	903	17.0%
2016	176	1,052	16.7%
2017	174	1,110	15.7%
2018	118	893	13.2%

Sources: FHA Volume from FHA Data Warehouse, September 30, 2018 extract. Market volume from Mortgage Bankers Association.

FHA's share of the volume of home sales has increased dramatically from its low of 2.5% in 2005 and 2006. From 2002 to 2007, 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 3.5% to 31.6% from 2007 to 2010. As the housing market has recovered, FHA has endorsed loans for 14 – 17% of the market share volume from 2013 - 2017. For the first three quarters of 2018, the FHA share has decreased to 13.2%.

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

- **Section 2. Summary of Findings and Comparison with Fiscal Year 2017 Actuarial Review** – presents the MMIF estimated Cash Flow NPV for fiscal year 2018 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 2017 and fiscal year 2018 Reports.

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

- **Section 4. Characteristics of the Fiscal Year 2018 Insurance Portfolio** – describes the fiscal year 2018 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 Modeling** – provides a technical description of our predictive models of current and default transitions, the model parameters and model validation results.

- **Appendix C: Claim Amount Modeling** – 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 MMIF and presents the variation in estimated Cash Flow NPV based on the additional economic scenarios. We also describe the details of the stochastic analysis.

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

- **Appendix F: 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 2017 Actuarial Review

This section presents the Cash Flow NPV of the MMIF Forward Loan portfolio as of the end of fiscal year 2018, and also shows a comparison of the elements of the economic value between the 2017 Actuarial Review and this review.

Fiscal Year 2018 Cash Flow NPV Estimate

The 2018 Actuarial Review estimates the Cash Flow NPV of the MMIF as of the end of fiscal year 2018 using data through September 30, 2018. 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 MMIF. The NPV of these cash flows along with the MMIF's capital resources represent the economic value of the MMIF.

The predictive models used in this report are similar conceptually to the models developed in the 2017 Actuarial Review. We have developed multinomial logistical models by product type which predict the likelihood of all possible transitions simultaneously.

Appendices A through F 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 during fiscal year 2019 and subsequent years. It is computed based on economic projections associated with the OMB Economic Assumptions. **As of the end of Fiscal Year 2018, Pinnacle estimates that the MMIF Cash Flow NPV is $3.457 billion.** The Cash Flow NPV estimate provided by FHA to be used in FHA's Annual Report to Congress is $1.372 billion.

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

Table 6: Cash Flow NPV by Cohort

Cohort	Pinnacle	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	-0.1	-0.1	0.0
2002	-0.2	-0.2	0.0
2003	-0.3	-0.3	-0.1
2004	-0.5	-0.5	0.0
2005	-0.5	-0.5	0.0
2006	-0.5	-0.6	0.1
2007	-0.7	-0.8	0.1
2008	-1.7	-1.7	-0.1
2009	-2.6	-2.1	-0.5
2010	-2.3	-1.7	-0.6
2011	-1.1	-0.6	-0.5
2012	-0.9	-0.1	-0.8
2013	-0.5	0.9	-1.5
2014	1.4	1.6	-0.1
2015	1.9	2.6	-0.6
2016	2.6	2.6	0.0
2017	4.2	1.7	2.5
2018	5.5	1.2	4.4
Total	3.5	1.4	2.1

The Pinnacle estimates by cohort are consistent with the FHA estimates through 2008, lower for cohorts 2009 – 2015, and higher for cohorts 2017 and 2018. The total Pinnacle Cash Flow NPV estimate is $2.1 billion higher than the FHA estimate, which as a percentage of IIF is 0.16%. The current IIF is $1,320 billion.

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 - 2010 cohorts are estimated to experience larger negative Cash Flow NPVs than any other cohorts. However, at the end of the housing recession, house prices bottomed out and then turned positive, and as a result mortgages originated in fiscal years 2014 - 2018 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.

The table below shows Pinnacle'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	(1,356,369)	-	(383,446)	(1,739,815)
1993	(2,178,671)	-	(547,931)	(2,726,602)
1994	(3,490,895)	-	(944,435)	(4,435,329)
1995	(3,275,943)	-	(933,880)	(4,209,823)
1996	(6,838,821)	-	(1,024,302)	(7,863,123)
1997	(8,407,236)	-	(1,407,726)	(9,814,962)
1998	(23,602,190)	-	(1,611,063)	(25,213,253)
1999	(31,587,712)	-	(200,513)	(31,788,226)
2000	(27,034,536)	-	(1,305,792)	(28,340,328)
2001	(108,518,156)	-	(684,651)	(109,202,807)
2002	(192,415,036)	-	(5,122,938)	(197,537,974)
2003	(333,208,334)	-	(6,637,458)	(339,845,793)
2004	(505,601,771)	(58,315)	(13,459,068)	(519,119,154)
2005	(503,741,843)	(438,248)	(15,465,673)	(519,645,765)
2006	(503,171,821)	(559,661)	(5,561,217)	(509,292,699)
2007	(676,333,494)	(1,070,980)	(2,854,252)	(680,258,727)
2008	(1,715,658,138)	(4,770,930)	(6,258,974)	(1,726,688,042)
2009	(2,596,923,849)	(9,721,700)	(8,619,971)	(2,615,265,520)
2010	(2,255,514,441)	(16,218,443)	(22,432,219)	(2,294,165,103)
2011	(1,113,315,948)	(16,745,533)	(15,854,475)	(1,145,915,956)
2012	(876,959,286)	(24,890,683)	(2,915,794)	(904,765,764)
2013	(532,038,713)	(19,078,954)	2,931,089	(548,186,578)
2014	1,376,895,599	12,094,558	23,760,753	1,412,750,910
2015	1,880,430,727	21,092,593	18,944,331	1,920,467,651
2016	2,559,460,881	31,970,030	9,798,458	2,601,229,369
2017	4,145,534,026	47,408,331	9,513,839	4,202,456,195
2018	5,487,178,646	43,502,474	15,176,763	5,545,857,882
Total	3,428,326,673	62,514,538	(34,100,548)	3,456,740,663

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

Change in the Cash Flow NPV

Table 8 shows the comparison of our estimate of the Fund's Cash Flow NPV and IIF at the end of fiscal year 2018 to the Cash Flow NPV estimate in the 2017 Review.

Table 8: Estimate of Cash Flow NPV as of the end of Fiscal Year 2018 ($ in millions)

Item	2017	2018	Percent Change
Cash Flow NPV	1,893	3,457	82.6%
Unamortized Insurance-In-Force	1,265,933	1,319,678	4.2%

As seen in Table 8, the estimated fiscal year 2018 Cash Flow NPV of the MMIF has increased by $1.564 billion from the level estimated in fiscal year 2017, from $1.893 billion to $3.457 billion. The unamortized IIF increased by 4.2% from $1.266 trillion to $1.320 trillion. 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 from the Fiscal Year 2017 Review to the Fiscal Year 2018 Review

Table 9 provides a summary of the decomposition of changes in the Cash Flow NPV of the MMIF as of the end of fiscal year 2018 as compared to the Cash Flow NPV in the fiscal year 2017 report. The overall net change in the Cash Flow NPV is positive.

Table 9: Changes in Projected Cash Flow NPV

	Change in NPV	NPV - 9/30/18
Baseline FY2009-FY2017		1,892,909,014
Impact of assumption change	1,817,117,569	3,710,026,583
Impact of model change	-1,684,181,261	2,025,845,322
Impact of book change	-4,114,962,539	-2,089,117,217
FY1992-FY2017	-3,982,026,231	
FY2018	5,545,857,882	3,456,740,665
Cumulative Change	1,563,831,651	

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, because it depends 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 2017 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 2018 PEA forecast to the 2019 PEA forecast. There was not a significant change in the HPI forecast. Short term treasury rate projections are lower than the projections used in the 2017 Actuarial Report, and the projected mortgage rates are also lower in the forecast this year. This leads to higher prepayment and claim rates, both resulting in lower economic value. The short term unemployment projection is lower this year than in the 2017 Actuarial Report, while the long term projections are similar. This will ultimately result in a higher projected Cash Flow NPV. The net impact of these changes is an increase of $1.817 billion in the projected Cash Flow NPV.

Updated Predictive Models

With this analysis, we have continued to refine the predictive models to better capture the termination behavior

and projected claim amounts of loans in the MMIF. We re-estimated the models using updated data and revised variable specifications. For details about these model updates and refinements, refer to Appendices B, C and E.

These model changes led to a decrease in estimated economic value in the Cash Flow NPV of $1.684 billion.

Actual Performance of Cohorts 2017 and Prior in Fiscal Year 2018

The actual performance of the MMIF 2017 and prior cohorts realized during Fiscal Year 2018 affects the Cash Flow NPV of the MMIF estimate of the in-force portfolio. The actual experience for this period was $4.115 billion worse than expected. The major source of change is the loss experience was higher than projected in the 2017 Review.

Fiscal Year 2018 Origination Volume

The addition of the origination volume for the fiscal year 2018 book of business had the largest impact on the NPV. This additional origination volume increased the Cash Flow NPV projection by $5.546 billion.

Section 3 - Cash Flow NPV Based on Alternative Scenarios

The Cash Flow NPV of the MMIF will vary from our estimates if the actual 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 and associated percentiles. These alternative estimates were then 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.

The Moody's scenarios are:

- Baseline
- Exceptionally Strong Growth
- Stronger Near-Term Rebound
- Slower Near-Term Growth
- Moderate Recession
- Protracted Slump
- Below-Trend Long-Term 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.

Moody's Baseline Assumptions

In this scenario, the HPI increases over the entire projection period, and the rate of change is consistently between 2.5% and 3.5%. The mortgage interest rate increases and settles at a long-term average of about 5.9%. The unemployment rate decreases to 3.4% over the next year, and then increases to a long-term average of around 5.0%.

Exceptionally Strong Growth Scenario

In Moody's Exceptionally Strong Growth scenario, the HPI is projected to increase more quickly than under the

Baseline scenario. In addition, mortgage interest rates are projected to increase throughout the entire projection period. The unemployment rate also is lower than projected in the Baseline scenario throughout the entire projection period.

Stronger Near-Term Rebound Scenario

In Moody's Stronger Near-Term Rebound scenario, the HPI is projected to increase at a higher rate than the Moody's scenario through the entire projection period. In addition, mortgage interest rates are projected to be higher than the Baseline scenario through 2022, then projected to be the same as the Baseline for the remainder of the projection period. The unemployment rate also is lower than projected in the Moody's scenario throughout the entire projection period.

Slower Near-Term Growth Scenario

In Moody's Slower Near-Term Growth scenario, the HPI increases slowly than the Baseline scenario. Mortgage interest rates are projected to be flat through 2020, and then increase for the remainder of the projection period. The unemployment rate is projected to be higher than the Moody's assumptions for the entire projection period.

Moderate Recession Scenario

In the Moderate Recession scenario, the HPI decreases through the end of 2019, and then begins to increase. Mortgage interest rates drop significantly through the end of 2019, and then begin to slowly increase until they reach the long-term average of about 6.0%. The unemployment rate spikes to 7.4% by 2020, and then recovers to a long-term average of just over 5%.

Protracted Slump

In Moody's Protracted Slump scenario, the HPI decreases significantly over the next 18 months, and then begins to increase again. Mortgage interest rates drop until the second quarter of 2020, then begin to slowly increase until they reach the long-term average of just under 6%. The unemployment rate spikes to 8.3% by 2020, and then recovers to a long-term average of just over 5%.

Below-Trend Long-Term Growth

In Moody's Below-Trend Long-Term Growth scenario, the HPI increases more slowly than in the Baseline scenario. Mortgage interest rates increase gradually and settle at a long-term average of about 5.6%. The unemployment rate increases to 5.9% by 2021, and then decreases to a long-term average of approximately 5.1%.

Stagflation

In Moody's Stagflation scenario, the HPI decreases through the third quarter of 2020, and then begins to increase. Mortgage interest rates increase sharply to 6.4% by the first quarter of 2019, and then drop through the second quarter of 2021. They then begin to slowly increase to the long-term average of just under 6.0%. Unemployment rates increase significantly to just over 7.4% by 2020, and then decrease to a long-term average

of 5%.

Next-Cycle Recession

In Moody's Next-Cycle Recession scenario, the HPI increases through the end of 2021, and then decreases significantly through the second quarter of 2022. The HPI then increases again. The mortgage interest rates increase through 2020, and then increase significantly to 6.2% in 2020. The rates then drop significantly, and then settle in at a long term average of about 6.0%. The unemployment rate is lower than the Baseline assumptions through the first quarter of 2020, and then increases sharply to over 8% by 2022. It then decreases to under 5% by 2025.

Low Oil Price

In Moody's Low Oil Price scenario, the HPI increases throughout the entire projection period. Mortgage interest rates increase at a slow rate through 2020, and then increase at a higher rate through the remainder of the projection period. Unemployment rates decrease through 2019, and then increase for the remainder of the projection period, settling at a long-term average of 5%.

Summary of Alternative Scenarios

Table 10 shows the projected Cash Flow NPV from the ten deterministic scenarios. The range of projected results is between negative $16.401 billion and positive $3.457 billion.

Table 10: Cash Flow NPV Summaries from Alternative Scenarios

Cohort	Pinnacle ACE	Moody's Baseline	Moody's Exceptionally Strong Growth	Moody's Stronger Near-Term Rebound	Slower Near Term Growth	Moderate Recession	Protracted Slump	Below-Trend Long-Term Growth	Stagflation	Next Cycle Recession	Low Oil Price
1992	-1,842,068	-1,748,383	-1,138,566	-1,479,076	-2,047,010	-2,706,170	-3,022,624	-2,191,778	-2,166,339	-1,889,286	-1,946,620
1993	-2,704,399	-2,724,949	-1,724,957	-1,998,836	-3,360,603	-4,378,298	-5,408,906	-3,104,869	-3,871,246	-3,006,964	-3,056,076
1994	-4,621,283	-4,676,937	-2,390,196	-3,717,375	-6,229,405	-7,594,009	-9,735,066	-6,137,668	-6,822,244	-5,809,697	-5,345,428
1995	-4,145,804	-4,943,352	-2,839,491	-4,059,164	-6,194,863	-7,978,353	-8,588,429	-5,701,656	-7,183,644	-5,995,049	-5,505,944
1996	-8,102,313	-8,916,296	-5,370,298	-7,997,955	-10,258,283	-14,926,821	-16,278,402	-10,660,153	-12,389,180	-11,584,101	-9,679,672
1997	-9,935,651	-12,323,903	-8,092,535	-10,670,854	-14,115,384	-21,396,069	-24,760,774	-15,989,979	-17,867,071	-16,919,946	-13,382,179
1998	-24,722,385	-27,801,327	-18,041,872	-22,427,004	-32,017,677	-39,685,087	-43,653,324	-29,680,370	-34,571,026	-30,998,938	-27,954,250
1999	-32,081,054	-38,307,010	-25,572,692	-35,285,520	-46,248,148	-62,069,348	-69,021,111	-45,093,453	-52,882,173	-50,354,047	-41,128,375
2000	-28,156,342	-33,179,587	-24,146,652	-30,916,815	-37,218,924	-50,570,781	-54,790,022	-39,929,606	-44,874,076	-43,280,496	-37,228,024
2001	-109,978,757	-121,514,055	-91,371,964	-104,498,411	-130,661,513	-153,056,519	-168,116,686	-127,245,184	-143,937,697	-138,913,877	-126,700,615
2002	-197,947,880	-214,106,588	-168,920,718	-194,945,472	-237,485,657	-277,570,637	-300,872,992	-234,282,594	-260,673,823	-243,134,664	-223,261,096
2003	-338,480,098	-379,647,039	-288,451,650	-343,487,829	-414,396,998	-480,836,634	-522,501,740	-409,712,095	-453,368,602	-428,935,081	-387,383,040
2004	-519,119,154	-580,476,434	-460,766,394	-530,016,279	-630,380,070	-721,100,524	-783,058,857	-636,650,227	-689,286,075	-647,544,602	-593,952,667
2005	-519,645,765	-571,928,926	-481,679,672	-529,367,451	-610,887,521	-681,047,191	-740,149,172	-610,516,917	-684,469,116	-622,105,170	-595,553,842
2006	-509,292,699	-559,662,539	-488,113,430	-519,938,704	-602,395,308	-671,555,490	-704,681,902	-581,325,156	-672,491,295	-623,144,738	-576,463,430
2007	-680,258,727	-743,405,625	-645,848,567	-693,426,523	-786,619,558	-868,833,907	-919,863,910	-777,034,150	-864,569,089	-821,162,771	-768,892,663
2008	-1,726,688,042	-1,887,796,480	-1,655,518,230	-1,779,355,897	-2,025,384,709	-2,213,642,857	-2,311,258,134	-1,998,838,638	-2,255,092,902	-2,138,811,298	-1,959,656,588
2009	-2,615,265,520	-2,904,692,313	-2,306,507,957	-2,622,207,839	-3,132,657,013	-3,526,966,676	-3,793,416,974	-3,124,292,508	-3,511,678,112	-3,230,623,705	-2,969,971,847
2010	-2,294,165,103	-2,573,252,726	-1,984,106,554	-2,310,990,279	-2,834,938,341	-3,253,257,523	-3,553,924,544	-2,829,730,482	-3,180,626,586	-2,931,408,377	-2,663,531,352
2011	-1,145,915,956	-1,315,906,552	-948,329,977	-1,149,531,376	-1,494,571,538	-1,802,239,645	-2,018,986,506	-1,491,810,420	-1,717,044,057	-1,553,647,339	-1,370,568,710
2012	-904,765,764	-1,117,989,697	-675,596,778	-937,476,605	-1,356,020,297	-1,725,270,179	-2,006,415,247	-1,347,333,213	-1,564,859,531	-1,395,539,543	-1,185,234,474
2013	-548,186,578	-903,234,506	-338,977,498	-622,692,716	-1,183,431,858	-1,761,229,799	-2,180,814,625	-1,216,870,301	-1,463,183,047	-1,237,938,261	-982,776,973
2014	1,412,750,910	1,107,153,261	1,026,798,311	1,042,725,664	1,039,497,827	768,450,373	625,996,933	1,067,748,436	1,078,706,687	998,945,516	995,923,585
2015	1,920,467,651	1,290,099,683	1,287,837,966	1,250,326,752	1,083,725,392	457,232,365	83,464,758	1,124,052,982	1,165,377,100	1,041,403,209	1,099,637,134
2016	2,601,229,369	1,600,038,067	1,757,164,722	1,620,044,846	1,322,552,599	408,395,579	-192,491,080	1,352,941,102	1,549,025,063	1,246,206,815	1,374,955,413
2017	4,202,456,195	3,002,341,640	3,085,796,421	3,005,922,664	2,769,910,023	1,666,658,225	925,401,371	2,776,630,488	3,200,120,326	2,723,255,729	2,773,509,730
2018	5,545,857,882	4,472,270,713	4,514,585,974	4,448,918,561	4,212,989,317	3,182,708,167	2,395,379,139	4,202,257,027	4,687,366,627	4,260,923,829	4,307,559,602
Total	3,456,740,665	-2,536,331,860	1,048,676,746	-1,088,549,493	-5,168,845,520	-11,864,467,808	-16,401,568,826	-5,020,501,382	-5,963,311,128	-5,912,012,852	-3,997,588,401

Stochastic Simulation

The stochastic simulation approach provides information about the probability distribution of the Cash Flow NPV of the MMIF with respect to 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 simulated future economic paths. The distribution of Cash Flow NPV based on these scenarios allows us to gain insights into the sensitivity of the MMIF's Cash Flow NPV to different economic conditions.

Figure 8 below shows the range of Cash Flow NPV for the 100 scenarios.

Figure 8: Stochastic Simulation Results
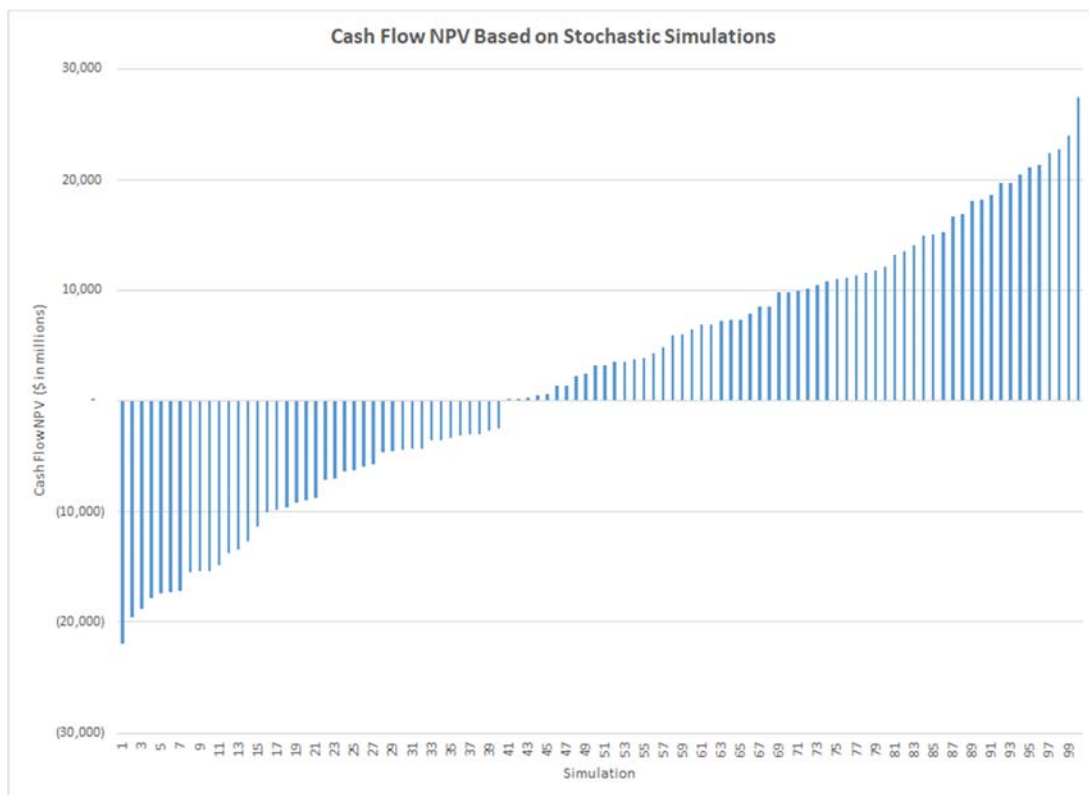
Based on the stochastic simulation results, we estimate that the range of reasonable Cash Flow NPV estimates is negative $15.422 billion to positive $18.191 billion. This range is based on an 80% likelihood that the ultimate Cash Flow NPV will fall within the lower and upper bound of the range. The 90th, 95th and 99th percentiles of the stochastic simulations are shown below:

- 90th percentile: $18.191 billion
- 95th percentile: $21.192 billion
- 99th percentile: $24.030 billion

The range of reasonable Cash Flow NPV estimates may not include all conceivable outcomes. For example, it

would not include conceivable 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 $1.371 billion. Based on Pinnacle's Actuarial Central Estimate and range of reasonable estimates, we conclude that the FHA estimate of Cash Flow NPV is reasonable.

Sensitivity Tests of Economic Variables

The above scenario analyses were conducted to estimate the distribution of the Cash Flow NPV of the MMIF with different combinations of the interest rate and house price movements in the future. It is also useful to understand the marginal impact of 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 two sets of economic variables:

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

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 9 shows the sensitivity of the Cash Flow NPV with respect to changes in future interest rates. Specifically, we applied parallel shift to the 1-year CMT rate, 10-year CMT rate and the mortgage rates up and down from the base scenario by 20, 50, 100 and 200 basis points. Interest rates are not allowed to be negative. The results show a positive slope, indicating that the Cash Flow NPV of the MMIF is positively related to future interest rates. Higher future interest rates benefit the MMIF 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 in order to continue to benefit from their below-market payments. A 100 basis point fall in interest rates will incur a decrease in Cash Flow NPV of $373 million, and a positive 100 basis point change in interest rates will result in an increase in Cash Flow NPV of $1.6 billion. For the interest rate sensitivity, the range of Cash Flow NPV impacts are -0.03% to +0.34% of IIF.

Figure 9 also reports the sensitivity of the Cash Flow NPV with respect to the unemployment rate. A negative 100 basis point change in the unemployment rates will produce an increase in Cash Flow NPV of positive $508

million, and a positive 100 basis point change in the unemployment rate will result in a decrease in Cash Flow NPV of $752 million. 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 are -0.13% to +0.05% of IIF.

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

Figure 9: Sensitivity Test of Selected Economic Variables
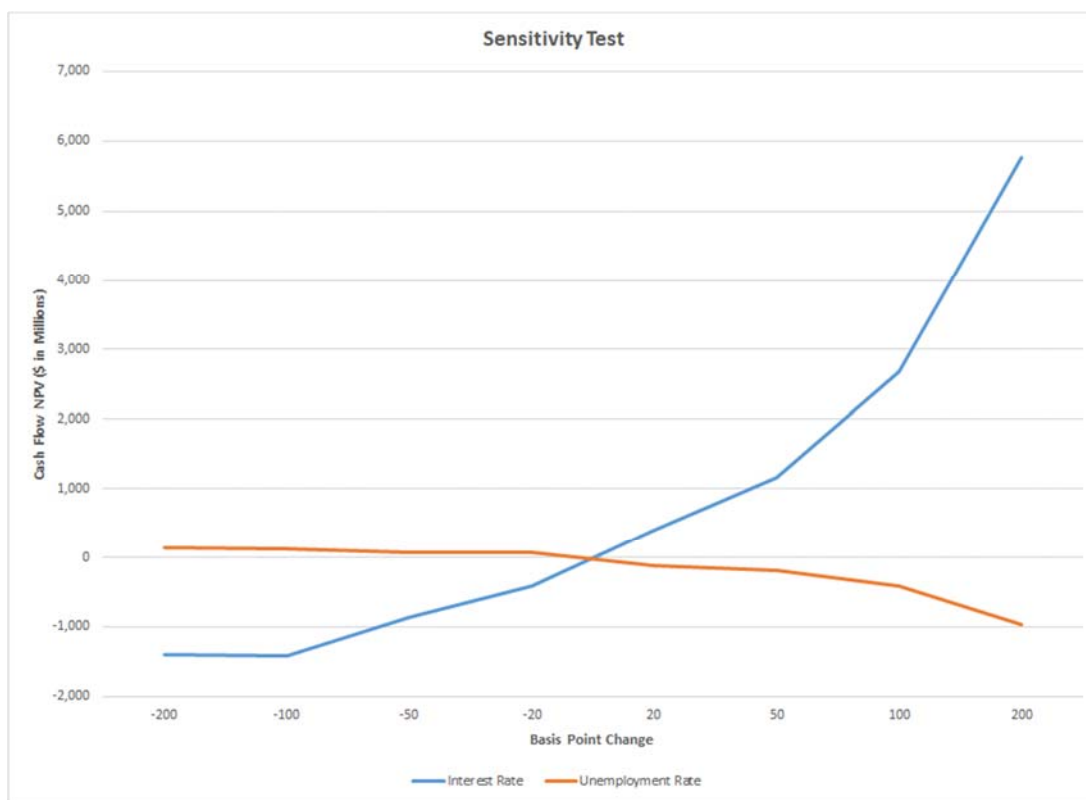
Figure 10: Sensitivity Test of Selected Economic Variables as a Percentage of IIF
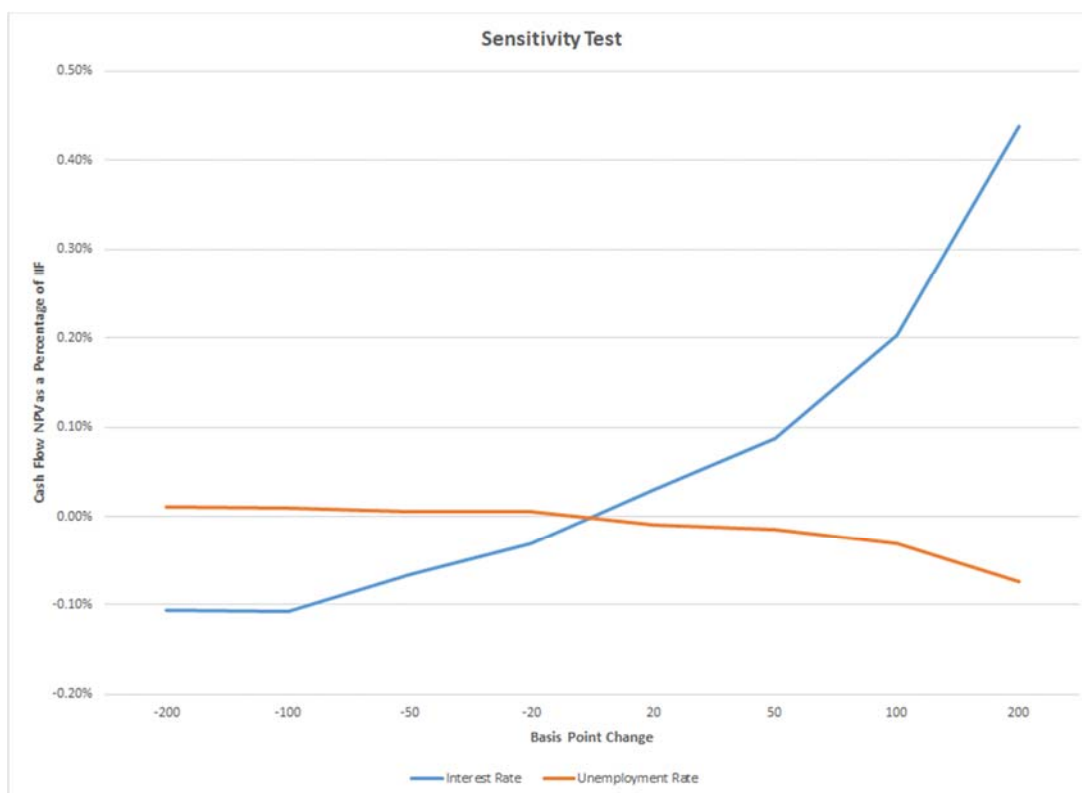
Section 4 - Characteristics of the Fiscal Year 2018 Insurance Portfolio

This section analyzes the characteristics of the loan portfolio insured by the MMIF as of fiscal year 2018. 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 2018 cohort with previous cohorts in order to determine how the 2018 cohort is likely to influence the future performance of the MMIF.

Volume and Share of Mortgage Originations

FHA will insured $206 billion in single-family forward mortgages in fiscal year 2018, bringing the MMIF's total unamortized IIF to $1.320 trillion. Table 11 shows FHA's origination count and volume by cohort. The new purchase count dropped significantly from fiscal year 2003 to fiscal year 2007, increased dramatically through fiscal year 2010, then returned to levels similar to those in fiscal years 2001 - 2003. The decline and subsequent rise were due to the Government Sponsored Enterprise (GSE)[42] 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 six years.

The volumes show a similar pattern, for the same reasons cited above, but the volumes subsequent to the housing crisis were much higher than volumes in the early 2000s. The loan size limits were increased 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.

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

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

Cohort	Count of Originations				Volume of Originations ($ Billions)		
	Purchase	Fully New Underwritten Refinance	Streamline Refinance		Purchase	Fully New 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	670,355	2	42,198		40.95	0.00	2.60
1989	557,894	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	537,864	12,253	300,986		39.99	0.89	21.78
1994	652,711	16,967	549,689		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	787,094	87,444	293,642		91.02	10.64	34.47
2003	602,452	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	777,101	239,344	180,227		134.36	44.36	38.92
2012	733,699	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	879,512	165,506	213,030		171.63	32.14	41.64
2017	882,079	200,256	164,099		178.62	40.54	31.79
2018	765,902	183,227	52,356		158.79	37.61	10.02

Table 12 shows FHA's origination volume and market share in home purchase mortgages from fiscal year 2001 through fiscal year 2018.

Table 12: FHA's Market Share in the Home Purchase Mortgage Market

Calender Year	Volume of Home Sales ($ Billions)		
	FHA	Market	FHA Share (%)
2001	89	960	9.2%
2002	82	1,097	7.5%
2003	71	1,280	5.6%
2004	53	1,309	4.1%
2005	37	1,512	2.5%
2006	36	1,399	2.5%
2007	39	1,140	3.5%
2008	129	731	17.7%
2009	185	664	27.8%
2010	167	530	31.6%
2011	129	505	25.6%
2012	127	588	21.5%
2013	119	734	16.2%
2014	107	759	14.1%
2015	154	903	17.0%
2016	176	1,052	16.7%
2017	174	1,110	15.7%
2018	118	893	13.2%

Sources: FHA Volume from FHA Data Warehouse, September 30, 2018 extract. Market volume from Mortgage Bankers Association. Calendar year 2018 includes data through September 30, 2018.

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 31.6%. Subsequently, the market share has decreased. The FHA share for the first nine months of calendar year 2018 was 13.2%.

Originations by Location

FHA insures loans in all regions of the U.S., but over half of FHA's total dollar volume is concentrated in only ten states. Table 10 shows the percentage of FHA's total dollar volume originated in these ten states from fiscal year 2012 through fiscal year 2018. The states are ordered based on the dollar volume endorsed during fiscal year 2018.

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

State	Fiscal Year						
	2012	2013	2014	2015	2016	2017	2018
California	18.9%	17.1%	16.3%	18.8%	17.5%	16.8%	14.8%
Florida	4.2%	4.8%	6.0%	6.0%	6.8%	7.5%	8.5%
Texas	6.6%	7.1%	8.9%	7.3%	7.5%	7.6%	8.0%
Georgia	2.8%	3.1%	3.4%	3.2%	3.7%	3.7%	4.0%
New York	4.2%	3.9%	4.0%	3.5%	3.5%	3.7%	3.6%
New Jersey	3.8%	3.5%	3.1%	3.5%	3.4%	3.5%	3.5%
Colorado	3.1%	3.3%	3.2%	3.4%	3.3%	3.5%	3.5%
Maryland	3.5%	3.5%	3.1%	3.6%	3.6%	3.5%	3.3%
Arizona	2.4%	2.9%	3.5%	3.7%	3.4%	3.2%	3.1%
Washington	3.0%	3.1%	2.6%	3.0%	3.1%	3.0%	3.0%

Currently, loans in California comprise the largest percentage of all FHA loans based on dollar volume, which is 14.8%. The percentage of loans in Florida has increased by 4.3% since 2012. Florida is now the second largest state based on origination volume, passing Texas.

Originations by Product

Table 14 shows that the fully underwritten 30-year fixed-rate mortgage (FRM) has comprised the majority of FHA's single-family business, representing a dollar-weighted average share of approximately 74.7% of the business over fiscal years 1986 - 2018. 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 has increased to 93.5% in fiscal year 2018.

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 account for only 0.5% of the endorsements in the 2018 cohort. 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 six years and are at 1.1% in fiscal year 2018. The 15-year SR continues to be a minor product type in the MMIF.

Table 14: Percentage of Origination Volume by Mortgage Product

	Fully Underwritten Mortgages				Streamline Refinancing		
Fiscal Year	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	93.54	1.12	0.48		4.70	0.15	0.01

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	0.67%	17.98%	30.59%	27.02%	20.75%	2.99%
1987	0.23%	18.27%	29.17%	27.97%	21.24%	3.12%
1988	0.08%	10.15%	21.72%	33.84%	29.51%	4.70%
1989	0.43%	7.58%	18.46%	35.95%	32.36%	5.22%
1990	20.81%	5.90%	14.77%	28.83%	25.62%	4.07%
1991	3.42%	5.99%	16.06%	30.32%	29.59%	14.61%
1992	10.92%	4.52%	13.29%	24.87%	33.23%	13.17%
1993	27.24%	3.73%	11.22%	19.57%	23.24%	15.00%
1994	34.40%	3.56%	9.67%	16.38%	19.79%	16.20%
1995	5.64%	3.15%	10.39%	22.94%	31.68%	26.21%
1996	9.48%	2.97%	10.55%	23.07%	30.84%	23.09%
1997	4.55%	3.41%	11.29%	24.94%	32.49%	23.31%
1998	13.34%	3.62%	11.76%	23.29%	29.09%	18.89%
1999	12.89%	4.00%	10.94%	14.77%	25.17%	32.23%
2000	1.44%	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%	6.56%	11.70%	10.33%	22.46%	48.94%
2005	0.01%	6.39%	10.72%	9.06%	22.17%	51.65%
2006	0.01%	7.12%	10.72%	14.35%	19.89%	47.91%
2007	0.01%	7.38%	11.68%	21.24%	18.20%	41.50%
2008	0.14%	6.18%	12.18%	24.03%	14.11%	43.35%
2009	0.01%	4.99%	13.33%	18.82%	35.68%	27.17%
2010	0.01%	4.81%	14.53%	12.63%	58.79%	9.24%
2011	0.01%	4.86%	14.80%	14.07%	59.89%	6.37%
2012	0.01%	5.50%	13.45%	20.00%	57.17%	3.87%
2013	0.01%	5.66%	16.15%	27.25%	48.60%	2.34%
2014	0.01%	6.07%	14.09%	12.92%	65.04%	1.86%
2015	0.01%	6.06%	14.84%	12.95%	63.83%	2.30%
2016	0.01%	6.86%	16.11%	11.14%	64.12%	1.75%
2017	0.02%	7.84%	17.19%	10.08%	63.65%	1.23%
2018	0.02%	7.80%	16.81%	8.11%	66.14%	1.11%

The distribution among original LTV categories shifted significantly after fiscal year 1998. Almost half of the loans insured during 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, MMIF placed a limit of 96.5% on original LTV, with no additional allowance for the financing of closing costs. During fiscal year 2009, 26.3% of mortgages had LTV ratios of 97% or more. In fiscal years 2010 - 2017, this concentration continued to decline and is 1.11% in fiscal year 2018. Since fiscal year 2014, over 60% of mortgages have LTV ratios between 95 to 97%.

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.

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 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 considered to be 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 36.38% of the fiscal year 2018 loans have credit scores above 680. Loans with credit scores below 600 are only 4.19% of the loans originated in fiscal year 2018, which is substantially lower than in the fiscal year 2007 book, where 31.51% of the loans had credit scores below 600. The proportion of loans with credit scores below 600 has been increasing slowly however since 2014. This continued improvement in credit scores will result in improved default and loss experience and thus will contribute positively to the economic value of the MMIF.

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.

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

Cohort	Missing / Not Collected	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%
1998	100.00%	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%
2000	100.00%	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%
2002	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2003	99.97%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%
2004	81.97%	0.16%	1.66%	3.12%	4.61%	3.89%	4.58%
2005	23.33%	0.80%	7.70%	13.75%	19.93%	16.36%	18.13%
2006	10.24%	0.90%	8.28%	15.68%	23.14%	19.54%	22.22%
2007	7.75%	1.48%	11.31%	18.72%	24.20%	18.25%	18.29%
2008	7.06%	0.81%	6.63%	13.41%	23.04%	21.58%	27.47%
2009	18.37%	0.07%	1.00%	4.17%	14.83%	20.56%	41.00%
2010	11.59%	0.04%	0.20%	0.79%	10.93%	22.46%	53.98%
2011	10.89%	0.02%	0.14%	0.45%	7.24%	24.17%	57.08%
2012	26.80%	0.00%	0.07%	0.39%	6.04%	22.63%	44.07%
2013	36.44%	0.00%	0.05%	0.28%	4.10%	23.02%	36.11%
2014	10.18%	0.00%	0.10%	0.91%	10.09%	37.24%	41.49%
2015	17.60%	0.00%	0.11%	1.34%	11.75%	31.01%	38.17%
2016	13.13%	0.01%	0.15%	1.67%	13.33%	31.49%	40.23%
2017	9.95%	0.01%	0.24%	2.34%	15.82%	32.37%	39.27%
2018	3.96%	0.00%	0.42%	3.77%	20.11%	35.41%	36.33%

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-to-125 percent 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 10.77% in

fiscal year 2001 to 19.48% in fiscal year 2018. On the other hand, the share in lowest loan size category also increased from 2.50% percent in fiscal year 2006 to 3.22% in fiscal year 2018. The increase in both the highest and lowest loan size categories demonstrate the penetration of FHA products into high-balance loans and the resurgence of the low-balance loan.

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%	21.11%	5.75%
1986	1.37%	10.11%	27.02%	38.74%	18.86%	3.90%
1987	1.15%	9.85%	26.95%	38.79%	19.68%	3.59%
1988	1.50%	10.82%	25.90%	35.57%	20.13%	6.08%
1989	1.74%	11.31%	25.56%	32.44%	20.94%	8.00%
1990	1.77%	11.54%	25.43%	31.12%	20.78%	9.36%
1991	1.85%	11.57%	25.44%	30.03%	21.41%	9.69%
1992	1.73%	11.30%	25.91%	31.42%	21.28%	8.36%
1993	1.44%	10.77%	27.26%	33.28%	20.62%	6.64%
1994	1.51%	11.08%	26.78%	31.72%	20.62%	8.28%
1995	1.80%	11.93%	25.15%	30.26%	21.85%	9.02%
1996	1.73%	11.63%	25.25%	31.47%	22.24%	7.68%
1997	1.83%	12.01%	25.11%	31.72%	21.76%	7.58%
1998	1.54%	10.86%	24.79%	33.76%	21.99%	7.06%
1999	1.76%	11.76%	25.70%	31.99%	19.63%	9.16%
2000	2.09%	11.95%	24.65%	29.28%	20.11%	11.92%
2001	2.01%	11.58%	26.03%	30.32%	19.30%	10.77%
2002	2.08%	11.29%	25.70%	30.24%	19.22%	11.47%
2003	2.03%	11.15%	25.77%	30.78%	19.01%	11.26%
2004	2.49%	11.75%	24.07%	28.63%	19.80%	13.26%
2005	2.64%	12.05%	23.57%	28.06%	19.98%	13.70%
2006	2.50%	12.39%	23.34%	27.90%	19.71%	14.16%
2007	2.50%	12.51%	23.44%	27.68%	19.45%	14.42%
2008	2.77%	12.88%	24.42%	25.72%	17.24%	16.99%
2009	3.40%	13.39%	23.11%	22.62%	16.12%	21.36%
2010	3.94%	14.06%	22.21%	20.94%	14.87%	23.99%
2011	4.35%	14.03%	20.98%	19.98%	14.61%	26.06%
2012	4.16%	13.94%	21.54%	20.67%	14.89%	24.79%
2013	3.62%	14.09%	22.76%	21.26%	14.88%	23.40%
2014	3.80%	14.16%	22.43%	20.89%	15.00%	23.72%
2015	3.51%	13.61%	22.90%	21.85%	15.85%	22.28%
2016	3.36%	13.32%	23.09%	22.34%	16.51%	21.38%
2017	3.31%	12.97%	23.11%	23.09%	17.23%	20.28%
2018	3.22%	12.65%	23.37%	24.20%	17.08%	19.48%

Initial Contract Interest Rate

Table 18 shows the average mortgage contract rate by mortgage type since fiscal year 1997. Average contract rates in fiscal year 2013 were the lowest of this entire time period.

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	ARMs	30-Year SRs	15-Year SRs	ARMs SRs	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	3.19	3.75	3.59	3.02	3.98
2018	4.54	3.87	3.50	4.07	4.03	3.49	4.50

Source of Down Payment Assistance

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

Starting in fiscal year 2003, 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 assist 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.

Table 19: Percentage of Down payment assist Loan Counts by Source

Cohort	No Gift	Relative	Non-Profit, Religious or Community	Government
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%	21.70%	0.41%	1.55%

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 – 2017)
3. Lossmit_Costs: derived table based on the Loss Mitigation table and IDB_1, used to obtain mitigation claim amounts
4. Sams_case_record: used to determine the status of the conveyances, the capital income/expense amounts, the sales and REO expenses and sales proceeds to FHA, where applicable
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:
8. SFDW Dictionary for Pinnacle: data dictionary for the data tables provided by FHA

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

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

From OMB, we have received the Economic Assumptions for the 2019 Mid-Session Review (updated as of March, 2018).

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

Data Processing – Mortgage Level Modeling (Appendix A)

Starting with the raw data, Pinnacle processed the data to create datasets for developing the mortgage level transition and loss severity models. The steps below describe the data processing that occurred to prepare the data that was used for this analyses.

The first step in preparing the data for analysis was the processing of 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 the end of fiscal year 2018 if the mortgage remained active.

Data Reconciliation

To reconcile the data processed by Pinnacle with the data provided by FHA, Pinnacle 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.

The following tables are based on data as of September 30, 2018.

Table 20: Data Reconciliation - Number of Active Loans

	Number of Active Loans			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	12,907	13,467	560	4%
1993	18,642	21,593	2,951	16%
1994	25,787	31,375	5,588	22%
1995	14,730	15,125	395	3%
1996	23,894	24,622	728	3%
1997	26,140	26,479	339	1%
1998	40,272	41,896	1,624	4%
1999	51,404	53,297	1,893	4%
2000	29,099	29,341	242	1%
2001	50,238	51,238	1,000	2%
2002	75,205	75,705	500	1%
2003	110,401	111,306	905	1%
2004	142,767	142,966	199	0%
2005	104,809	104,933	124	0%
2006	82,849	82,931	82	0%
2007	79,015	79,045	30	0%
2008	186,810	187,018	208	0%
2009	423,088	423,147	59	0%
2010	542,356	542,388	32	0%
2011	437,232	437,246	14	0%
2012	538,121	538,146	25	0%
2013	748,868	748,890	22	0%
2014	364,447	364,459	12	0%
2015	689,264	689,278	14	0%
2016	988,626	988,646	20	0%
2017	1,125,996	1,126,020	24	0%
2018	987,897	987,924	27	0%
Total	7,920,864	7,938,481	17,617	0%

Table 21: Data Reconciliation - Insurance in Force

	Insurance in Force ($M) = Original Loan Amount on Active Loans			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	787,948	$825,364	37,416	5%
1993	1,207,761	1,419,868	212,107	18%
1994	1,706,032	2,099,317	393,285	23%
1995	929,512	957,280	27,768	3%
1996	1,566,240	1,620,828	54,588	3%
1997	1,762,905	1,788,925	26,020	1%
1998	2,928,640	3,068,932	140,292	5%
1999	3,941,146	4,098,278	157,131	4%
2000	2,215,018	2,232,384	17,367	1%
2001	4,308,259	4,402,731	94,472	2%
2002	7,009,577	7,050,371	40,794	1%
2003	11,641,328	11,722,070	80,741	1%
2004	14,958,461	14,975,512	17,051	0%
2005	11,269,481	11,279,568	10,086	0%
2006	9,407,055	9,414,260	7,205	0%
2007	9,676,966	9,679,792	2,826	0%
2008	26,156,309	26,186,122	29,812	0%
2009	64,630,140	64,639,657	9,517	0%
2010	81,500,651	81,505,712	5,060	0%
2011	67,749,410	67,751,272	1,862	0%
2012	85,383,510	85,389,667	6,157	0%
2013	122,396,104	122,399,244	3,140	0%
2014	51,701,970	51,703,035	1,065	0%
2015	119,638,261	119,639,653	1,392	0%
2016	185,053,544	185,057,051	3,507	0%
2017	223,319,527	223,325,794	6,266	0%
2018	203,296,356	203,303,811	7,455	0%
Total	1,316,142,112	1,317,536,496	1,394,383	0%
Note:	Unamortized IIF as of September 30, 2018			

Table 22: Data Reconciliation - Number of 90 Day Delinquencies

	Federal Housing Administration			
	Independent Actuary Comparison Template			
	Data Reconciliation: Forward			
	Number of 90 Day Delinquencies			
	= Current Number of 90 Day Delinquencies			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	462	486	24	5%
1993	691	765	74	11%
1994	1,022	1,153	131	13%
1995	877	912	35	4%
1996	1,454	1,523	69	5%
1997	1,850	1,897	47	3%
1998	2,666	2,772	106	4%
1999	3,651	3,803	152	4%
2000	2,803	2,862	59	2%
2001	3,936	4,076	140	4%
2002	5,525	5,631	106	2%
2003	6,652	6,843	191	3%
2004	9,231	9,383	152	2%
2005	7,786	7,909	123	2%
2006	7,823	7,927	104	1%
2007	9,457	9,595	138	1%
2008	22,415	22,711	296	1%
2009	31,097	31,450	353	1%
2010	26,817	27,228	411	2%
2011	17,486	17,809	323	2%
2012	17,689	18,101	412	2%
2013	20,739	21,226	487	2%
2014	17,323	17,803	480	3%
2015	26,026	26,684	658	3%
2016	30,012	30,857	845	3%
2017	25,301	26,201	900	4%
2018	4,685	4,970	285	6%
Total	305,476	312,577	7,101	2%
Note:	Outstanding Delinquencies as of September 30, 2018			
	= Reported Delinquencies - Submitted Claims - Cured Delinquencies			
	on a cumulative basis.			

Table 23: Data Reconciliation - Number of Claims to Date

Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	35,064	36,718	1,654	5%
1993	41,787	52,155	10,368	25%
1994	53,170	65,740	12,570	24%
1995	43,333	44,521	1,188	3%
1996	60,475	63,190	2,715	4%
1997	58,251	59,511	1,260	2%
1998	63,636	66,957	3,321	5%
1999	81,019	83,456	2,437	3%
2000	70,502	70,731	229	0%
2001	82,119	84,424	2,305	3%
2002	89,100	89,112	12	0%
2003	89,630	89,637	7	0%
2004	113,437	113,447	10	0%
2005	89,792	89,830	38	0%
2006	91,588	91,627	39	0%
2007	102,904	102,914	10	0%
2008	215,271	215,564	293	0%
2009	214,386	214,434	48	0%
2010	106,383	106,392	9	0%
2011	42,268	42,270	2	0%
2012	24,466	24,468	2	0%
2013	20,614	20,614	0	0%
2014	10,329	10,330	1	0%
2015	7,428	7,428	0	0%
2016	3,705	3,706	1	0%
2017	768	768	0	0%
2018	15	15	0	0%
Total	1,811,440	1,849,959	38,519	2%

Note: Cumulated Number of Submitted Claims as of September 30, 2018

Specification of Mortgage Transition Models (Appendix B)

The purpose of the transition predictive models is to estimate the future occurrences of claim and prepayment terminations for FHA forward mortgages in the MMIF 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, one to prepay the mortgage and the other to default by permanently ceasing payment. From FHA's point of view, prepayment and claim events are the corresponding outcomes of "competing risks" in the sense that 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 six possible transitions from a mortgage in current status: remain current, default (enter 90+ days delinquent), prepay by streamlined refinance (SR), other prepayments, cure with a mortgage modification or self-cure. Given that these are mutually exclusive outcomes, the sum of the probabilities for all five transitions is one. For a mortgage in default status at the beginning of a particular time 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.

We use multinomial logistic models to estimate the probability of transition for current and default mortgages. There are several benefits to using multinomial logistic models. First, they ensure 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, they allow 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).

Estimation Sample

The entire population of mortgage-level data from the FHA single-family data warehouse was provided to Pinnacle for this analysis. This data represents the history of over 33 million single family mortgages originated between fiscal year 1975 through the end of the third quarter of fiscal year 2018.

We have applied random sampling to improve the efficiency of the model estimation. For the transition models with the initial condition of Current, we used the following sampling percentages:

Table 24: Current Transition Model Sampling Percentages

Ending Condition	Sampling Percentage
Current	2.5%
Current with Self-Cure	100%
Current with Mortgage Modification	100%
Claim	100%
Pre-payment	75%
Streamline Refinance	75%

For transition models with the initial condition of Default, we sampled 25% of the records with ending condition of Default. For all other ending conditions, we used 100% of the data.

The sampling percentages were selected as a balance between having a credible amount of data to estimate the probability of the transition and efficiently running the models.

Loss Severity Model (Appendix C)

FHA incurs a loss from a mortgage claim event. This loss amount depends on many factors, including the disposition channel. In practice, foreclosed properties generally have higher severity compared to pre-foreclosure-sales (PFS). Foreclosure mortgages can be further separated into real-estate-owned (REO) and Claims Without Conveyance of Title (CWCOT). We have developed multiple models to predict loss severity: a model to predict whether the property is disposed by PFS, REO or CWCOT, and separate loss severity models for REO, PFS 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 have also developed a model to project the severity associated with loss mitigation claims.

Cash Flow Projections (Appendix E)

After projecting the future transitions and severities using the predictive models, we use this information to project the corresponding 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 2018.

FHA executed note sales in November 2015 and September 2016. 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 by using ten alternative economic projection scenarios from Moody's. These scenarios includes 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 MMIF Cash Flow NPV:

- 1-year CMT rates
- 3-year CMT rates
- 5-year CMT rates
- 10-year CMT rates
- 30-year CMT rates
- 30-year Fixed Rate Mortgage (FRM) rates
- FHFA national purchase-only HPI
- Unemployment rates by state
- Change in unemployment rate
- 1-year GDP ratio

Appendices

Appendix A: Data – Sources, Processing and Reconciliation

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 – 2018)
3. Lossmit_Costs: derived table based on the Loss Mitigation table and IDB_1, used to obtain mitigation claim amounts
4. Sams_case_record: used to determine the status of the conveyances, the capital income/expense amounts, the sales and REO expenses and sales proceeds to FHA, where applicable
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:
8. SFDW Dictionary for Pinnacle: data dictionary for the data tables provided by FHA

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

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

From OMB, we have received the Economic Assumptions for the 2019 Mid-Session Review (updated as of June, 2018).

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

Data Processing – Mortgage Level Modeling (Appendix A)

Starting with the raw data, Pinnacle processed the data to create datasets for developing the mortgage level transition and loss severity models. The steps below describe the data processing that occurred to prepare the data that was used for this analyses.

The first step in preparing the data for analysis was the processing of 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 the end of the end of the fourth quarter of fiscal year 2018 if the mortgage remained active.

Data Reconciliation

To reconcile the data processed by Pinnacle with the data provided by FHA, Pinnacle 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.

The following tables are based on data as of September 30, 2018, as this was the data used to develop the transition and net loss models.

Table 25: Data Reconciliation - Number of Active Loans

	Number of Active Loans			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	12,907	13,467	560	4%
1993	18,642	21,593	2,951	16%
1994	25,787	31,375	5,588	22%
1995	14,730	15,125	395	3%
1996	23,894	24,622	728	3%
1997	26,140	26,479	339	1%
1998	40,272	41,896	1,624	4%
1999	51,404	53,297	1,893	4%
2000	29,099	29,341	242	1%
2001	50,238	51,238	1,000	2%
2002	75,205	75,705	500	1%
2003	110,401	111,306	905	1%
2004	142,767	142,966	199	0%
2005	104,809	104,933	124	0%
2006	82,849	82,931	82	0%
2007	79,015	79,045	30	0%
2008	186,810	187,018	208	0%
2009	423,088	423,147	59	0%
2010	542,356	542,388	32	0%
2011	437,232	437,246	14	0%
2012	538,121	538,146	25	0%
2013	748,868	748,890	22	0%
2014	364,447	364,459	12	0%
2015	689,264	689,278	14	0%
2016	988,626	988,646	20	0%
2017	1,125,996	1,126,020	24	0%
2018	987,897	987,924	27	0%
Total	7,920,864	7,938,481	17,617	0%

Table 26: Data Reconciliation - Insurance in Force

	Insurance in Force ($M) = Original Loan Amount on Active Loans			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	787,948	$825,364	37,416	5%
1993	1,207,761	1,419,868	212,107	18%
1994	1,706,032	2,099,317	393,285	23%
1995	929,512	957,280	27,768	3%
1996	1,566,240	1,620,828	54,588	3%
1997	1,762,905	1,788,925	26,020	1%
1998	2,928,640	3,068,932	140,292	5%
1999	3,941,146	4,098,278	157,131	4%
2000	2,215,018	2,232,384	17,367	1%
2001	4,308,259	4,402,731	94,472	2%
2002	7,009,577	7,050,371	40,794	1%
2003	11,641,328	11,722,070	80,741	1%
2004	14,958,461	14,975,512	17,051	0%
2005	11,269,481	11,279,568	10,086	0%
2006	9,407,055	9,414,260	7,205	0%
2007	9,676,966	9,679,792	2,826	0%
2008	26,156,309	26,186,122	29,812	0%
2009	64,630,140	64,639,657	9,517	0%
2010	81,500,651	81,505,712	5,060	0%
2011	67,749,410	67,751,272	1,862	0%
2012	85,383,510	85,389,667	6,157	0%
2013	122,396,104	122,399,244	3,140	0%
2014	51,701,970	51,703,035	1,065	0%
2015	119,638,261	119,639,653	1,392	0%
2016	185,053,544	185,057,051	3,507	0%
2017	223,319,527	223,325,794	6,266	0%
2018	203,296,356	203,303,811	7,455	0%
Total	1,316,142,112	1,317,536,496	1,394,383	0%
Note:	Unamortized IIF as of September 30, 2018			

Table 27: Data Reconciliation - Number of 90 Day Delinquencies

	Federal Housing Administration			
	Independent Actuary Comparison Template			
	Data Reconciliation: Forward			
	Number of 90 Day Delinquencies			
	= Current Number of 90 Day Delinquencies			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	462	486	24	5%
1993	691	765	74	11%
1994	1,022	1,153	131	13%
1995	877	912	35	4%
1996	1,454	1,523	69	5%
1997	1,850	1,897	47	3%
1998	2,666	2,772	106	4%
1999	3,651	3,803	152	4%
2000	2,803	2,862	59	2%
2001	3,936	4,076	140	4%
2002	5,525	5,631	106	2%
2003	6,652	6,843	191	3%
2004	9,231	9,383	152	2%
2005	7,786	7,909	123	2%
2006	7,823	7,927	104	1%
2007	9,457	9,595	138	1%
2008	22,415	22,711	296	1%
2009	31,097	31,450	353	1%
2010	26,817	27,228	411	2%
2011	17,486	17,809	323	2%
2012	17,689	18,101	412	2%
2013	20,739	21,226	487	2%
2014	17,323	17,803	480	3%
2015	26,026	26,684	658	3%
2016	30,012	30,857	845	3%
2017	25,301	26,201	900	4%
2018	4,685	4,970	285	6%
Total	305,476	312,577	7,101	2%
Note:	Outstanding Delinquencies as of September 30, 2018			
	= Reported Delinquencies - Submitted Claims - Cured Delinquencies			
	on a cumulative basis.			

Table 28: Data Reconciliation - Number of Claims to Date

	Number of Claims To Date			
Credit Subsidy Cohort	Federal Housing Administration	Independent Actuary	Absolute Difference (Actuary - FHA)	Percent Difference (Actuary - FHA) / FHA
1992	35,064	36,718	1,654	5%
1993	41,787	52,155	10,368	25%
1994	53,170	65,740	12,570	24%
1995	43,333	44,521	1,188	3%
1996	60,475	63,190	2,715	4%
1997	58,251	59,511	1,260	2%
1998	63,636	66,957	3,321	5%
1999	81,019	83,456	2,437	3%
2000	70,502	70,731	229	0%
2001	82,119	84,424	2,305	3%
2002	89,100	89,112	12	0%
2003	89,630	89,637	7	0%
2004	113,437	113,447	10	0%
2005	89,792	89,830	38	0%
2006	91,588	91,627	39	0%
2007	102,904	102,914	10	0%
2008	215,271	215,564	293	0%
2009	214,386	214,434	48	0%
2010	106,383	106,392	9	0%
2011	42,268	42,270	2	0%
2012	24,466	24,468	2	0%
2013	20,614	20,614	0	0%
2014	10,329	10,330	1	0%
2015	7,428	7,428	0	0%
2016	3,705	3,706	1	0%
2017	768	768	0	0%
2018	15	15	0	0%
Total	1,811,440	1,849,959	38,519	2%

Note: Cumulated Number of Submitted Claims as of September 30, 2018

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 multinomial logistic models.

Section 1: Model Specification

Prior to the 2010 Actuarial Review, a competing-risk framework based on multinomial logistic models for quarterly conditional probabilities of prepayment and claim terminations was used. Starting with the 2010 Review, a third "competing risk" was introduced: 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 11 below shows the possible "current" status transitions that have been modeled using the multinomial framework.

Figure 11: Transition Models – Initial Current Status
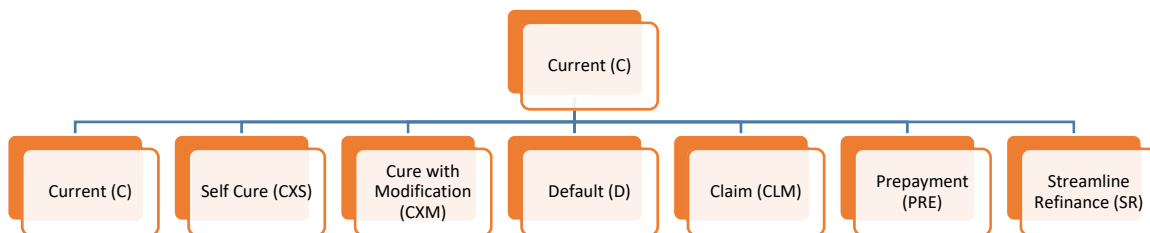
Mortgages in current status (C) at the beginning of the quarter can default and cure in the same quarter (CXS and CXM), transition to default status (D) at the start of the next quarter, result in a claim (CLM) or terminate as a prepayment due to an FHA Streamlined Refinance (SR) or as a prepayment (PRE) 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).

The figure below shows the possible default status transitions that have been modeled using the multinomial framework.

Figure 12: Transition Models – Initial Default Status
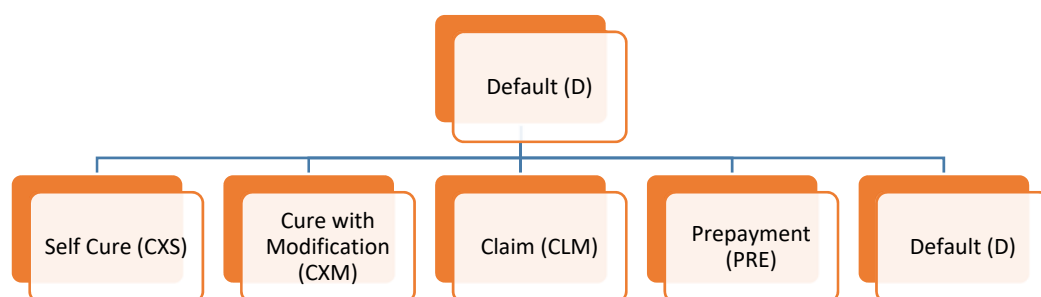
For mortgages that begin the quarter in default, they can cure either by the borrower becoming current on their own (CXS), or they can cure with a modification in the terms of the mortgage (CXM). The mortgage can also terminate as a prepayment due to an SR or as a prepayment (PRE) for any reason other than SR, turn into a claim (CLM) for the MMIF or remain in default (D).

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.

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 $X_1,…,X_g$, that is used to model Y's distribution. We assume that Y and $X_1,…,X_g$ are jointly observed n times with the ith random observation being labeled as

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

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 $<Y_i, X_{1i},..., X_{gi}>$ are jointly independent across all i
2. Given that $X_{1i},..., X_{gi}$ have been observed at $x_{1i},..., x_{gi}$, 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 in order to find those parameters that are most likely to have given rise to the data.

The target variables for the current and default transition models are shown above in Figure 11 and Figure 12. The independent variables used in the models are described in the following section. Six models were built, three for the current (C) transitions and three for the Default (D) transitions. Three product groups are modeled: fixed rate 30-year term, fixed rate 15-year term and adjustable rate mortgages. The model development was completed using a train/test/validate approach. A random sample of the data is used to train the multinomial model, to determine inclusion and exclusion of explanatory variables, and to calculate model parameters. The model is refined based on results from applying the model to the test data. The remaining sample, the validation data, is used as a final validation step to measure 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, 40% of the cases were assigned to the train dataset, 30% were assigned to the test dataset, and 30% were assigned to the validation dataset.

There are over 33 million single-family mortgages insured by FHA originated between the first quarter of fiscal year 1975 and the second quarter of fiscal year 2018. Sampling enhances the efficiency of model estimation. In predictive modeling, a choice-based sample is commonly used for large populations with relatively rare events of interest. We use a sampling process for estimating the transition equations where the sampling rates are determined by the ending condition of each mortgage at each period.

For the transition models with the initial condition of C, we sample ending conditions using the following sampling percentages:

Table 29: Current Transition Model Sampling Percentages

Ending Condition	Sampling Percentage
Current (C)	2.5%
Current with Self-Cure (CXS)	100%
Current with Mortgage Modification (CSM)	100%
Default/Claim (DCLM)	100%
Pre-payment (PRE)	75%
Streamline Refinance (SR)	75%

For transition models with the initial condition of D, we sample 50% of the records with ending condition of D. For all other ending conditions, we used 100% of the data.

Section 2: Transition Model Explanatory Variables

Multiple categories of explanatory variables were used 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 assist, 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
- Dynamic variables derived by combining mortgage information and external economic data: spread, season
- Dynamic macroeconomic variables: ten-year average unemployment rate, change in the unemployment rate, HPI, treasury rates, GDP measures
- Geographic variables: judicial state, collateral state

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

Table 30: Distribution of Final Condition – Current Transition Models

Final Condition	Percentage
CXS	0.29%
DCLM	1.00%
CXM	0.02%
SR	0.74%
PRE	2.27%
C	95.68%

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

Table 31: Distribution of Final Condition - Default Transition Models

Final Condition	Percentage
CLM	6.10%
CXM	5.44%
CXS	11.65%
END	1.41%
D	75.40%

Section 3: Multinomial Model Results

Current Transition Model Parameters – FRM30

The current transition model parameters for the fixed rate 30-year mortgage are shown below.

Table 32: Current Transition FRM30 Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CXM	1	7.6561	0.3962	373.4510	<.0001
Intercept		CXS	1	-2.2883	0.1256	332.1503	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		DCLM	1	0.5503	0.0823	44.6803	<.0001
Intercept		PRE	1	-16.3614	0.0744	48412.5138	<.0001
Intercept		SR	1	4.9058	0.0936	2746.8179	<.0001
credit_score_group	0	CXM	1	0.9783	0.0342	820.6417	<.0001
credit_score_group	0	CXS	1	1.7537	0.0158	12325.1427	<.0001
credit_score_group	0	DCLM	1	1.4435	0.0071	40897.8924	<.0001
credit_score_group	0	PRE	1	0.0713	0.0043	276.6498	<.0001
credit_score_group	0	SR	1	0.4034	0.0053	5807.9397	<.0001
credit_score_group	5	CXM	1	2.0313	0.0388	2734.7793	<.0001
credit_score_group	5	CXS	1	2.4560	0.0187	17215.8458	<.0001
credit_score_group	5	DCLM	1	2.2121	0.0104	45522.5183	<.0001
credit_score_group	5	PRE	1	-0.5688	0.0139	1668.9523	<.0001
credit_score_group	5	SR	1	0.3678	0.0118	973.4436	<.0001
credit_score_group	6	CXM	1	1.5189	0.0331	2107.7692	<.0001
credit_score_group	6	CXS	1	1.9993	0.0156	16444.0242	<.0001
credit_score_group	6	DCLM	1	1.7343	0.0070	61942.3804	<.0001
credit_score_group	6	PRE	1	-0.5842	0.0045	16565.4837	<.0001
credit_score_group	6	SR	1	0.2679	0.0051	2739.9582	<.0001
credit_score_group	7	CXM	1	0.8144	0.0334	594.6075	<.0001
credit_score_group	7	CXS	1	1.1841	0.0157	5692.6844	<.0001
credit_score_group	7	DCLM	1	0.9781	0.0069	19911.7535	<.0001
credit_score_group	7	PRE	1	-0.2601	0.0039	4402.8857	<.0001
credit_score_group	7	SR	1	0.1331	0.0048	782.0628	<.0001
loansize_raw_grp	0	CXM	1	-1.2421	0.0897	191.7614	<.0001
loansize_raw_grp	0	CXS	1	-0.0155	0.0434	0.1266	0.722
loansize_raw_grp	0	DCLM	1	-0.3210	0.0222	209.3578	<.0001
loansize_raw_grp	0	PRE	1	-1.4663	0.0154	9086.3759	<.0001
loansize_raw_grp	0	SR	1	-2.4176	0.0179	18147.7602	<.0001
loansize_raw_grp	1	CXM	1	-0.8089	0.0860	88.5018	<.0001
loansize_raw_grp	1	CXS	1	-0.0775	0.0431	3.2394	0.0719
loansize_raw_grp	1	DCLM	1	-0.3291	0.0218	227.3761	<.0001
loansize_raw_grp	1	PRE	1	-1.2301	0.0150	6709.4594	<.0001
loansize_raw_grp	1	SR	1	-1.1996	0.0161	5534.3975	<.0001
loansize_raw_grp	2	CXM	1	-0.4892	0.0858	32.4955	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
loansize_raw_grp	2	CXS	1	-0.0770	0.0431	3.1980	0.0737
loansize_raw_grp	2	DCLM	1	-0.1750	0.0218	64.4031	<.0001
loansize_raw_grp	2	PRE	1	-0.9275	0.0150	3833.5768	<.0001
loansize_raw_grp	2	SR	1	-0.6625	0.0160	1706.9211	<.0001
loansize_raw_grp	3	CXM	1	-0.2791	0.0867	10.3590	0.0013
loansize_raw_grp	3	CXS	1	-0.0495	0.0436	1.2887	0.2563
loansize_raw_grp	3	DCLM	1	-0.0275	0.0221	1.5553	0.2123
loansize_raw_grp	3	PRE	1	-0.7324	0.0153	2296.0338	<.0001
loansize_raw_grp	3	SR	1	-0.3671	0.0163	508.8482	<.0001
loansize_raw_grp	4	CXM	1	-0.0934	0.0909	1.0558	0.3042
loansize_raw_grp	4	CXS	1	-0.0203	0.0458	0.1961	0.6579
loansize_raw_grp	4	DCLM	1	0.0225	0.0233	0.9329	0.3341
loansize_raw_grp	4	PRE	1	-0.5094	0.0164	961.0813	<.0001
loansize_raw_grp	4	SR	1	-0.1534	0.0173	78.2902	<.0001
loansize_raw_grp	5	CXM	1	-0.1492	0.1062	1.9745	0.16
loansize_raw_grp	5	CXS	1	-0.1736	0.0535	10.5426	0.0012
loansize_raw_grp	5	DCLM	1	-0.1485	0.0271	30.0843	<.0001
loansize_raw_grp	5	PRE	1	-0.3800	0.0189	405.5470	<.0001
loansize_raw_grp	5	SR	1	-0.1746	0.0200	76.4438	<.0001
prior_default_cnt_grp	1-2	CXM	1	2.4611	0.0112	48665.6391	<.0001
prior_default_cnt_grp	1-2	CXS	1	2.7745	0.0041	468860.9400	<.0001
prior_default_cnt_grp	1-2	DCLM	1	2.4278	0.0032	566235.8640	<.0001
prior_default_cnt_grp	1-2	PRE	1	-0.4323	0.0042	10742.7669	<.0001
prior_default_cnt_grp	1-2	SR	1	-0.6354	0.0074	7352.7314	<.0001
prior_default_cnt_grp	3+	CXM	1	2.9754	0.0167	31665.0389	<.0001
prior_default_cnt_grp	3+	CXS	1	3.6506	0.0063	340301.3040	<.0001
prior_default_cnt_grp	3+	DCLM	1	3.2144	0.0053	367465.5120	<.0001
prior_default_cnt_grp	3+	PRE	1	-0.3232	0.0073	1939.9453	<.0001
prior_default_cnt_grp	3+	SR	1	-0.4545	0.0158	824.7600	<.0001
prior_modific_cnt_grp	1-2	CXM	1	-0.6468	0.0133	2364.2696	<.0001
prior_modific_cnt_grp	1-2	CXS	1	-1.0414	0.0059	31286.3259	<.0001
prior_modific_cnt_grp	1-2	DCLM	1	-0.4788	0.0046	10730.1612	<.0001
prior_modific_cnt_grp	1-2	PRE	1	-1.1020	0.0086	16578.7077	<.0001
prior_modific_cnt_grp	1-2	SR	1	-0.7920	0.0136	3403.4551	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
prior_modific_cnt_grp	3+	CXM	1	-0.3174	0.0345	84.8311	<.0001
prior_modific_cnt_grp	3+	CXS	1	-0.8192	0.0162	2562.8449	<.0001
prior_modific_cnt_grp	3+	DCLM	1	-0.0549	0.0133	16.9627	<.0001
prior_modific_cnt_grp	3+	PRE	1	-1.7971	0.0373	2325.6954	<.0001
prior_modific_cnt_grp	3+	SR	1	-1.7953	0.0848	448.2945	<.0001
loan to value ratio	65-99	CXM	1	-0.2108	0.0113	349.1355	<.0001
loan to value ratio	65-99	CXS	1	-0.1191	0.0035	1135.0792	<.0001
loan to value ratio	65-99	DCLM	1	-0.1933	0.0023	6810.6118	<.0001
loan to value ratio	65-99	PRE	1	0.0648	0.0020	1096.7633	<.0001
loan to value ratio	65-99	SR	1	-0.1728	0.0027	4207.4830	<.0001
loan to value ratio	lt65	CXM	1	-1.4827	0.0626	561.4285	<.0001
loan to value ratio	lt65	CXS	1	-0.5283	0.0103	2626.9621	<.0001
loan to value ratio	lt65	DCLM	1	-0.7782	0.0067	13630.5872	<.0001
loan to value ratio	lt65	PRE	1	0.2907	0.0043	4507.7959	<.0001
loan to value ratio	lt65	SR	1	-0.0813	0.0062	171.4987	<.0001
Season	fall	CXM	1	0.0751	0.0122	38.0628	<.0001
Season	fall	CXS	1	-0.2311	0.0039	3534.7585	<.0001
Season	fall	DCLM	1	0.4453	0.0026	28857.9425	<.0001
Season	fall	PRE	1	0.1053	0.0023	2099.1815	<.0001
Season	fall	SR	1	-0.0681	0.0029	559.0796	<.0001
Season	spring	CXM	1	-0.1221	0.0127	91.7675	<.0001
Season	spring	CXS	1	-0.2419	0.0039	3852.2129	<.0001
Season	spring	DCLM	1	0.0063	0.0028	5.1120	0.0238
Season	spring	PRE	1	0.2826	0.0023	14977.2058	<.0001
Season	spring	SR	1	-0.0647	0.0029	485.9777	<.0001
Season	summer	CXM	1	0.0858	0.0120	50.8839	<.0001
Season	summer	CXS	1	-0.4499	0.0040	12420.1215	<.0001
Season	summer	DCLM	1	0.2553	0.0027	9039.2129	<.0001
Season	summer	PRE	1	0.2445	0.0023	11335.2082	<.0001
Season	summer	SR	1	-0.1572	0.0030	2828.7782	<.0001
State	AL	CXM	1	-0.2581	0.0337	58.7446	<.0001
State	AL	CXS	1	0.3064	0.0106	842.6331	<.0001
State	AL	DCLM	1	0.1669	0.0074	513.8579	<.0001
State	AL	PRE	1	0.1394	0.0071	389.8377	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	AL	SR	1	0.1753	0.0099	314.9220	<.0001
State	AR	CXM	1	-0.2159	0.0467	21.3967	<.0001
State	AR	CXS	1	0.0535	0.0137	15.2939	<.0001
State	AR	DCLM	1	0.0653	0.0092	50.0387	<.0001
State	AR	PRE	1	0.1310	0.0079	272.0319	<.0001
State	AR	SR	1	0.0029	0.0130	0.0485	0.8257
State	AZ	CXM	1	-0.4260	0.0343	154.3237	<.0001
State	AZ	CXS	1	-0.0520	0.0106	24.2078	<.0001
State	AZ	DCLM	1	-0.0222	0.0065	11.5921	0.0007
State	AZ	PRE	1	0.5895	0.0051	13475.4449	<.0001
State	AZ	SR	1	0.6455	0.0066	9718.6551	<.0001
State	CA	CXM	1	-0.8493	0.0279	928.7306	<.0001
State	CA	CXS	1	-0.0251	0.0078	10.3089	0.0013
State	CA	DCLM	1	-0.1659	0.0050	1104.0431	<.0001
State	CA	PRE	1	0.8967	0.0039	53132.4068	<.0001
State	CA	SR	1	0.5178	0.0054	9340.5024	<.0001
State	CO	CXM	1	-0.2576	0.0359	51.5740	<.0001
State	CO	CXS	1	-0.1303	0.0118	121.8091	<.0001
State	CO	DCLM	1	0.0321	0.0071	20.6433	<.0001
State	CO	PRE	1	0.5074	0.0053	9171.3929	<.0001
State	CO	SR	1	0.6542	0.0068	9334.7862	<.0001
State	CT	CXM	1	-0.0396	0.0429	0.8503	0.3565
State	CT	CXS	1	0.1711	0.0148	133.7847	<.0001
State	CT	DCLM	1	0.2084	0.0096	468.2032	<.0001
State	CT	PRE	1	-0.0916	0.0088	107.9060	<.0001
State	CT	SR	1	0.1732	0.0114	230.9636	<.0001
State	FL	CXM	1	-0.1171	0.0227	26.5308	<.0001
State	FL	CXS	1	0.1609	0.0070	521.6715	<.0001
State	FL	DCLM	1	0.2651	0.0046	3306.7819	<.0001
State	FL	PRE	1	0.1892	0.0041	2169.3912	<.0001
State	FL	SR	1	0.0409	0.0060	46.5238	<.0001
State	GA	CXM	1	0.0952	0.0206	21.3874	<.0001
State	GA	CXS	1	0.3232	0.0073	1977.4772	<.0001
State	GA	DCLM	1	0.2537	0.0050	2597.4851	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	GA	PRE	1	0.0099	0.0048	4.1875	0.0407
State	GA	SR	1	0.3622	0.0062	3420.0120	<.0001
State	IA	CXM	1	0.1552	0.0551	7.9384	0.0048
State	IA	CXS	1	-0.0703	0.0182	14.8716	0.0001
State	IA	DCLM	1	0.1581	0.0118	179.0927	<.0001
State	IA	PRE	1	-0.0474	0.0099	22.8237	<.0001
State	IA	SR	1	0.0675	0.0144	22.0967	<.0001
State	ID	CXM	1	-0.3598	0.0658	29.8729	<.0001
State	ID	CXS	1	-0.1090	0.0193	32.0424	<.0001
State	ID	DCLM	1	-0.0115	0.0120	0.9286	0.3352
State	ID	PRE	1	0.2970	0.0092	1042.3517	<.0001
State	ID	SR	1	0.3424	0.0131	679.8407	<.0001
State	IL	CXM	1	-0.1453	0.0255	32.5765	<.0001
State	IL	CXS	1	0.2446	0.0086	808.9966	<.0001
State	IL	DCLM	1	0.2052	0.0056	1326.7651	<.0001
State	IL	PRE	1	0.4322	0.0052	7047.9710	<.0001
State	IL	SR	1	0.5628	0.0064	7697.5856	<.0001
State	IN	CXM	1	-0.1419	0.0265	28.6793	<.0001
State	IN	CXS	1	0.1907	0.0088	472.3829	<.0001
State	IN	DCLM	1	0.1882	0.0059	1014.4073	<.0001
State	IN	PRE	1	0.0641	0.0056	131.8900	<.0001
State	IN	SR	1	0.4313	0.0071	3689.9833	<.0001
State	KS	CXM	1	-0.0603	0.0519	1.3513	0.2451
State	KS	CXS	1	0.0037	0.0156	0.0570	0.8112
State	KS	DCLM	1	0.1549	0.0101	233.2811	<.0001
State	KS	PRE	1	0.0662	0.0084	61.5536	<.0001
State	KS	SR	1	0.2907	0.0117	617.0088	<.0001
State	KY	CXM	1	-0.4078	0.0407	100.2844	<.0001
State	KY	CXS	1	0.1659	0.0130	163.7036	<.0001
State	KY	DCLM	1	-0.0193	0.0088	4.8159	0.0282
State	KY	PRE	1	0.4200	0.0077	2990.2228	<.0001
State	KY	SR	1	0.2893	0.0105	755.6466	<.0001
State	LA	CXM	1	-0.0784	0.0369	4.5130	0.0336
State	LA	CXS	1	0.2951	0.0109	736.1384	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	LA	DCLM	1	0.2005	0.0077	679.0772	<.0001
State	LA	PRE	1	0.3230	0.0071	2087.1052	<.0001
State	LA	SR	1	-0.0450	0.0115	15.4418	<.0001
State	MD	CXM	1	0.2935	0.0280	110.2910	<.0001
State	MD	CXS	1	0.2443	0.0093	685.9181	<.0001
State	MD	DCLM	1	0.2688	0.0063	1817.3599	<.0001
State	MD	PRE	1	-0.0340	0.0055	38.4075	<.0001
State	MD	SR	1	0.6791	0.0066	10637.0424	<.0001
State	ME	CXM	1	-0.1629	0.0965	2.8495	0.0914
State	ME	CXS	1	0.1373	0.0290	22.3946	<.0001
State	ME	DCLM	1	0.1347	0.0192	49.3377	<.0001
State	ME	PRE	1	0.1196	0.0159	56.5794	<.0001
State	ME	SR	1	0.1613	0.0222	52.8738	<.0001
State	MI	CXM	1	-0.3924	0.0285	188.9124	<.0001
State	MI	CXS	1	0.3097	0.0088	1253.7015	<.0001
State	MI	DCLM	1	0.1555	0.0059	691.0526	<.0001
State	MI	PRE	1	0.5698	0.0054	11329.4034	<.0001
State	MI	SR	1	0.5630	0.0069	6653.3634	<.0001
State	MN	CXM	1	-0.1250	0.0431	8.4109	0.0037
State	MN	CXS	1	-0.2543	0.0133	364.0307	<.0001
State	MN	DCLM	1	-0.0869	0.0083	109.6504	<.0001
State	MN	PRE	1	0.0842	0.0059	203.1568	<.0001
State	MN	SR	1	0.2530	0.0085	889.5616	<.0001
State	MO	CXM	1	-0.1249	0.0309	16.3330	<.0001
State	MO	CXS	1	0.1475	0.0101	213.0971	<.0001
State	MO	DCLM	1	0.1075	0.0067	254.5156	<.0001
State	MO	PRE	1	0.2147	0.0059	1320.2280	<.0001
State	MO	SR	1	0.6670	0.0072	8594.2248	<.0001
State	MS	CXM	1	-0.4345	0.0457	90.5257	<.0001
State	MS	CXS	1	0.2985	0.0134	494.5944	<.0001
State	MS	DCLM	1	0.0627	0.0095	43.1847	<.0001
State	MS	PRE	1	0.3631	0.0090	1644.7470	<.0001
State	MS	SR	1	0.1348	0.0136	98.1642	<.0001
State	Mid_Atlntc	CXM	1	-0.0255	0.0470	0.2953	0.5868

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	Mid_Atlntc	CXS	1	0.1799	0.0159	127.5721	<.0001
State	Mid_Atlntc	DCLM	1	0.1199	0.0108	123.9241	<.0001
State	Mid_Atlntc	PRE	1	0.1547	0.0098	252.0347	<.0001
State	Mid_Atlntc	SR	1	0.1843	0.0132	194.8258	<.0001
State	Mtn_Wst	CXM	1	-0.6292	0.0621	102.6873	<.0001
State	Mtn_Wst	CXS	1	-0.3209	0.0158	414.3921	<.0001
State	Mtn_Wst	DCLM	1	-0.2527	0.0100	635.8845	<.0001
State	Mtn_Wst	PRE	1	0.2346	0.0068	1197.6017	<.0001
State	Mtn_Wst	SR	1	0.0697	0.0110	39.9990	<.0001
State	NC	CXM	1	-0.1425	0.0256	30.9533	<.0001
State	NC	CXS	1	0.2052	0.0091	511.0249	<.0001
State	NC	DCLM	1	0.0703	0.0062	128.8474	<.0001
State	NC	PRE	1	0.1299	0.0058	495.8175	<.0001
State	NC	SR	1	0.4726	0.0073	4241.4273	<.0001
State	NE	CXM	1	0.1851	0.0670	7.6339	0.0057
State	NE	CXS	1	-0.2982	0.0199	223.6756	<.0001
State	NE	DCLM	1	0.0136	0.0128	1.1338	0.287
State	NE	PRE	1	-0.2459	0.0094	689.0242	<.0001
State	NE	SR	1	0.0893	0.0146	37.1986	<.0001
State	NJ	CXM	1	-0.0732	0.0298	6.0431	0.014
State	NJ	CXS	1	0.3569	0.0099	1314.2850	<.0001
State	NJ	DCLM	1	0.3653	0.0065	3181.4961	<.0001
State	NJ	PRE	1	0.2013	0.0060	1109.2896	<.0001
State	NJ	SR	1	0.5301	0.0071	5540.1200	<.0001
State	NM	CXM	1	-0.6403	0.0632	102.6895	<.0001
State	NM	CXS	1	-0.0096	0.0172	0.3084	0.5787
State	NM	DCLM	1	-0.0442	0.0112	15.6690	<.0001
State	NM	PRE	1	0.0990	0.0097	104.0380	<.0001
State	NM	SR	1	0.3348	0.0126	709.7579	<.0001
State	NV	CXM	1	-0.8024	0.0507	250.6773	<.0001
State	NV	CXS	1	-0.0437	0.0154	8.0426	0.0046
State	NV	DCLM	1	-0.0206	0.0091	5.1452	0.0233
State	NV	PRE	1	0.6102	0.0073	6979.4502	<.0001
State	NV	SR	1	0.5705	0.0091	3963.3742	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	NY	CXM	1	-0.1643	0.0262	39.2522	<.0001
State	NY	CXS	1	0.1573	0.0084	352.5743	<.0001
State	NY	DCLM	1	0.0638	0.0057	126.1268	<.0001
State	NY	PRE	1	0.0855	0.0051	284.2271	<.0001
State	NY	SR	1	-0.3154	0.0077	1676.2281	<.0001
State	Nw_Engld	CXM	1	-0.0516	0.0382	1.8227	0.177
State	Nw_Engld	CXS	1	0.0824	0.0134	37.5717	<.0001
State	Nw_Engld	DCLM	1	0.0828	0.0085	94.0909	<.0001
State	Nw_Engld	PRE	1	0.3099	0.0068	2055.4928	<.0001
State	Nw_Engld	SR	1	0.3419	0.0085	1608.2463	<.0001
State	OH	CXM	1	-0.2238	0.0244	84.3447	<.0001
State	OH	CXS	1	0.1742	0.0079	484.4652	<.0001
State	OH	DCLM	1	0.1819	0.0053	1196.7446	<.0001
State	OH	PRE	1	0.1475	0.0049	898.3503	<.0001
State	OH	SR	1	0.3686	0.0065	3251.8745	<.0001
State	OK	CXM	1	-0.1292	0.0415	9.7028	0.0018
State	OK	CXS	1	-0.0499	0.0119	17.7355	<.0001
State	OK	DCLM	1	0.1116	0.0079	200.3219	<.0001
State	OK	PRE	1	-0.0861	0.0067	166.6482	<.0001
State	OK	SR	1	-0.2970	0.0115	665.8166	<.0001
State	OR	CXM	1	-0.6205	0.0549	127.5977	<.0001
State	OR	CXS	1	-0.2929	0.0197	222.0938	<.0001
State	OR	DCLM	1	-0.2757	0.0112	606.3509	<.0001
State	OR	PRE	1	0.7628	0.0081	8785.6231	<.0001
State	OR	SR	1	0.5383	0.0104	2691.0064	<.0001
State	PA	CXM	1	-0.0351	0.0250	1.9770	0.1597
State	PA	CXS	1	0.1548	0.0081	365.6199	<.0001
State	PA	DCLM	1	0.1032	0.0056	343.9868	<.0001
State	PA	PRE	1	-0.0045	0.0051	0.7653	0.3817
State	PA	SR	1	0.1861	0.0070	712.3287	<.0001
State	SC	CXM	1	-0.3324	0.0386	74.1998	<.0001
State	SC	CXS	1	0.2314	0.0129	322.0542	<.0001
State	SC	DCLM	1	0.0433	0.0088	24.0841	<.0001
State	SC	PRE	1	0.2601	0.0083	990.0824	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	SC	SR	1	0.2149	0.0112	369.0849	<.0001
State	TN	CXM	1	-0.2595	0.0286	82.2879	<.0001
State	TN	CXS	1	0.1777	0.0088	404.0627	<.0001
State	TN	DCLM	1	0.1106	0.0060	335.3015	<.0001
State	TN	PRE	1	0.1848	0.0054	1179.7681	<.0001
State	TN	SR	1	0.3149	0.0075	1746.5641	<.0001
State	UT	CXM	1	0.0473	0.0465	1.0337	0.3093
State	UT	CXS	1	-0.0056	0.0146	0.1452	0.7032
State	UT	DCLM	1	0.2498	0.0087	817.0390	<.0001
State	UT	PRE	1	0.3334	0.0068	2420.0339	<.0001
State	UT	SR	1	1.0488	0.0078	18331.3156	<.0001
State	VA	CXM	1	0.1042	0.0291	12.8431	0.0003
State	VA	CXS	1	-0.0130	0.0095	1.8776	0.1706
State	VA	DCLM	1	0.0450	0.0064	49.9708	<.0001
State	VA	PRE	1	-0.1866	0.0052	1300.8434	<.0001
State	VA	SR	1	0.2320	0.0070	1103.8427	<.0001
State	WA	CXM	1	-0.4280	0.0378	128.2559	<.0001
State	WA	CXS	1	-0.1954	0.0136	207.5482	<.0001
State	WA	DCLM	1	-0.1424	0.0079	326.6758	<.0001
State	WA	PRE	1	0.5702	0.0061	8677.7080	<.0001
State	WA	SR	1	0.4953	0.0077	4160.3654	<.0001
State	WI	CXM	1	-0.0423	0.0444	0.9063	0.3411
State	WI	CXS	1	0.0033	0.0165	0.0398	0.8419
State	WI	DCLM	1	0.1523	0.0101	226.2450	<.0001
State	WI	PRE	1	0.1806	0.0091	391.5372	<.0001
State	WI	SR	1	0.6218	0.0101	3766.8504	<.0001
State	isld	CXM	1	-1.3977	0.0477	858.1305	<.0001
State	isld	CXS	1	0.6873	0.0140	2404.9715	<.0001
State	isld	DCLM	1	-0.3798	0.0100	1437.7421	<.0001
State	isld	PRE	1	1.3941	0.0094	22207.4869	<.0001
State	isld	SR	1	0.1595	0.0144	123.0767	<.0001
Refinance indicator	Y	CXM	1	0.5424	0.0167	1050.6686	<.0001
Refinance indicator	Y	CXS	1	0.0069	0.0055	1.5880	0.2076
Refinance indicator	Y	DCLM	1	0.2283	0.0035	4202.0889	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Refinance indicator	Y	PRE	1	-0.2526	0.0029	7521.4081	<.0001
Refinance indicator	Y	SR	1	-0.0646	0.0037	300.0241	<.0001
Spread at Origination	sato1	CXM	1	-0.9429	0.0263	1281.6041	<.0001
Spread at Origination	sato1	CXS	1	-0.4924	0.0068	5219.9362	<.0001
Spread at Origination	sato1	DCLM	1	-0.6539	0.0048	18301.2090	<.0001
Spread at Origination	sato1	PRE	1	-0.2315	0.0042	2994.7969	<.0001
Spread at Origination	sato1	SR	1	-1.5633	0.0069	50759.7310	<.0001
Spread at Origination	sato2	CXM	1	-0.6508	0.0176	1366.0811	<.0001
Spread at Origination	sato2	CXS	1	-0.5647	0.0056	10269.8389	<.0001
Spread at Origination	sato2	DCLM	1	-0.6390	0.0038	27857.7379	<.0001
Spread at Origination	sato2	PRE	1	-0.1211	0.0036	1130.3388	<.0001
Spread at Origination	sato2	SR	1	-1.0937	0.0043	65385.1309	<.0001
Spread at Origination	sato3	CXM	1	-0.4697	0.0170	761.9106	<.0001
Spread at Origination	sato3	CXS	1	-0.4645	0.0054	7449.5420	<.0001
Spread at Origination	sato3	DCLM	1	-0.5177	0.0037	19400.9216	<.0001
Spread at Origination	sato3	PRE	1	-0.0243	0.0035	47.4604	<.0001
Spread at Origination	sato3	SR	1	-0.7286	0.0041	32396.4714	<.0001
Spread at Origination	sato4	CXM	1	-0.2605	0.0171	233.0857	<.0001
Spread at Origination	sato4	CXS	1	-0.2518	0.0053	2234.9423	<.0001
Spread at Origination	sato4	DCLM	1	-0.2829	0.0037	5829.1577	<.0001
Spread at Origination	sato4	PRE	1	-0.0027	0.0036	0.5974	0.4396
Spread at Origination	sato4	SR	1	-0.3830	0.0040	9117.9774	<.0001
Down payment assist	govt	CXM	1	0.3218	0.0327	96.7373	<.0001
Down payment assist	govt	CXS	1	0.3561	0.0103	1192.4034	<.0001
Down payment assist	govt	DCLM	1	0.4123	0.0073	3198.8099	<.0001
Down payment assist	govt	PRE	1	-0.2682	0.0082	1072.0202	<.0001
Down payment assist	govt	SR	1	-0.0372	0.0096	15.0895	0.0001
Down payment assist	non-profit	CXM	1	0.7847	0.0146	2907.0761	<.0001
Down payment assist	non-profit	CXS	1	0.3672	0.0060	3810.2344	<.0001
Down payment assist	non-profit	DCLM	1	0.6249	0.0040	24516.8746	<.0001
Down payment assist	non-profit	PRE	1	-0.2604	0.0050	2677.1363	<.0001
Down payment assist	non-profit	SR	1	0.3820	0.0048	6377.0852	<.0001
Down payment assist	relative	CXM	1	0.2111	0.0146	209.5829	<.0001
Down payment assist	relative	CXS	1	0.2373	0.0045	2847.2439	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Down payment assist	relative	DCLM	1	0.2138	0.0031	4920.8610	<.0001
Down payment assist	relative	PRE	1	0.0379	0.0028	185.3362	<.0001
Down payment assist	relative	SR	1	-0.1071	0.0036	897.4509	<.0001
First time buyer	N	CXM	1	-0.1096	0.0142	59.5099	<.0001
First time buyer	N	CXS	1	-0.1555	0.0042	1361.3645	<.0001
First time buyer	N	DCLM	1	-0.1460	0.0028	2708.9286	<.0001
First time buyer	N	PRE	1	0.2021	0.0022	8157.9292	<.0001
First time buyer	N	SR	1	0.1637	0.0030	2908.2621	<.0001
Treasury_mo_3		CXM	1	-0.3324	0.0123	724.8604	<.0001
Treasury_mo_3		CXS	1	-0.1644	0.0032	2587.2038	<.0001
Treasury_mo_3		DCLM	1	0.1409	0.0021	4653.5559	<.0001
Treasury_mo_3		PRE	1	-0.0697	0.0017	1606.3413	<.0001
Treasury_mo_3		SR	1	0.1635	0.0024	4716.3162	<.0001
Treasury_yr_05		CXM	1	0.0116	0.0184	0.4006	0.5268
Treasury_yr_05		CXS	1	-0.2914	0.0055	2820.1405	<.0001
Treasury_yr_05		DCLM	1	-0.3902	0.0037	11314.0206	<.0001
Treasury_yr_05		PRE	1	-0.4318	0.0031	19216.4010	<.0001
Treasury_yr_05		SR	1	-0.9422	0.0040	55392.0163	<.0001
Treasury_yr_30		CXM	1	-0.0959	0.0161	35.6287	<.0001
Treasury_yr_30		CXS	1	0.3705	0.0046	6501.0869	<.0001
Treasury_yr_30		DCLM	1	0.2171	0.0031	4898.4136	<.0001
Treasury_yr_30		PRE	1	0.4294	0.0026	26444.1815	<.0001
Treasury_yr_30		SR	1	0.7778	0.0034	52435.0725	<.0001
Delta UE seas adj state		CXM	1	-0.1285	0.0107	143.8987	<.0001
Delta UE seas adj state		CXS	1	0.1879	0.0034	3033.2700	<.0001
Delta UE seas adj state		DCLM	1	0.1494	0.0022	4487.0999	<.0001
Delta UE seas adj state		PRE	1	0.4000	0.0021	35416.7325	<.0001
Delta UE seas adj state		SR	1	0.2131	0.0026	6668.6896	<.0001
UE seas adj state		CXM	1	0.2165	0.0046	2228.0001	<.0001
UE seas adj state		CXS	1	-0.0362	0.0015	621.5240	<.0001
UE seas adj state		DCLM	1	0.0876	0.0009	8730.7424	<.0001
UE seas adj state		PRE	1	-0.2766	0.0009	96818.4188	<.0001
UE seas adj state		SR	1	-0.0483	0.0011	2064.1692	<.0001
GDP ratio 1 yr		CXM	1	-15.2258	0.3743	1654.2676	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
GDP ratio 1 yr		CXS	1	-3.5169	0.1137	956.6344	<.0001
GDP ratio 1 yr		DCLM	1	-5.3231	0.0770	4779.6431	<.0001
GDP ratio 1 yr		PRE	1	14.1485	0.0705	40304.2271	<.0001
GDP ratio 1 yr		SR	1	-7.3485	0.0889	6837.7533	<.0001
Yield curve slope_grp	2	CXM	1	-2.1528	0.0352	3734.7280	<.0001
Yield curve slope_grp	2	CXS	1	-0.3890	0.0115	1138.1128	<.0001
Yield curve slope_grp	2	DCLM	1	-0.1265	0.0080	248.0890	<.0001
Yield curve slope_grp	2	PRE	1	-0.5426	0.0071	5841.6681	<.0001
Yield curve slope_grp	2	SR	1	0.7139	0.0169	1793.1716	<.0001
Yield curve slope_grp	3	CXM	1	-3.0783	0.0457	4542.5501	<.0001
Yield curve slope_grp	3	CXS	1	-0.7483	0.0136	3034.6633	<.0001
Yield curve slope_grp	3	DCLM	1	-0.1747	0.0093	351.4199	<.0001
Yield curve slope_grp	3	PRE	1	-0.2860	0.0081	1255.8286	<.0001
Yield curve slope_grp	3	SR	1	0.8258	0.0178	2157.1303	<.0001
Yield curve slope_grp	4	CXM	1	-2.8975	0.0485	3565.0799	<.0001
Yield curve slope_grp	4	CXS	1	-0.9432	0.0141	4463.3702	<.0001
Yield curve slope_grp	4	DCLM	1	-0.3226	0.0096	1122.5756	<.0001
Yield curve slope_grp	4	PRE	1	-0.8399	0.0083	10202.3556	<.0001
Yield curve slope_grp	4	SR	1	0.3319	0.0180	339.2529	<.0001
Period Piecewise1		CXM	1	0.9320	0.0125	5536.4183	<.0001
Period Piecewise1		CXS	1	0.5307	0.0026	42851.1219	<.0001
Period Piecewise1		DCLM	1	0.5012	0.0013	141855.0100	<.0001
Period Piecewise1		PRE	1	0.6378	0.0013	244211.5660	<.0001
Period Piecewise1		SR	1	0.3369	0.0012	84636.6370	<.0001
Period Piecewise2		CXM	1	0.0032	0.0007	18.8888	<.0001
Period Piecewise2		CXS	1	-0.0130	0.0002	2833.5083	<.0001
Period Piecewise2		DCLM	1	-0.0182	0.0002	12814.0510	<.0001
Period Piecewise2		PRE	1	0.0266	0.0001	39981.2791	<.0001
Period Piecewise2		SR	1	-0.0297	0.0002	23861.8524	<.0001
Period Piecewise3		CXM	1	-0.0280	0.0010	717.0147	<.0001
Period Piecewise3		CXS	1	-0.0247	0.0003	5131.1195	<.0001
Period Piecewise3		DCLM	1	-0.0302	0.0003	13648.8508	<.0001
Period Piecewise3		PRE	1	-0.0127	0.0002	3215.3315	<.0001
Period Piecewise3		SR	1	-0.0220	0.0004	2482.9533	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Period Piecewise4		CXM	1	-0.0049	0.0017	8.7480	0.0031
Period Piecewise4		CXS	1	-0.0066	0.0005	201.7145	<.0001
Period Piecewise4		DCLM	1	-0.0063	0.0004	303.4422	<.0001
Period Piecewise4		PRE	1	-0.0165	0.0003	2883.3424	<.0001
Period Piecewise4		SR	1	-0.0531	0.0011	2231.8545	<.0001
Period Piecewise5		CXM	1	-0.0257	0.0032	65.0373	<.0001
Period Piecewise5		CXS	1	-0.0212	0.0007	949.2121	<.0001
Period Piecewise5		DCLM	1	-0.0200	0.0005	1453.5975	<.0001
Period Piecewise5		PRE	1	0.0426	0.0003	16189.0529	<.0001
Period Piecewise5		SR	1	-0.0723	0.0040	327.7285	<.0001

Current Transition Model Parameters – FRM15

The current transition model parameters for the fixed rate 15-year mortgage are shown below.

Table 33: Current Transition FRM15 Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CXM	1	14.3677	2.5428	31.9272	<.0001
Intercept		CXS	1	-6.6679	0.6902	93.3188	<.0001
Intercept		DCLM	1	-2.1490	0.4773	20.2743	<.0001
Intercept		PRE	1	-13.0139	0.2665	2384.1019	<.0001
Intercept		SR	1	0.7909	0.5452	2.1048	0.1468
Treasury_mo_3		CXM	1	-0.2812	0.0818	11.8129	0.0006
Treasury_mo_3		CXS	1	-0.2113	0.0192	120.8531	<.0001
Treasury_mo_3		DCLM	1	0.0682	0.0127	28.7035	<.0001
Treasury_mo_3		PRE	1	-0.0104	0.0063	2.7270	0.0987
Treasury_mo_3		SR	1	-0.0010	0.0141	0.0047	0.9455
Treasury_yr_05		CXM	1	-0.1918	0.1145	2.8059	0.0939
Treasury_yr_05		CXS	1	-0.1753	0.0317	30.6253	<.0001
Treasury_yr_05		DCLM	1	-0.3442	0.0213	260.9156	<.0001
Treasury_yr_05		PRE	1	-0.2416	0.0109	489.6445	<.0001
Treasury_yr_05		SR	1	-1.1102	0.0227	2396.2360	<.0001
Treasury_yr_30		CXM	1	0.0494	0.0953	0.2692	0.6039
Treasury_yr_30		CXS	1	0.1048	0.0257	16.5628	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Treasury_yr_30		DCLM	1	0.0583	0.0175	11.0932	0.0009
Treasury_yr_30		PRE	1	0.1627	0.0092	313.7311	<.0001
Treasury_yr_30		SR	1	0.8154	0.0189	1868.8145	<.0001
Delta UE seas adj state		CXM	1	-0.1318	0.0687	3.6776	0.0551
Delta UE seas adj state		CXS	1	0.2298	0.0188	149.8311	<.0001
Delta UE seas adj state		DCLM	1	0.2197	0.0128	296.1470	<.0001
Delta UE seas adj state		PRE	1	0.1820	0.0072	637.5380	<.0001
Delta UE seas adj state		SR	1	0.1953	0.0141	190.9144	<.0001
UE seas adj state		CXM	1	0.0880	0.0160	30.1219	<.0001
UE seas adj state		CXS	1	0.0773	0.0043	318.8335	<.0001
UE seas adj state		DCLM	1	0.0809	0.0030	725.4296	<.0001
UE seas adj state		PRE	1	-0.0941	0.0018	2773.3184	<.0001
UE seas adj state		SR	1	0.0343	0.0034	103.0613	<.0001
GDP ratio 1 yr		CXM	1	-21.9635	2.4587	79.7988	<.0001
GDP ratio 1 yr		CXS	1	0.4148	0.6614	0.3934	0.5305
GDP ratio 1 yr		DCLM	1	-2.5234	0.4611	29.9489	<.0001
GDP ratio 1 yr		PRE	1	10.0375	0.2558	1539.5347	<.0001
GDP ratio 1 yr		SR	1	-3.3975	0.5276	41.4628	<.0001
Yield curve slope_grp	2	CXM	1	-2.2896	0.2073	121.9953	<.0001
Yield curve slope_grp	2	CXS	1	-0.5605	0.0640	76.7077	<.0001
Yield curve slope_grp	2	DCLM	1	-0.3133	0.0443	49.9413	<.0001
Yield curve slope_grp	2	PRE	1	-0.2414	0.0245	96.9090	<.0001
Yield curve slope_grp	2	SR	1	-0.3668	0.0784	21.8807	<.0001
Yield curve slope_grp	3	CXM	1	-3.4286	0.2809	148.9829	<.0001
Yield curve slope_grp	3	CXS	1	-1.0683	0.0768	193.6691	<.0001
Yield curve slope_grp	3	DCLM	1	-0.5245	0.0531	97.6938	<.0001
Yield curve slope_grp	3	PRE	1	-0.0199	0.0285	0.4876	0.485
Yield curve slope_grp	3	SR	1	-0.8884	0.0854	108.1411	<.0001
Yield curve slope_grp	4	CXM	1	-2.9655	0.2961	100.3375	<.0001
Yield curve slope_grp	4	CXS	1	-1.4601	0.0794	338.5520	<.0001
Yield curve slope_grp	4	DCLM	1	-0.6427	0.0549	137.2130	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Yield curve slope_grp	4	PRE	1	-0.4326	0.0293	217.4790	<.0001
Yield curve slope_grp	4	SR	1	-1.4899	0.0874	290.8086	<.0001
prior_default_cnt_grp	1-2	CXM	1	3.0061	0.0753	1593.4942	<.0001
prior_default_cnt_grp	1-2	CXS	1	3.2334	0.0234	19091.5676	<.0001
prior_default_cnt_grp	1-2	DCLM	1	2.9687	0.0188	24994.6446	<.0001
prior_default_cnt_grp	1-2	PRE	1	-0.3454	0.0212	264.6917	<.0001
prior_default_cnt_grp	1-2	SR	1	-0.5287	0.0649	66.3493	<.0001
prior_default_cnt_grp	3+	CXM	1	3.8792	0.1154	1129.1130	<.0001
prior_default_cnt_grp	3+	CXS	1	4.4954	0.0400	12602.3459	<.0001
prior_default_cnt_grp	3+	DCLM	1	4.1200	0.0355	13450.2699	<.0001
prior_default_cnt_grp	3+	PRE	1	-0.2064	0.0455	20.5795	<.0001
prior_default_cnt_grp	3+	SR	1	0.1018	0.1535	0.4401	0.5071
prior_modific_cnt_grp	1-2	CXM	1	-0.5182	0.0932	30.8984	<.0001
prior_modific_cnt_grp	1-2	CXS	1	-1.2752	0.0388	1078.9212	<.0001
prior_modific_cnt_grp	1-2	DCLM	1	-0.7293	0.0302	583.2073	<.0001
prior_modific_cnt_grp	1-2	PRE	1	-1.1323	0.0486	541.7419	<.0001
prior_modific_cnt_grp	1-2	SR	1	-0.5897	0.1217	23.4618	<.0001
prior_modific_cnt_grp	3+	CXM	1	-0.1914	0.2553	0.5622	0.4534
prior_modific_cnt_grp	3+	CXS	1	-1.1936	0.1218	95.9720	<.0001
prior_modific_cnt_grp	3+	DCLM	1	-0.3781	0.1025	13.6195	0.0002
prior_modific_cnt_grp	3+	PRE	1	-1.8486	0.2317	63.6478	<.0001
prior_modific_cnt_grp	3+	SR	1	-1.0980	0.7298	2.2638	0.1324
credit_score_group	0	CXM	1	1.0454	0.2031	26.5019	<.0001
credit_score_group	0	CXS	1	2.2166	0.1001	490.6527	<.0001
credit_score_group	0	DCLM	1	1.7057	0.0448	1446.8386	<.0001
credit_score_group	0	PRE	1	0.0177	0.0146	1.4700	0.2253
credit_score_group	0	SR	1	-0.0161	0.0261	0.3805	0.5373
credit_score_group	5	CXM	1	2.9579	0.2189	182.5694	<.0001
credit_score_group	5	CXS	1	3.5257	0.1105	1018.8527	<.0001
credit_score_group	5	DCLM	1	3.2688	0.0577	3210.5050	<.0001
credit_score_group	5	PRE	1	-0.2723	0.0530	26.3903	<.0001
credit_score_group	5	SR	1	0.8885	0.0572	240.8578	<.0001
credit_score_group	6	CXM	1	1.7105	0.1966	75.6932	<.0001
credit_score_group	6	CXS	1	2.6108	0.0999	683.2594	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
credit_score_group	6	DCLM	1	2.2614	0.0445	2586.3623	<.0001
credit_score_group	6	PRE	1	-0.3042	0.0176	297.9144	<.0001
credit_score_group	6	SR	1	0.3937	0.0251	246.1343	<.0001
credit_score_group	7	CXM	1	0.8254	0.1974	17.4745	<.0001
credit_score_group	7	CXS	1	1.6389	0.1003	266.9797	<.0001
credit_score_group	7	DCLM	1	1.3120	0.0441	886.6999	<.0001
credit_score_group	7	PRE	1	-0.0757	0.0135	31.4310	<.0001
credit_score_group	7	SR	1	0.2632	0.0209	158.8356	<.0001
loan to value ratio	65-99	CXM	1	-0.4401	0.0814	29.2129	<.0001
loan to value ratio	65-99	CXS	1	-0.2094	0.0243	74.4918	<.0001
loan to value ratio	65-99	DCLM	1	-0.3225	0.0162	398.4220	<.0001
loan to value ratio	65-99	PRE	1	-0.0024	0.0092	0.0710	0.7898
loan to value ratio	65-99	SR	1	-0.1808	0.0178	103.3316	<.0001
loan to value ratio	lt65	CXM	1	-2.0152	0.2693	55.9851	<.0001
loan to value ratio	lt65	CXS	1	-0.5631	0.0383	215.9766	<.0001
loan to value ratio	lt65	DCLM	1	-0.7884	0.0265	884.6714	<.0001
loan to value ratio	lt65	PRE	1	0.0895	0.0124	52.2513	<.0001
loan to value ratio	lt65	SR	1	-0.1255	0.0301	17.3755	<.0001
Season	fall	CXM	1	0.1006	0.0833	1.4587	0.2271
Season	fall	CXS	1	-0.1384	0.0231	35.8127	<.0001
Season	fall	DCLM	1	0.3891	0.0159	599.1009	<.0001
Season	fall	PRE	1	0.0811	0.0083	94.9698	<.0001
Season	fall	SR	1	-0.0826	0.0165	25.0589	<.0001
Season	spring	CXM	1	-0.1640	0.0882	3.4542	0.0631
Season	spring	CXS	1	-0.1408	0.0234	36.2390	<.0001
Season	spring	DCLM	1	-0.0143	0.0172	0.6846	0.408
Season	spring	PRE	1	0.2173	0.0083	677.9946	<.0001
Season	spring	SR	1	-0.0658	0.0168	15.3555	<.0001
Season	summer	CXM	1	0.0453	0.0831	0.2974	0.5855
Season	summer	CXS	1	-0.3338	0.0241	191.2117	<.0001
Season	summer	DCLM	1	0.1894	0.0165	132.5604	<.0001
Season	summer	PRE	1	0.1772	0.0083	454.2289	<.0001
Season	summer	SR	1	-0.1994	0.0172	134.7602	<.0001
Judicial State	1	CXM	1	0.1162	0.0612	3.6108	0.0574

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Judicial State	1	CXS	1	0.0964	0.0175	30.2485	<.0001
Judicial State	1	DCLM	1	0.2032	0.0117	300.3416	<.0001
Judicial State	1	PRE	1	-0.1135	0.0061	344.2554	<.0001
Judicial State	1	SR	1	-0.0320	0.0124	6.7001	0.0096
Refinance indicator	Y	CXM	1	0.8174	0.1714	22.7431	<.0001
Refinance indicator	Y	CXS	1	0.0170	0.0345	0.2420	0.6228
Refinance indicator	Y	DCLM	1	0.0986	0.0238	17.1666	<.0001
Refinance indicator	Y	PRE	1	-0.2390	0.0111	459.8103	<.0001
Refinance indicator	Y	SR	1	0.0643	0.0266	5.8278	0.0158
Spread at Origination	sato1	CXM	1	-0.2273	0.2090	1.1824	0.2769
Spread at Origination	sato1	CXS	1	-0.7279	0.0439	274.6589	<.0001
Spread at Origination	sato1	DCLM	1	-0.7264	0.0318	521.5483	<.0001
Spread at Origination	sato1	PRE	1	-0.1330	0.0173	59.4314	<.0001
Spread at Origination	sato1	SR	1	-1.1540	0.0376	943.2424	<.0001
Spread at Origination	sato2	CXM	1	-0.1045	0.2004	0.2716	0.6023
Spread at Origination	sato2	CXS	1	-0.5960	0.0410	211.6343	<.0001
Spread at Origination	sato2	DCLM	1	-0.5596	0.0300	349.1025	<.0001
Spread at Origination	sato2	PRE	1	-0.0218	0.0165	1.7340	0.1879
Spread at Origination	sato2	SR	1	-0.6902	0.0349	390.7525	<.0001
Spread at Origination	sato3	CXM	1	0.0839	0.2048	0.1677	0.6822
Spread at Origination	sato3	CXS	1	-0.4400	0.0427	106.3231	<.0001
Spread at Origination	sato3	DCLM	1	-0.4171	0.0311	179.5930	<.0001
Spread at Origination	sato3	PRE	1	-0.0959	0.0172	30.9843	<.0001
Spread at Origination	sato3	SR	1	-0.4259	0.0358	141.2430	<.0001
Spread at Origination	sato4	CXM	1	0.2003	0.2131	0.8837	0.3472
Spread at Origination	sato4	CXS	1	-0.2475	0.0443	31.2778	<.0001
Spread at Origination	sato4	DCLM	1	-0.2538	0.0325	61.0944	<.0001
Spread at Origination	sato4	PRE	1	-0.0196	0.0178	1.2111	0.2711
Spread at Origination	sato4	SR	1	-0.1395	0.0372	14.0494	0.0002
First time buyer	N	CXM	1	-0.7132	0.1770	16.2401	<.0001
First time buyer	N	CXS	1	-0.3906	0.0368	112.3346	<.0001
First time buyer	N	DCLM	1	-0.4995	0.0255	382.5030	<.0001
First time buyer	N	PRE	1	0.0625	0.0132	22.4726	<.0001
First time buyer	N	SR	1	0.2740	0.0319	73.8569	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Period Piecewise1		CXM	1	0.8251	0.0807	104.4474	<.0001
Period Piecewise1		CXS	1	0.5153	0.0175	870.2176	<.0001
Period Piecewise1		DCLM	1	0.4610	0.0094	2385.8610	<.0001
Period Piecewise1		PRE	1	0.5411	0.0050	11782.7818	<.0001
Period Piecewise1		SR	1	0.3908	0.0067	3418.9338	<.0001
Period Piecewise2		CXM	1	-0.0125	0.0051	5.9731	0.0145
Period Piecewise2		CXS	1	-0.0035	0.0014	6.2463	0.0124
Period Piecewise2		DCLM	1	-0.0148	0.0010	241.9082	<.0001
Period Piecewise2		PRE	1	0.0126	0.0005	672.4964	<.0001
Period Piecewise2		SR	1	-0.0782	0.0012	4278.2188	<.0001
Period Piecewise3		CXM	1	-0.0502	0.0077	42.3142	<.0001
Period Piecewise3		CXS	1	-0.0262	0.0019	194.5621	<.0001
Period Piecewise3		DCLM	1	-0.0273	0.0014	373.4805	<.0001
Period Piecewise3		PRE	1	0.0118	0.0007	280.3685	<.0001
Period Piecewise3		SR	1	-0.1152	0.0045	656.8362	<.0001
Period Piecewise4		CXM	1	-0.0193	0.0617	0.0980	0.7543
Period Piecewise4		CXS	1	-0.0417	0.0127	10.7760	0.001
Period Piecewise4		DCLM	1	-0.0194	0.0096	4.0709	0.0436
Period Piecewise4		PRE	1	0.1532	0.0046	1097.0146	<.0001
Period Piecewise4		SR	1	0.1624	0.0376	18.6570	<.0001

Current Transition Model Parameters – ARM

The current transition model parameters for the adjustable rate mortgages are shown below.

Table 34: Current Transition ARM Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CXM	1	21.8397	2.1961	98.8967	<.0001
Intercept		CXS	1	9.3710	0.5016	349.0605	<.0001
Intercept		DCLM	1	3.7261	0.3336	124.7747	<.0001
Intercept		PRE	1	-11.8634	0.2853	1728.5387	<.0001
Intercept		SR	1	14.8477	0.3974	1396.0741	<.0001
credit_score_group	0	CXM	1	1.6619	0.2232	55.4610	<.0001
credit_score_group	0	CXS	1	2.6929	0.1050	658.3768	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
credit_score_group	0	DCLM	1	2.0050	0.0424	2233.0057	<.0001
credit_score_group	0	PRE	1	-0.0856	0.0251	11.6465	0.0006
credit_score_group	0	SR	1	1.2378	0.0352	1234.0723	<.0001
credit_score_group	5	CXM	1	2.9623	0.2525	137.6426	<.0001
credit_score_group	5	CXS	1	3.3389	0.1213	757.2165	<.0001
credit_score_group	5	DCLM	1	2.8563	0.0618	2134.3879	<.0001
credit_score_group	5	PRE	1	-0.6112	0.0656	86.8154	<.0001
credit_score_group	5	SR	1	0.6462	0.0744	75.4989	<.0001
credit_score_group	6	CXM	1	1.9901	0.2223	80.1304	<.0001
credit_score_group	6	CXS	1	2.3742	0.1058	503.8478	<.0001
credit_score_group	6	DCLM	1	2.0003	0.0432	2146.0991	<.0001
credit_score_group	6	PRE	1	-0.7087	0.0281	635.8974	<.0001
credit_score_group	6	SR	1	0.3620	0.0376	92.4841	<.0001
credit_score_group	7	CXM	1	0.9443	0.2245	17.6976	<.0001
credit_score_group	7	CXS	1	1.2399	0.1068	134.6853	<.0001
credit_score_group	7	DCLM	1	0.9414	0.0430	479.8422	<.0001
credit_score_group	7	PRE	1	-0.3856	0.0250	237.6041	<.0001
credit_score_group	7	SR	1	0.2513	0.0349	51.7337	<.0001
loansize_raw_grp	0	CXM	1	-1.0377	0.3316	9.7912	0.0018
loansize_raw_grp	0	CXS	1	0.4151	0.1507	7.5834	0.0059
loansize_raw_grp	0	DCLM	1	0.3182	0.0753	17.8646	<.0001
loansize_raw_grp	0	PRE	1	-1.5506	0.0485	1022.3623	<.0001
loansize_raw_grp	0	SR	1	-1.5610	0.0695	505.1732	<.0001
loansize_raw_grp	1	CXM	1	-0.6811	0.2802	5.9093	0.0151
loansize_raw_grp	1	CXS	1	0.4132	0.1487	7.7201	0.0055
loansize_raw_grp	1	DCLM	1	0.3430	0.0734	21.8591	<.0001
loansize_raw_grp	1	PRE	1	-1.2277	0.0463	702.1002	<.0001
loansize_raw_grp	1	SR	1	-0.1642	0.0591	7.7221	0.0055
loansize_raw_grp	2	CXM	1	-0.2469	0.2780	0.7891	0.3744
loansize_raw_grp	2	CXS	1	0.4001	0.1486	7.2529	0.0071
loansize_raw_grp	2	DCLM	1	0.5243	0.0731	51.3784	<.0001
loansize_raw_grp	2	PRE	1	-0.8888	0.0460	373.0254	<.0001
loansize_raw_grp	2	SR	1	0.0258	0.0586	0.1939	0.6597
loansize_raw_grp	3	CXM	1	-0.1236	0.2842	0.1891	0.6637

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
loansize_raw_grp	3	CXS	1	0.1456	0.1519	0.9187	0.3378
loansize_raw_grp	3	DCLM	1	0.4903	0.0748	42.9970	<.0001
loansize_raw_grp	3	PRE	1	-0.8151	0.0480	288.8661	<.0001
loansize_raw_grp	3	SR	1	-0.1170	0.0609	3.6966	0.0545
loansize_raw_grp	4	CXM	1	-0.2086	0.3118	0.4476	0.5035
loansize_raw_grp	4	CXS	1	0.0431	0.1639	0.0692	0.7924
loansize_raw_grp	4	DCLM	1	0.4275	0.0802	28.4347	<.0001
loansize_raw_grp	4	PRE	1	-0.5855	0.0535	119.7978	<.0001
loansize_raw_grp	4	SR	1	-0.0269	0.0672	0.1609	0.6883
loansize_raw_grp	5	CXM	1	-0.1472	0.3826	0.1481	0.7003
loansize_raw_grp	5	CXS	1	0.1787	0.1883	0.8999	0.3428
loansize_raw_grp	5	DCLM	1	0.3609	0.0931	15.0403	0.0001
loansize_raw_grp	5	PRE	1	-0.2457	0.0622	15.5901	<.0001
loansize_raw_grp	5	SR	1	0.0004	0.0785	0.0000	0.9955
Refinance indicator	Y	CXM	1	1.0037	0.0859	136.4167	<.0001
Refinance indicator	Y	CXS	1	0.0571	0.0203	7.8956	0.005
Refinance indicator	Y	DCLM	1	0.4224	0.0127	1113.9514	<.0001
Refinance indicator	Y	PRE	1	-0.0892	0.0100	79.0756	<.0001
Refinance indicator	Y	SR	1	-0.3868	0.0138	780.2546	<.0001
loan to value ratio	65-99	CXM	1	-0.3775	0.0540	48.9291	<.0001
loan to value ratio	65-99	CXS	1	-0.0637	0.0114	31.0345	<.0001
loan to value ratio	65-99	DCLM	1	-0.1823	0.0075	590.0933	<.0001
loan to value ratio	65-99	PRE	1	0.1009	0.0060	287.1085	<.0001
loan to value ratio	65-99	SR	1	-0.0341	0.0083	17.0007	<.0001
loan to value ratio	lt65	CXM	1	-1.7438	0.3106	31.5259	<.0001
loan to value ratio	lt65	CXS	1	-0.4264	0.0380	125.7389	<.0001
loan to value ratio	lt65	DCLM	1	-0.5909	0.0224	693.2818	<.0001
loan to value ratio	lt65	PRE	1	0.2656	0.0158	283.3207	<.0001
loan to value ratio	lt65	SR	1	0.6334	0.0207	933.3432	<.0001
Season	fall	CXM	1	0.1179	0.0628	3.5177	0.0607
Season	fall	CXS	1	-0.2471	0.0153	261.2131	<.0001
Season	fall	DCLM	1	0.4771	0.0096	2496.4450	<.0001
Season	fall	PRE	1	0.0348	0.0078	19.8546	<.0001
Season	fall	SR	1	-0.2813	0.0101	771.2642	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Season	spring	CXM	1	0.0563	0.0671	0.7038	0.4015
Season	spring	CXS	1	0.4544	0.0138	1084.4996	<.0001
Season	spring	DCLM	1	0.1585	0.0103	235.7941	<.0001
Season	spring	PRE	1	0.3314	0.0078	1791.9810	<.0001
Season	spring	SR	1	-0.0367	0.0104	12.4065	0.0004
Season	summer	CXM	1	0.1210	0.0642	3.5526	0.0595
Season	summer	CXS	1	-0.3349	0.0157	456.6324	<.0001
Season	summer	DCLM	1	0.4372	0.0097	2033.0464	<.0001
Season	summer	PRE	1	0.2080	0.0078	717.1831	<.0001
Season	summer	SR	1	-0.3426	0.0105	1058.0170	<.0001
Judicial State	1	CXM	1	0.1869	0.0475	15.4988	<.0001
Judicial State	1	CXS	1	0.0958	0.0107	79.7532	<.0001
Judicial State	1	DCLM	1	0.0688	0.0071	93.8940	<.0001
Judicial State	1	PRE	1	-0.1133	0.0059	370.7764	<.0001
Judicial State	1	SR	1	-0.2590	0.0083	966.3458	<.0001
Down payment assist	govt	CXM	1	0.3993	0.2763	2.0881	0.1484
Down payment assist	govt	CXS	1	0.4819	0.0718	44.9952	<.0001
Down payment assist	govt	DCLM	1	0.6015	0.0514	137.1180	<.0001
Down payment assist	govt	PRE	1	-0.3967	0.0580	46.8402	<.0001
Down payment assist	govt	SR	1	-0.1692	0.0652	6.7373	0.0094
Down payment assist	non-profit	CXM	1	0.9974	0.0749	177.5281	<.0001
Down payment assist	non-profit	CXS	1	0.3881	0.0247	247.2502	<.0001
Down payment assist	non-profit	DCLM	1	0.6713	0.0162	1718.9024	<.0001
Down payment assist	non-profit	PRE	1	-0.3323	0.0174	363.6956	<.0001
Down payment assist	non-profit	SR	1	-0.2048	0.0204	100.6213	<.0001
Down payment assist	relative	CXM	1	0.5495	0.0805	46.5845	<.0001
Down payment assist	relative	CXS	1	0.3907	0.0178	480.5071	<.0001
Down payment assist	relative	DCLM	1	0.3781	0.0124	931.6518	<.0001
Down payment assist	relative	PRE	1	0.0144	0.0110	1.7204	0.1896
Down payment assist	relative	SR	1	-0.2803	0.0142	388.4677	<.0001
First time buyer	N	CXM	1	-0.1948	0.0716	7.4076	0.0065

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
First time buyer	N	CXS	1	-0.2446	0.0136	323.1788	<.0001
First time buyer	N	DCLM	1	-0.2232	0.0089	632.4234	<.0001
First time buyer	N	PRE	1	0.1379	0.0067	424.2412	<.0001
First time buyer	N	SR	1	0.0076	0.0094	0.6549	0.4184
Number of Units	2+	CXM	1	-0.6584	0.1973	11.1396	0.0008
Number of Units	2+	CXS	1	0.0311	0.0296	1.1043	0.2933
Number of Units	2+	DCLM	1	0.0646	0.0189	11.6365	0.0006
Number of Units	2+	PRE	1	-0.1292	0.0159	65.6926	<.0001
Number of Units	2+	SR	1	-0.0688	0.0213	10.4187	0.0012
Spread at Origination	sato1	CXM	1	-1.7923	0.4181	18.3751	<.0001
Spread at Origination	sato1	CXS	1	-1.0568	0.1085	94.8060	<.0001
Spread at Origination	sato1	DCLM	1	-1.1220	0.0784	205.0380	<.0001
Spread at Origination	sato1	PRE	1	-0.3108	0.0761	16.6641	<.0001
Spread at Origination	sato1	SR	1	-0.9438	0.0807	136.8327	<.0001
Spread at Origination	sato2	CXM	1	-1.5342	0.4215	13.2459	0.0003
Spread at Origination	sato2	CXS	1	-0.6306	0.1094	33.2405	<.0001
Spread at Origination	sato2	DCLM	1	-0.7166	0.0789	82.5661	<.0001
Spread at Origination	sato2	PRE	1	-0.2817	0.0766	13.5229	0.0002
Spread at Origination	sato2	SR	1	-0.5229	0.0812	41.4637	<.0001
Spread at Origination	sato3	CXM	1	-1.5658	0.4530	11.9473	0.0005
Spread at Origination	sato3	CXS	1	-0.4617	0.1137	16.4767	<.0001
Spread at Origination	sato3	DCLM	1	-0.5380	0.0817	43.3292	<.0001
Spread at Origination	sato3	PRE	1	-0.3544	0.0794	19.9034	<.0001
Spread at Origination	sato3	SR	1	-0.4276	0.0844	25.6445	<.0001
Spread at Origination	sato4	CXM	1	-1.4991	0.5087	8.6848	0.0032
Spread at Origination	sato4	CXS	1	-0.6090	0.1204	25.5674	<.0001
Spread at Origination	sato4	DCLM	1	-0.6975	0.0865	65.0214	<.0001
Spread at Origination	sato4	PRE	1	-0.4275	0.0837	26.1215	<.0001
Spread at Origination	sato4	SR	1	-0.5139	0.0903	32.4146	<.0001
Treasury_mo_3		CXM	1	-0.1417	0.0592	5.7378	0.0166
Treasury_mo_3		CXS	1	-0.4092	0.0119	1181.7438	<.0001
Treasury_mo_3		DCLM	1	0.2880	0.0075	1490.6097	<.0001
Treasury_mo_3		PRE	1	0.0802	0.0062	169.3175	<.0001
Treasury_mo_3		SR	1	0.5818	0.0085	4719.6759	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Treasury_yr_05		CXM	1	-0.4574	0.0946	23.3625	<.0001
Treasury_yr_05		CXS	1	-0.3080	0.0204	228.6985	<.0001
Treasury_yr_05		DCLM	1	-0.5612	0.0136	1697.9386	<.0001
Treasury_yr_05		PRE	1	-0.3933	0.0115	1176.2402	<.0001
Treasury_yr_05		SR	1	-0.7801	0.0161	2353.2530	<.0001
Treasury_yr_30		CXM	1	-0.3288	0.0797	17.0092	<.0001
Treasury_yr_30		CXS	1	0.1243	0.0183	46.0670	<.0001
Treasury_yr_30		DCLM	1	-0.0972	0.0123	62.5228	<.0001
Treasury_yr_30		PRE	1	-0.0053	0.0105	0.2574	0.6119
Treasury_yr_30		SR	1	-0.2607	0.0148	309.9406	<.0001
Delta UE seas adj state		CXM	1	-0.0470	0.0542	0.7538	0.3853
Delta UE seas adj state		CXS	1	0.1342	0.0135	99.4764	<.0001
Delta UE seas adj state		DCLM	1	0.2739	0.0088	964.9588	<.0001
Delta UE seas adj state		PRE	1	0.4643	0.0079	3480.5726	<.0001
Delta UE seas adj state		SR	1	0.3160	0.0104	915.9456	<.0001
UE seas adj state		CXM	1	0.1593	0.0174	83.4287	<.0001
UE seas adj state		CXS	1	-0.0631	0.0046	187.4290	<.0001
UE seas adj state		DCLM	1	0.1042	0.0029	1290.1940	<.0001
UE seas adj state		PRE	1	-0.2133	0.0026	6958.4993	<.0001
UE seas adj state		SR	1	-0.0303	0.0033	84.3232	<.0001
GDP ratio 1 yr		CXM	1	-26.9566	2.0101	179.8486	<.0001
GDP ratio 1 yr		CXS	1	-12.4092	0.4385	800.8834	<.0001
GDP ratio 1 yr		DCLM	1	-7.4211	0.3012	606.8758	<.0001
GDP ratio 1 yr		PRE	1	12.2470	0.2586	2243.5021	<.0001
GDP ratio 1 yr		SR	1	-14.5039	0.3661	1569.4317	<.0001
Yield curve slope_grp	2	CXM	1	-2.3586	0.1271	344.2970	<.0001
Yield curve slope_grp	2	CXS	1	-1.0776	0.0390	762.6418	<.0001
Yield curve slope_grp	2	DCLM	1	-0.2100	0.0254	68.2794	<.0001
Yield curve slope_grp	2	PRE	1	-0.5235	0.0226	537.6385	<.0001
Yield curve slope_grp	2	SR	1	0.6566	0.0350	351.8741	<.0001
Yield curve slope_grp	3	CXM	1	-4.0948	0.1852	488.5961	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Yield curve slope_grp	3	CXS	1	-2.1197	0.0470	2033.6392	<.0001
Yield curve slope_grp	3	DCLM	1	-0.2757	0.0309	79.6133	<.0001
Yield curve slope_grp	3	PRE	1	-0.2843	0.0269	112.0661	<.0001
Yield curve slope_grp	3	SR	1	0.7730	0.0408	359.1620	<.0001
Yield curve slope_grp	4	CXM	1	-3.9624	0.1894	437.5292	<.0001
Yield curve slope_grp	4	CXS	1	-2.7480	0.0487	3190.1803	<.0001
Yield curve slope_grp	4	DCLM	1	-0.7424	0.0322	530.0361	<.0001
Yield curve slope_grp	4	PRE	1	-1.3997	0.0286	2398.8554	<.0001
Yield curve slope_grp	4	SR	1	-0.0726	0.0431	2.8381	0.0921
Period Piecewise1		CXM	1	1.0819	0.1027	110.9325	<.0001
Period Piecewise1		CXS	1	0.5169	0.0117	1953.6650	<.0001
Period Piecewise1		DCLM	1	0.5385	0.0064	7012.0731	<.0001
Period Piecewise1		PRE	1	0.6204	0.0045	19219.4498	<.0001
Period Piecewise1		SR	1	0.5246	0.0047	12447.7093	<.0001
Period Piecewise2		CXM	1	0.1107	0.0090	151.0449	<.0001
Period Piecewise2		CXS	1	0.0950	0.0019	2515.7655	<.0001
Period Piecewise2		DCLM	1	0.0867	0.0012	5598.5144	<.0001
Period Piecewise2		PRE	1	0.0327	0.0009	1310.3215	<.0001
Period Piecewise2		SR	1	-0.1009	0.0012	7044.9656	<.0001
Period Piecewise3		CXM	1	-0.0070	0.0036	3.7051	0.0542
Period Piecewise3		CXS	1	-0.0166	0.0009	368.8494	<.0001
Period Piecewise3		DCLM	1	-0.0205	0.0006	1143.3120	<.0001
Period Piecewise3		PRE	1	-0.0129	0.0005	608.4140	<.0001
Period Piecewise3		SR	1	-0.1193	0.0014	7847.1064	<.0001
Period Piecewise4		CXM	1	-0.0331	0.0044	56.4284	<.0001
Period Piecewise4		CXS	1	-0.0268	0.0011	646.8788	<.0001
Period Piecewise4		DCLM	1	-0.0247	0.0007	1128.2387	<.0001
Period Piecewise4		PRE	1	-0.0367	0.0008	2321.8665	<.0001
Period Piecewise4		SR	1	-0.0199	0.0025	64.6833	<.0001

Default Transition Model Parameters – FRM30

The default transition model parameters for the fixed rate 30-year mortgage are shown below.

Table 35: Default Transition FRM30 Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CLM	1	1.7723	0.1489	141.7174	<.0001
Intercept		CXM	1	14.6786	0.1572	8720.4283	<.0001
Intercept		CXS	1	-4.3264	0.1204	1292.2598	<.0001
Intercept		REFI	1	-20.7232	0.2732	5753.1557	<.0001
Down payment assist	govt	CLM	1	0.0928	0.0105	78.8039	<.0001
Down payment assist	govt	CXM	1	-0.0970	0.0111	76.9919	<.0001
Down payment assist	govt	CXS	1	-0.1016	0.0094	117.8421	<.0001
Down payment assist	govt	REFI	1	-0.4780	0.0257	347.0239	<.0001
Down payment assist	non-profit	CLM	1	0.2972	0.0050	3576.7721	<.0001
Down payment assist	non-profit	CXM	1	0.0089	0.0052	2.8653	0.0905
Down payment assist	non-profit	CXS	1	-0.3760	0.0050	5708.8929	<.0001
Down payment assist	non-profit	REFI	1	-0.7876	0.0150	2771.3575	<.0001
Down payment assist	relative	CLM	1	-0.0082	0.0054	2.3222	0.1275
Down payment assist	relative	CXM	1	0.0621	0.0053	136.4461	<.0001
Down payment assist	relative	CXS	1	0.0651	0.0044	222.1874	<.0001
Down payment assist	relative	REFI	1	0.1471	0.0092	256.4725	<.0001
Default duration grp	2	CLM	1	0.8630	0.0069	15454.1276	<.0001
Default duration grp	2	CXM	1	0.4336	0.0049	7790.7874	<.0001
Default duration grp	2	CXS	1	-0.8753	0.0039	51426.1706	<.0001
Default duration grp	2	REFI	1	-0.2032	0.0088	533.7901	<.0001
Default duration grp	3	CLM	1	1.3168	0.0069	36090.9040	<.0001
Default duration grp	3	CXM	1	0.3890	0.0054	5281.3558	<.0001
Default duration grp	3	CXS	1	-1.3425	0.0048	76845.0458	<.0001
Default duration grp	3	REFI	1	-0.3895	0.0105	1383.0470	<.0001
Default duration grp	4	CLM	1	1.5637	0.0071	48024.0828	<.0001
Default duration grp	4	CXM	1	0.2360	0.0060	1539.8589	<.0001
Default duration grp	4	CXS	1	-1.6709	0.0060	76744.6134	<.0001
Default duration grp	4	REFI	1	-0.5435	0.0125	1889.8151	<.0001
Default duration grp	5+	CLM	1	1.5656	0.0060	67217.9723	<.0001
Default duration grp	5+	CXM	1	-0.5787	0.0048	14390.2889	<.0001
Default duration grp	5+	CXS	1	-2.1847	0.0040	293570.2850	<.0001
Default duration grp	5+	REFI	1	-0.8047	0.0083	9492.2268	<.0001
First time buyer	N	CLM	1	0.1056	0.0051	435.1701	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
First time buyer	N	CXM	1	-0.0312	0.0054	33.4763	<.0001
First time buyer	N	CXS	1	-0.0324	0.0044	54.8743	<.0001
First time buyer	N	REFI	1	0.0824	0.0090	83.7735	<.0001
Judicial State	1	CLM	1	-0.3660	0.0032	12757.4686	<.0001
Judicial State	1	CXM	1	-0.1854	0.0033	3095.1433	<.0001
Judicial State	1	CXS	1	-0.2049	0.0029	5099.1581	<.0001
Judicial State	1	REFI	1	-0.4222	0.0064	4373.2515	<.0001
Number of Units	2+	CLM	1	-0.3564	0.0111	1024.2104	<.0001
Number of Units	2+	CXM	1	-0.3464	0.0125	764.6834	<.0001
Number of Units	2+	CXS	1	-0.2122	0.0097	476.6946	<.0001
Number of Units	2+	REFI	1	0.4199	0.0162	669.3878	<.0001
Refinance indicator	Y	CLM	1	0.0709	0.0061	133.8562	<.0001
Refinance indicator	Y	CXM	1	0.0887	0.0064	190.3382	<.0001
Refinance indicator	Y	CXS	1	-0.2840	0.0055	2703.7269	<.0001
Refinance indicator	Y	REFI	1	-0.4064	0.0119	1166.2644	<.0001
Period Piecewise1		CLM	1	0.1177	0.0095	154.4968	<.0001
Period Piecewise1		CXM	1	0.4849	0.0102	2257.4748	<.0001
Period Piecewise1		CXS	1	-0.0119	0.0048	6.2274	0.0126
Period Piecewise1		REFI	1	0.2010	0.0145	193.3264	<.0001
Period Piecewise2		CLM	1	0.0081	0.0003	787.1276	<.0001
Period Piecewise2		CXM	1	0.0057	0.0003	371.6776	<.0001
Period Piecewise2		CXS	1	0.0117	0.0002	2221.7012	<.0001
Period Piecewise2		REFI	1	0.0274	0.0005	2573.7882	<.0001
Period Piecewise3		CLM	1	-0.0089	0.0004	572.0777	<.0001
Period Piecewise3		CXM	1	-0.0006	0.0004	2.4085	0.1207
Period Piecewise3		CXS	1	0.0084	0.0003	752.0441	<.0001
Period Piecewise3		REFI	1	0.0032	0.0007	23.5861	<.0001
Period Piecewise4		CLM	1	-0.0124	0.0007	357.7043	<.0001
Period Piecewise4		CXM	1	-0.0027	0.0006	22.9877	<.0001
Period Piecewise4		CXS	1	0.0031	0.0004	51.4949	<.0001
Period Piecewise4		REFI	1	0.0079	0.0009	84.5765	<.0001
Period Piecewise5		CLM	1	-0.0209	0.0014	213.9649	<.0001
Period Piecewise5		CXM	1	-0.0062	0.0011	32.7807	<.0001
Period Piecewise5		CXS	1	0.0024	0.0007	11.1947	0.0008

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Period Piecewise5		REFI	1	0.0354	0.0011	1059.2896	<.0001
Delta UE seas adj state		CLM	1	-0.0166	0.0037	20.0429	<.0001
Delta UE seas adj state		CXM	1	-0.2148	0.0038	3124.4341	<.0001
Delta UE seas adj state		CXS	1	0.0422	0.0031	180.5961	<.0001
Delta UE seas adj state		REFI	1	0.1461	0.0069	449.9087	<.0001
GDP ratio 1 yr		CLM	1	-4.8300	0.1360	1260.6056	<.0001
GDP ratio 1 yr		CXM	1	-16.1487	0.1435	12666.4966	<.0001
GDP ratio 1 yr		CXS	1	3.8694	0.1142	1147.1978	<.0001
GDP ratio 1 yr		REFI	1	17.4844	0.2533	4764.7486	<.0001
Treasury_mo_3		CLM	1	0.0908	0.0041	500.2033	<.0001
Treasury_mo_3		CXM	1	-0.3120	0.0048	4261.4892	<.0001
Treasury_mo_3		CXS	1	0.1482	0.0033	2000.6703	<.0001
Treasury_mo_3		REFI	1	-0.1108	0.0071	245.8353	<.0001
Treasury_yr_05		CLM	1	0.0176	0.0060	8.6978	0.0032
Treasury_yr_05		CXM	1	0.1315	0.0061	468.8566	<.0001
Treasury_yr_05		CXS	1	0.0303	0.0052	33.9925	<.0001
Treasury_yr_05		REFI	1	0.3455	0.0120	835.1195	<.0001
Treasury_yr_30		CLM	1	0.1486	0.0048	949.9832	<.0001
Treasury_yr_30		CXM	1	-0.1227	0.0051	581.4125	<.0001
Treasury_yr_30		CXS	1	0.0723	0.0042	297.2773	<.0001
Treasury_yr_30		REFI	1	-0.0734	0.0093	61.7013	<.0001
UE seas adj state		CLM	1	-0.0679	0.0011	4206.6033	<.0001
UE seas adj state		CXM	1	-0.0399	0.0010	1498.4766	<.0001
UE seas adj state		CXS	1	-0.0480	0.0009	2918.5722	<.0001
UE seas adj state		REFI	1	-0.1609	0.0024	4612.5892	<.0001
credit_score_group	0	CLM	1	-0.4060	0.0126	1039.9917	<.0001
credit_score_group	0	CXM	1	0.2344	0.0165	201.0521	<.0001
credit_score_group	0	CXS	1	0.3462	0.0151	527.6211	<.0001
credit_score_group	0	REFI	1	-0.0224	0.0314	0.5102	0.475
credit_score_group	5	CLM	1	-0.6850	0.0145	2219.2386	<.0001
credit_score_group	5	CXM	1	0.4527	0.0177	656.4021	<.0001
credit_score_group	5	CXS	1	0.1478	0.0167	78.2513	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
credit_score_group	5	REFI	1	-0.6845	0.0408	281.9629	<.0001
credit_score_group	6	CLM	1	-0.5564	0.0123	2036.3921	<.0001
credit_score_group	6	CXM	1	0.4514	0.0162	773.0054	<.0001
credit_score_group	6	CXS	1	0.2767	0.0149	345.8453	<.0001
credit_score_group	6	REFI	1	-0.4404	0.0312	199.0997	<.0001
credit_score_group	7	CLM	1	-0.3705	0.0125	875.3392	<.0001
credit_score_group	7	CXM	1	0.3654	0.0164	494.2530	<.0001
credit_score_group	7	CXS	1	0.2531	0.0151	282.1759	<.0001
credit_score_group	7	REFI	1	-0.1170	0.0313	13.9274	0.0002
loan to value ratio	65-99	CLM	1	-0.1622	0.0042	1500.8460	<.0001
loan to value ratio	65-99	CXM	1	-0.0535	0.0043	155.2625	<.0001
loan to value ratio	65-99	CXS	1	0.1249	0.0036	1224.8025	<.0001
loan to value ratio	65-99	REFI	1	0.2305	0.0075	951.0726	<.0001
loan to value ratio	lt65	CLM	1	-0.3827	0.0190	403.5903	<.0001
loan to value ratio	lt65	CXM	1	-0.3610	0.0239	227.3805	<.0001
loan to value ratio	lt65	CXS	1	0.4727	0.0129	1336.6402	<.0001
loan to value ratio	lt65	REFI	1	0.8423	0.0206	1674.8104	<.0001
prior_default_cnt_grp	1-2	CLM	1	-0.3605	0.0037	9738.0148	<.0001
prior_default_cnt_grp	1-2	CXM	1	0.0980	0.0039	649.1007	<.0001
prior_default_cnt_grp	1-2	CXS	1	0.0624	0.0033	356.5076	<.0001
prior_default_cnt_grp	1-2	REFI	1	-0.1779	0.0070	648.3080	<.0001
prior_default_cnt_grp	3+	CLM	1	-0.7258	0.0060	14884.0206	<.0001
prior_default_cnt_grp	3+	CXM	1	0.2868	0.0052	3000.4232	<.0001
prior_default_cnt_grp	3+	CXS	1	0.2018	0.0045	2033.5648	<.0001
prior_default_cnt_grp	3+	REFI	1	-0.4696	0.0102	2134.9907	<.0001
Spread at Origination	sato1	CLM	1	0.0352	0.0086	16.6733	<.0001
Spread at Origination	sato1	CXM	1	-0.0608	0.0094	42.0617	<.0001
Spread at Origination	sato1	CXS	1	0.2029	0.0069	866.3735	<.0001
Spread at Origination	sato1	REFI	1	0.0970	0.0140	47.9759	<.0001
Spread at Origination	sato2	CLM	1	0.0585	0.0060	95.7432	<.0001
Spread at Origination	sato2	CXM	1	0.1211	0.0064	360.6231	<.0001
Spread at Origination	sato2	CXS	1	0.0761	0.0053	209.2532	<.0001
Spread at Origination	sato2	REFI	1	0.0176	0.0113	2.4233	0.1195
Spread at Origination	sato3	CLM	1	0.0485	0.0058	70.7623	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Spread at Origination	sato3	CXM	1	0.1326	0.0062	460.9397	<.0001
Spread at Origination	sato3	CXS	1	0.0562	0.0051	122.9732	<.0001
Spread at Origination	sato3	REFI	1	0.0397	0.0108	13.5576	0.0002
Spread at Origination	sato4	CLM	1	0.0398	0.0057	48.2580	<.0001
Spread at Origination	sato4	CXM	1	0.0930	0.0062	226.5609	<.0001
Spread at Origination	sato4	CXS	1	0.0339	0.0050	45.6155	<.0001
Spread at Origination	sato4	REFI	1	0.0034	0.0107	0.0988	0.7533
Yield curve slope_grp	2	CLM	1	0.4864	0.0156	973.4351	<.0001
Yield curve slope_grp	2	CXM	1	-1.5056	0.0160	8817.3110	<.0001
Yield curve slope_grp	2	CXS	1	0.1630	0.0112	211.9816	<.0001
Yield curve slope_grp	2	REFI	1	-0.1772	0.0197	80.8018	<.0001
Yield curve slope_grp	3	CLM	1	0.7077	0.0185	1462.8093	<.0001
Yield curve slope_grp	3	CXM	1	-2.4449	0.0198	15306.2420	<.0001
Yield curve slope_grp	3	CXS	1	0.2648	0.0137	373.5699	<.0001
Yield curve slope_grp	3	REFI	1	-0.0240	0.0251	0.9180	0.338
Yield curve slope_grp	4	CLM	1	0.6333	0.0194	1060.2175	<.0001
Yield curve slope_grp	4	CXM	1	-1.9691	0.0210	8759.1908	<.0001
Yield curve slope_grp	4	CXS	1	0.0630	0.0145	19.0188	<.0001
Yield curve slope_grp	4	REFI	1	-0.7446	0.0268	771.4384	<.0001

Default Transition Model Parameters – FRM15

The default transition model parameters for the fixed rate 15-year mortgage are shown below.

Table 36: Default Transition FRM15 Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CLM	1	2.6711	1.2894	4.2915	0.0383
Intercept		CXM	1	14.2496	1.1082	165.3503	<.0001
Intercept		CXS	1	-4.3195	0.8155	28.0553	<.0001
Intercept		REFI	1	-13.7708	1.4856	85.9289	<.0001
Period Piecewise1		CLM	1	0.0184	0.0779	0.0556	0.8136
Period Piecewise1		CXM	1	0.3698	0.0662	31.2213	<.0001
Period Piecewise1		CXS	1	0.0415	0.0353	1.3861	0.2391
Period Piecewise1		REFI	1	0.2029	0.0878	5.3415	0.0208

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Period Piecewise2		CLM	1	-0.0122	0.0026	22.5862	<.0001
Period Piecewise2		CXM	1	0.0038	0.0022	3.0492	0.0808
Period Piecewise2		CXS	1	0.0147	0.0017	75.6577	<.0001
Period Piecewise2		REFI	1	0.0314	0.0032	95.6378	<.0001
Period Piecewise3		CLM	1	-0.0281	0.0036	61.7569	<.0001
Period Piecewise3		CXM	1	-0.0139	0.0028	24.6409	<.0001
Period Piecewise3		CXS	1	0.0074	0.0020	13.2692	0.0003
Period Piecewise3		REFI	1	0.0240	0.0034	51.3905	<.0001
Period Piecewise4		CLM	1	0.0071	0.0291	0.0600	0.8065
Period Piecewise4		CXM	1	0.0076	0.0208	0.1323	0.716
Period Piecewise4		CXS	1	-0.0211	0.0143	2.1773	0.1401
Period Piecewise4		REFI	1	0.1037	0.0186	31.1037	<.0001
loan to value ratio	65-99	CLM	1	-0.4878	0.0309	249.4820	<.0001
loan to value ratio	65-99	CXM	1	-0.0073	0.0276	0.0698	0.7917
loan to value ratio	65-99	CXS	1	0.1498	0.0230	42.5049	<.0001
loan to value ratio	65-99	REFI	1	0.1501	0.0442	11.5391	0.0007
loan to value ratio	lt65	CLM	1	-0.3380	0.0918	13.5580	0.0002
loan to value ratio	lt65	CXM	1	-0.8037	0.1118	51.6691	<.0001
loan to value ratio	lt65	CXS	1	0.3942	0.0484	66.2559	<.0001
loan to value ratio	lt65	REFI	1	0.4491	0.0712	39.7435	<.0001
Treasury_mo_3		CLM	1	0.1924	0.0255	56.9737	<.0001
Treasury_mo_3		CXM	1	-0.1949	0.0255	58.4048	<.0001
Treasury_mo_3		CXS	1	0.2065	0.0155	178.2763	<.0001
Treasury_mo_3		REFI	1	0.0882	0.0249	12.5242	0.0004
Delta UE seas adj state		CLM	1	0.0595	0.0313	3.6231	0.057
Delta UE seas adj state		CXM	1	-0.1602	0.0267	36.0191	<.0001
Delta UE seas adj state		CXS	1	0.0795	0.0198	16.0300	<.0001
Delta UE seas adj state		REFI	1	0.2963	0.0343	74.4457	<.0001
UE seas adj state		CLM	1	-0.0901	0.0086	109.6201	<.0001
UE seas adj state		CXM	1	-0.0505	0.0067	57.1284	<.0001
UE seas adj state		CXS	1	-0.0310	0.0051	36.5718	<.0001
UE seas adj state		REFI	1	-0.1367	0.0108	160.8321	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
GDP ratio 1 yr		CLM	1	-4.7245	1.1794	16.0462	<.0001
GDP ratio 1 yr		CXM	1	-15.2543	1.0228	222.4395	<.0001
GDP ratio 1 yr		CXS	1	3.7421	0.7667	23.8226	<.0001
GDP ratio 1 yr		REFI	1	11.1456	1.3453	68.6339	<.0001
Yield curve slope_grp	2	CLM	1	0.8302	0.1418	34.2842	<.0001
Yield curve slope_grp	2	CXM	1	-1.2424	0.1083	131.5928	<.0001
Yield curve slope_grp	2	CXS	1	0.2810	0.0765	13.4874	0.0002
Yield curve slope_grp	2	REFI	1	0.0401	0.1186	0.1142	0.7355
Yield curve slope_grp	3	CLM	1	1.1903	0.1654	51.7839	<.0001
Yield curve slope_grp	3	CXM	1	-2.0688	0.1350	234.9846	<.0001
Yield curve slope_grp	3	CXS	1	0.4759	0.0926	26.4251	<.0001
Yield curve slope_grp	3	REFI	1	0.1795	0.1456	1.5196	0.2177
Yield curve slope_grp	4	CLM	1	1.0895	0.1731	39.5947	<.0001
Yield curve slope_grp	4	CXM	1	-1.5748	0.1427	121.7720	<.0001
Yield curve slope_grp	4	CXS	1	0.3113	0.0981	10.0730	0.0015
Yield curve slope_grp	4	REFI	1	-0.3144	0.1569	4.0134	0.0451
prior_default_cnt_grp	1-2	CLM	1	-0.2627	0.0332	62.5977	<.0001
prior_default_cnt_grp	1-2	CXM	1	0.1022	0.0285	12.8541	0.0003
prior_default_cnt_grp	1-2	CXS	1	0.0799	0.0227	12.4161	0.0004
prior_default_cnt_grp	1-2	REFI	1	-0.3404	0.0412	68.3693	<.0001
prior_default_cnt_grp	3+	CLM	1	-0.6508	0.0570	130.1823	<.0001
prior_default_cnt_grp	3+	CXM	1	0.2850	0.0386	54.5079	<.0001
prior_default_cnt_grp	3+	CXS	1	0.1576	0.0306	26.4547	<.0001
prior_default_cnt_grp	3+	REFI	1	-0.7466	0.0591	159.8200	<.0001
credit_score_group	0	CLM	1	-0.6583	0.1009	42.5746	<.0001
credit_score_group	0	CXM	1	0.3137	0.1197	6.8623	0.0088
credit_score_group	0	CXS	1	0.4366	0.0953	20.9835	<.0001
credit_score_group	0	REFI	1	0.1201	0.1567	0.5871	0.4436
credit_score_group	5	CLM	1	-0.7830	0.1060	54.5293	<.0001
credit_score_group	5	CXM	1	0.2888	0.1227	5.5414	0.0186
credit_score_group	5	CXS	1	-0.1571	0.1007	2.4363	0.1186
credit_score_group	5	REFI	1	-1.0668	0.1874	32.4090	<.0001
credit_score_group	6	CLM	1	-0.7644	0.0992	59.4307	<.0001
credit_score_group	6	CXM	1	0.3418	0.1185	8.3229	0.0039

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
credit_score_group	6	CXS	1	0.1620	0.0953	2.8872	0.0893
credit_score_group	6	REFI	1	-0.7197	0.1616	19.8438	<.0001
credit_score_group	7	CLM	1	-0.5412	0.1003	29.1217	<.0001
credit_score_group	7	CXM	1	0.2509	0.1198	4.3812	0.0363
credit_score_group	7	CXS	1	0.1062	0.0965	1.2110	0.2711
credit_score_group	7	REFI	1	-0.3759	0.1614	5.4207	0.0199
Judicial State	1	CLM	1	-0.1728	0.0289	35.8772	<.0001
Judicial State	1	CXM	1	-0.1269	0.0248	26.1839	<.0001
Judicial State	1	CXS	1	-0.2105	0.0199	111.9217	<.0001
Judicial State	1	REFI	1	-0.2326	0.0364	40.9182	<.0001
Default duration grp	2	CLM	1	1.1151	0.0665	280.9837	<.0001
Default duration grp	2	CXM	1	0.3671	0.0354	107.6063	<.0001
Default duration grp	2	CXS	1	-0.8573	0.0269	1016.9654	<.0001
Default duration grp	2	REFI	1	-0.1506	0.0494	9.2816	0.0023
Default duration grp	3	CLM	1	1.5433	0.0672	528.0016	<.0001
Default duration grp	3	CXM	1	0.3244	0.0392	68.6224	<.0001
Default duration grp	3	CXS	1	-1.3087	0.0336	1515.0093	<.0001
Default duration grp	3	REFI	1	-0.3014	0.0592	25.9589	<.0001
Default duration grp	4	CLM	1	1.7753	0.0689	662.9478	<.0001
Default duration grp	4	CXM	1	0.1056	0.0449	5.5191	0.0188
Default duration grp	4	CXS	1	-1.6272	0.0411	1571.1437	<.0001
Default duration grp	4	REFI	1	-0.5373	0.0715	56.5168	<.0001
Default duration grp	5+	CLM	1	2.0360	0.0589	1195.2870	<.0001
Default duration grp	5+	CXM	1	-0.6889	0.0358	370.4784	<.0001
Default duration grp	5+	CXS	1	-2.1962	0.0282	6052.0573	<.0001
Default duration grp	5+	REFI	1	-1.0897	0.0504	467.3923	<.0001

Default Transition Model Parameters – ARM

The default transition model parameters for the adjustable rate mortgages are shown below.

Table 37: Default Transition ARM Model Parameters

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CLM	1	4.6048	0.6390	51.9285	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		CXM	1	19.9241	0.8595	537.4011	<.0001
Intercept		CXS	1	-8.3271	0.5338	243.3681	<.0001
Intercept		REFI	1	-25.4593	1.0290	612.1404	<.0001
Period Piecewise1		CLM	1	0.1655	0.0436	14.3895	0.0001
Period Piecewise1		CXM	1	0.6992	0.0821	72.5620	<.0001
Period Piecewise1		CXS	1	-0.0429	0.0243	3.1300	0.0769
Period Piecewise1		REFI	1	0.1836	0.0614	8.9392	0.0028
Period Piecewise2		CLM	1	0.0233	0.0030	60.6546	<.0001
Period Piecewise2		CXM	1	0.0259	0.0037	47.6836	<.0001
Period Piecewise2		CXS	1	0.0254	0.0025	101.2230	<.0001
Period Piecewise2		REFI	1	0.0436	0.0051	73.6462	<.0001
Period Piecewise3		CLM	1	-0.0165	0.0011	212.9258	<.0001
Period Piecewise3		CXM	1	-0.0024	0.0013	3.2712	0.0705
Period Piecewise3		CXS	1	0.0158	0.0009	275.8814	<.0001
Period Piecewise3		REFI	1	0.0230	0.0017	188.3105	<.0001
Period Piecewise4		CLM	1	-0.0061	0.0015	17.8002	<.0001
Period Piecewise4		CXM	1	0.0013	0.0013	0.9418	0.3318
Period Piecewise4		CXS	1	0.0094	0.0010	84.0980	<.0001
Period Piecewise4		REFI	1	0.0086	0.0020	18.1562	<.0001
credit_score_group	0	CLM	1	-0.2768	0.0698	15.7243	<.0001
credit_score_group	0	CXM	1	0.0174	0.0936	0.0345	0.8527
credit_score_group	0	CXS	1	0.7050	0.1011	48.6093	<.0001
credit_score_group	0	REFI	1	-0.0468	0.1839	0.0649	0.7989
credit_score_group	5	CLM	1	-0.3556	0.0834	18.1937	<.0001
credit_score_group	5	CXM	1	0.4671	0.1028	20.6425	<.0001
credit_score_group	5	CXS	1	0.6152	0.1119	30.2147	<.0001
credit_score_group	5	REFI	1	-0.1922	0.2233	0.7408	0.3894
credit_score_group	6	CLM	1	-0.4858	0.0704	47.6505	<.0001
credit_score_group	6	CXM	1	0.3448	0.0933	13.6576	0.0002
credit_score_group	6	CXS	1	0.5770	0.1016	32.2778	<.0001
credit_score_group	6	REFI	1	-0.3360	0.1872	3.2204	0.0727
credit_score_group	7	CLM	1	-0.2856	0.0717	15.8799	<.0001
credit_score_group	7	CXM	1	0.2868	0.0948	9.1501	0.0025
credit_score_group	7	CXS	1	0.5891	0.1030	32.7120	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
credit_score_group	7	REFI	1	-0.0118	0.1890	0.0039	0.9502
loan to value ratio	65-99	CLM	1	-0.1596	0.0164	95.2628	<.0001
loan to value ratio	65-99	CXM	1	-0.0370	0.0190	3.7930	0.0515
loan to value ratio	65-99	CXS	1	0.1326	0.0134	97.3450	<.0001
loan to value ratio	65-99	REFI	1	0.2478	0.0239	107.2610	<.0001
loan to value ratio	lt65	CLM	1	-0.1737	0.0767	5.1253	0.0236
loan to value ratio	lt65	CXM	1	-0.3008	0.1134	7.0401	0.008
loan to value ratio	lt65	CXS	1	0.5870	0.0543	117.0695	<.0001
loan to value ratio	lt65	REFI	1	0.8123	0.0821	97.8161	<.0001
Treasury_mo_3		CLM	1	0.1872	0.0122	235.2378	<.0001
Treasury_mo_3		CXM	1	-0.1574	0.0158	98.6942	<.0001
Treasury_mo_3		CXS	1	0.1826	0.0098	344.3624	<.0001
Treasury_mo_3		REFI	1	0.0546	0.0175	9.7622	0.0018
Treasury_yr_30		CLM	1	0.0986	0.0136	52.2201	<.0001
Treasury_yr_30		CXM	1	-0.1519	0.0159	91.8147	<.0001
Treasury_yr_30		CXS	1	0.2309	0.0124	345.5253	<.0001
Treasury_yr_30		REFI	1	0.1595	0.0247	41.6816	<.0001
Delta UE seas adj state		CLM	1	-0.0798	0.0152	27.7531	<.0001
Delta UE seas adj state		CXM	1	-0.2969	0.0176	284.3019	<.0001
Delta UE seas adj state		CXS	1	0.0870	0.0136	40.7868	<.0001
Delta UE seas adj state		REFI	1	0.1894	0.0282	45.0770	<.0001
UE seas adj state		CLM	1	-0.0110	0.0052	4.4044	0.0358
UE seas adj state		CXM	1	-0.0088	0.0056	2.4411	0.1182
UE seas adj state		CXS	1	-0.1029	0.0048	458.1561	<.0001
UE seas adj state		REFI	1	-0.1483	0.0103	207.4577	<.0001
GDP ratio 1 yr		CLM	1	-7.8867	0.5683	192.5907	<.0001
GDP ratio 1 yr		CXM	1	-22.6775	0.6909	1077.3599	<.0001
GDP ratio 1 yr		CXS	1	7.0946	0.4903	209.3781	<.0001
GDP ratio 1 yr		REFI	1	21.8096	0.9239	557.2218	<.0001
Yield curve slope_grp	2	CLM	1	0.6385	0.0504	160.3484	<.0001
Yield curve slope_grp	2	CXM	1	-1.0747	0.0553	377.6520	<.0001
Yield curve slope_grp	2	CXS	1	0.3117	0.0375	69.1782	<.0001

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Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Yield curve slope_grp	2	REFI	1	-0.1579	0.0616	6.5678	0.0104
Yield curve slope_grp	3	CLM	1	0.7738	0.0651	141.4425	<.0001
Yield curve slope_grp	3	CXM	1	-2.6732	0.0743	1293.9704	<.0001
Yield curve slope_grp	3	CXS	1	0.3238	0.0504	41.3377	<.0001
Yield curve slope_grp	3	REFI	1	0.0107	0.0864	0.0155	0.901
Yield curve slope_grp	4	CLM	1	0.7382	0.0696	112.4257	<.0001
Yield curve slope_grp	4	CXM	1	-1.7860	0.0783	520.0984	<.0001
Yield curve slope_grp	4	CXS	1	0.5174	0.0540	91.8714	<.0001
Yield curve slope_grp	4	REFI	1	-0.8670	0.0959	81.7876	<.0001
prior_default_cnt_grp	1-2	CLM	1	-0.4037	0.0160	636.3109	<.0001
prior_default_cnt_grp	1-2	CXM	1	0.1367	0.0203	45.2752	<.0001
prior_default_cnt_grp	1-2	CXS	1	-0.2349	0.0141	277.7500	<.0001
prior_default_cnt_grp	1-2	REFI	1	-0.2580	0.0250	106.9187	<.0001
prior_default_cnt_grp	3+	CLM	1	-0.7160	0.0240	887.5188	<.0001
prior_default_cnt_grp	3+	CXM	1	0.4473	0.0244	335.0200	<.0001
prior_default_cnt_grp	3+	CXS	1	-0.1335	0.0183	53.4495	<.0001
prior_default_cnt_grp	3+	REFI	1	-0.5080	0.0348	212.8800	<.0001
Refinance indicator	Y	CLM	1	0.1588	0.0211	56.7208	<.0001
Refinance indicator	Y	CXM	1	0.1646	0.0242	46.4572	<.0001
Refinance indicator	Y	CXS	1	-0.3540	0.0185	365.6440	<.0001
Refinance indicator	Y	REFI	1	-0.2780	0.0355	61.3353	<.0001
Judicial State	1	CLM	1	-0.3182	0.0144	486.6773	<.0001
Judicial State	1	CXM	1	-0.2103	0.0170	153.2967	<.0001
Judicial State	1	CXS	1	-0.2199	0.0122	325.7724	<.0001
Judicial State	1	REFI	1	-0.5031	0.0231	476.1060	<.0001
Down payment assist	govt	CLM	1	0.1430	0.0655	4.7695	0.029
Down payment assist	govt	CXM	1	-0.1599	0.0804	3.9504	0.0469
Down payment assist	govt	CXS	1	-0.3706	0.0652	32.2830	<.0001
Down payment assist	govt	REFI	1	-0.8231	0.1685	23.8712	<.0001
Down payment assist	non-profit	CLM	1	0.2771	0.0235	139.5308	<.0001
Down payment assist	non-profit	CXM	1	0.1103	0.0262	17.7495	<.0001
Down payment assist	non-profit	CXS	1	-0.3508	0.0227	239.2025	<.0001

Parameter	Level	Target	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Down payment assist	non-profit	REFI	1	-0.8412	0.0588	205.0015	<.0001
Down payment assist	relative	CLM	1	-0.0401	0.0235	2.8974	0.0887
Down payment assist	relative	CXM	1	0.1286	0.0272	22.3876	<.0001
Down payment assist	relative	CXS	1	-0.1105	0.0192	33.2127	<.0001
Down payment assist	relative	REFI	1	-0.0363	0.0348	1.0870	0.2971
Number of Units	2+	CLM	1	-0.1591	0.0410	15.0508	0.0001
Number of Units	2+	CXM	1	-0.3022	0.0558	29.3309	<.0001
Number of Units	2+	CXS	1	-0.0851	0.0351	5.8860	0.0153
Number of Units	2+	REFI	1	0.4300	0.0543	62.7449	<.0001
Default duration grp	2	CLM	1	0.5181	0.0269	371.2761	<.0001
Default duration grp	2	CXM	1	0.4333	0.0243	319.1003	<.0001
Default duration grp	2	CXS	1	-0.9313	0.0166	3157.6594	<.0001
Default duration grp	2	REFI	1	-0.1198	0.0314	14.5574	0.0001
Default duration grp	3	CLM	1	1.0254	0.0266	1487.1577	<.0001
Default duration grp	3	CXM	1	0.3705	0.0265	195.1564	<.0001
Default duration grp	3	CXS	1	-1.3514	0.0204	4394.2382	<.0001
Default duration grp	3	REFI	1	-0.3071	0.0371	68.3867	<.0001
Default duration grp	4	CLM	1	1.2834	0.0278	2129.7485	<.0001
Default duration grp	4	CXM	1	0.1993	0.0299	44.4140	<.0001
Default duration grp	4	CXS	1	-1.6307	0.0252	4194.7140	<.0001
Default duration grp	4	REFI	1	-0.4448	0.0441	101.6371	<.0001
Default duration grp	5+	CLM	1	1.2133	0.0231	2755.4692	<.0001
Default duration grp	5+	CXM	1	-0.5634	0.0241	547.6701	<.0001
Default duration grp	5+	CXS	1	-2.0825	0.0171	14904.1399	<.0001
Default duration grp	5+	REFI	1	-0.7086	0.0303	548.6577	<.0001

Section 3: Model Validation

Model validation was accomplished 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 1.0 for the final transition state of the record and 0.0 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 1.0 for each record.

Decile charts are then created for each final condition transition state. All records are sorted, or ranked, 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 also the actual vs. predictive ratio for each decile are consistent as well.

Current FRM30 Transition Models

The validation charts by ending condition for the FRM30 model are shown below.

Figure 13: Current FRM30 Transition Model Validation - Ending Condition Current
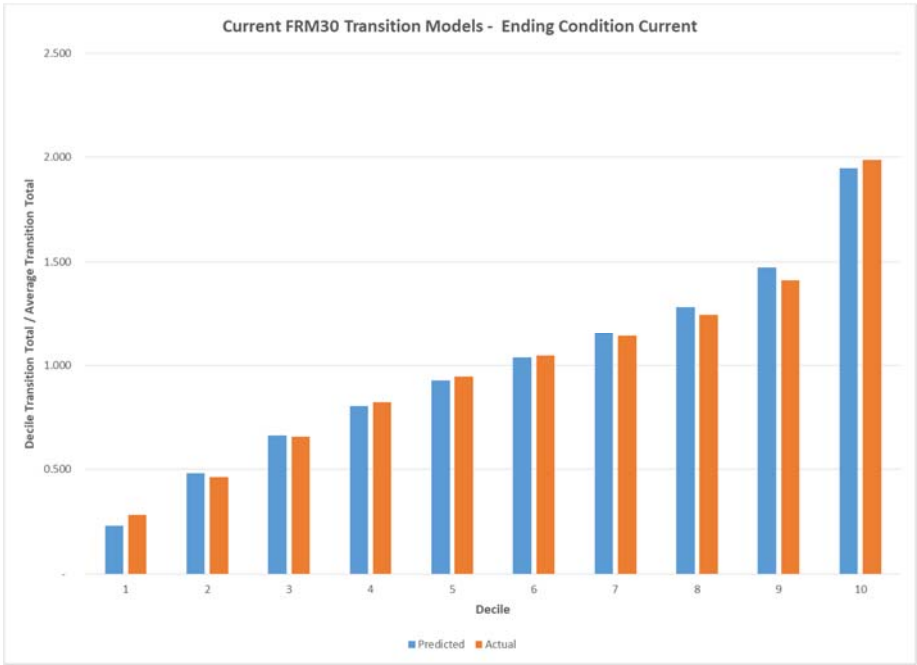
Figure 14: Current FRM30 Transition Model Validation - Ending Condition Default
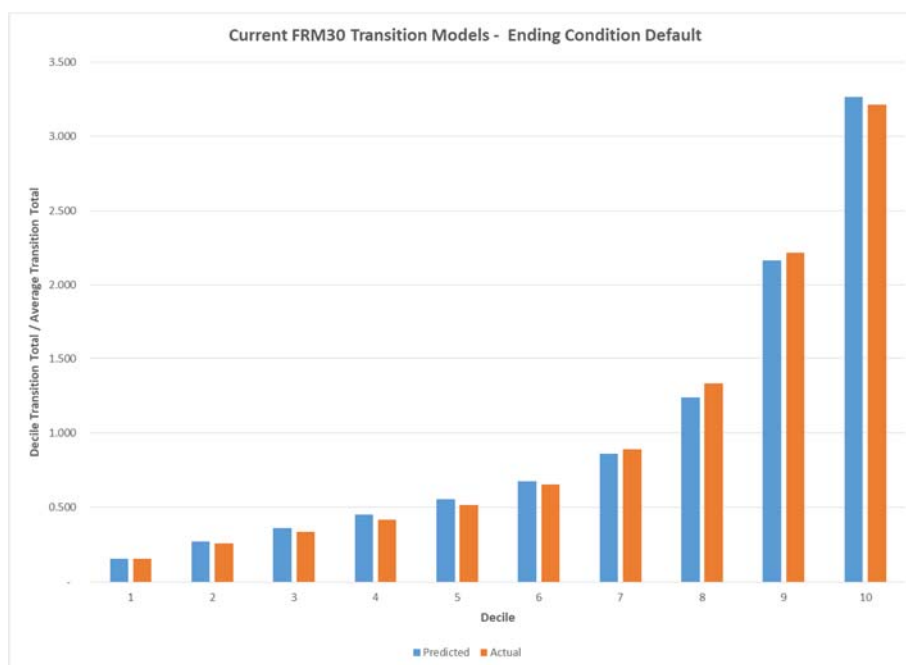
Figure 15: Current FRM30 Transition Model Validation - Ending Condition Cure with Modification
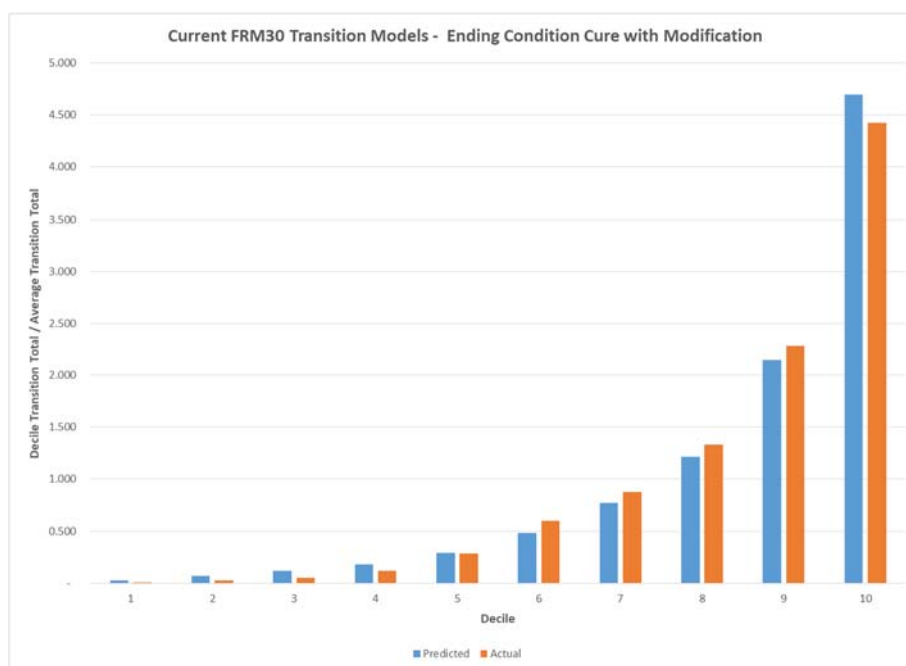
Figure 16: Current FRM30 Transition Model Validation - Ending Condition Self-Cure
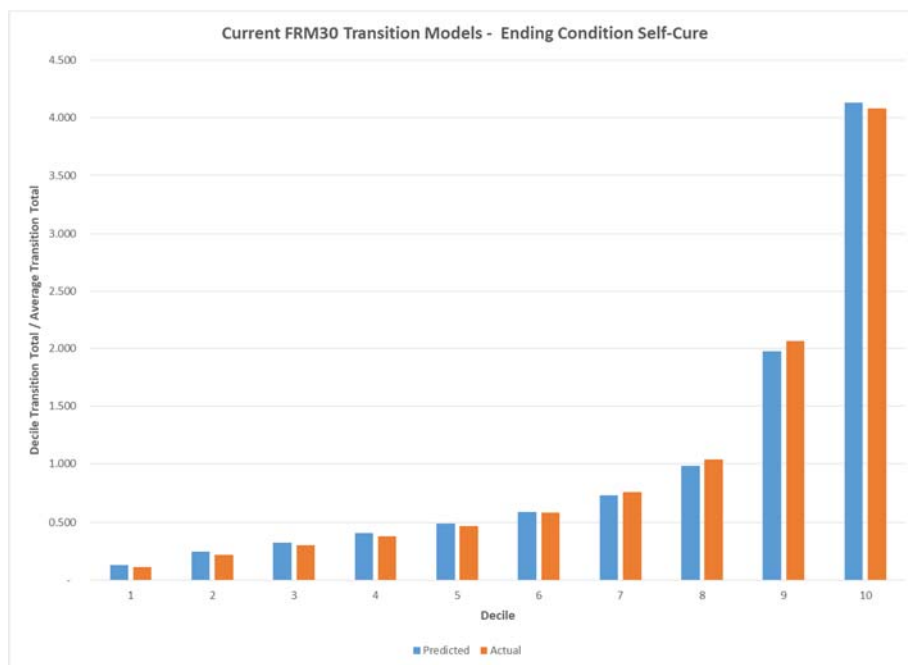
Figure 17: Current FRM30 Transition Model Validation - Ending Condition Prepayment
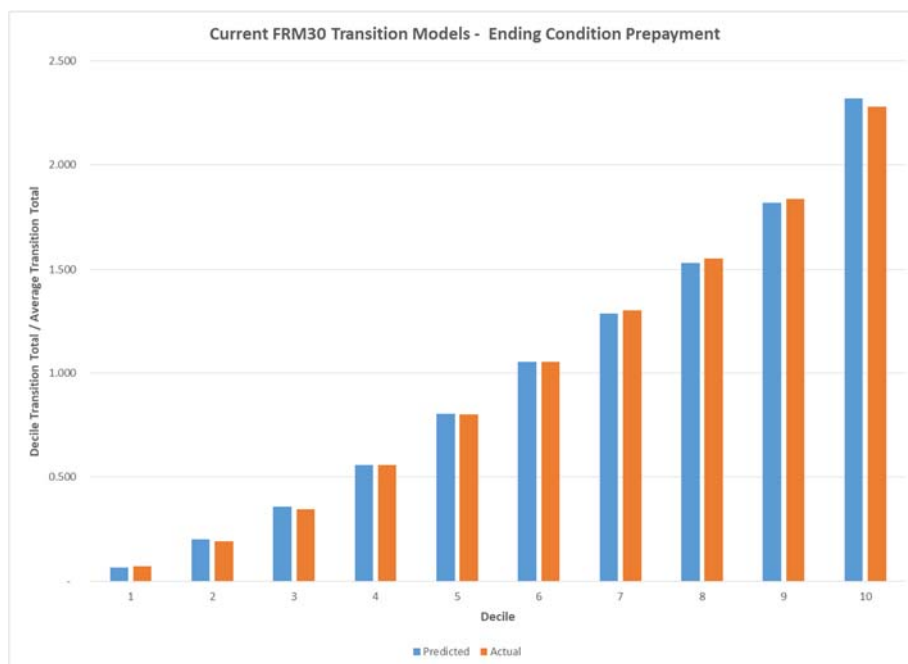
Figure 18: Current FRM30 Transition Model Validation - Ending Streamlined Refinance
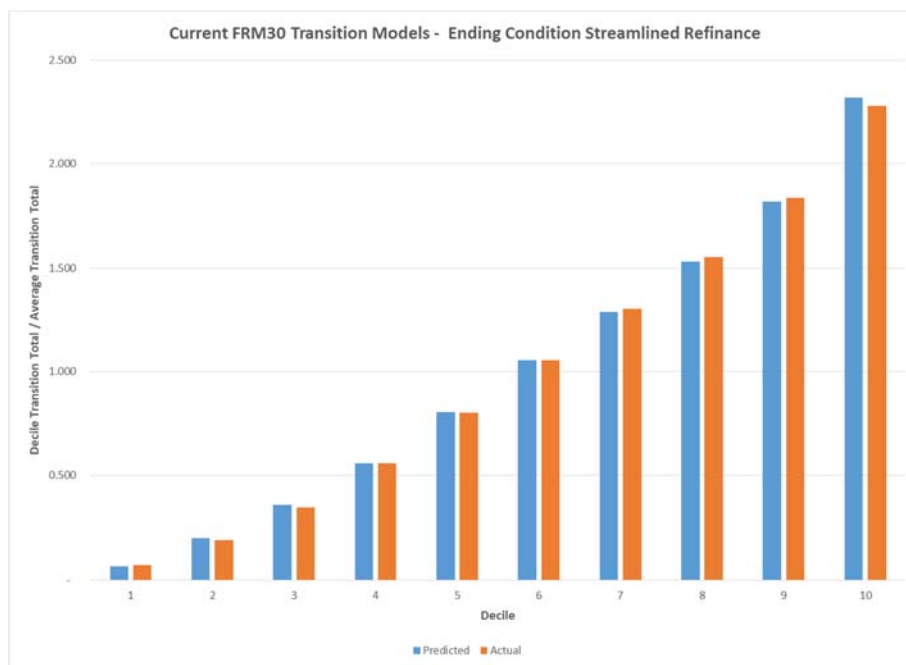
Current FRM15 Transition Models

The validation charts by ending condition for the FRM15 model are shown below.

Figure 19: Current FRM15 Transition Model Validation - Ending Condition Current
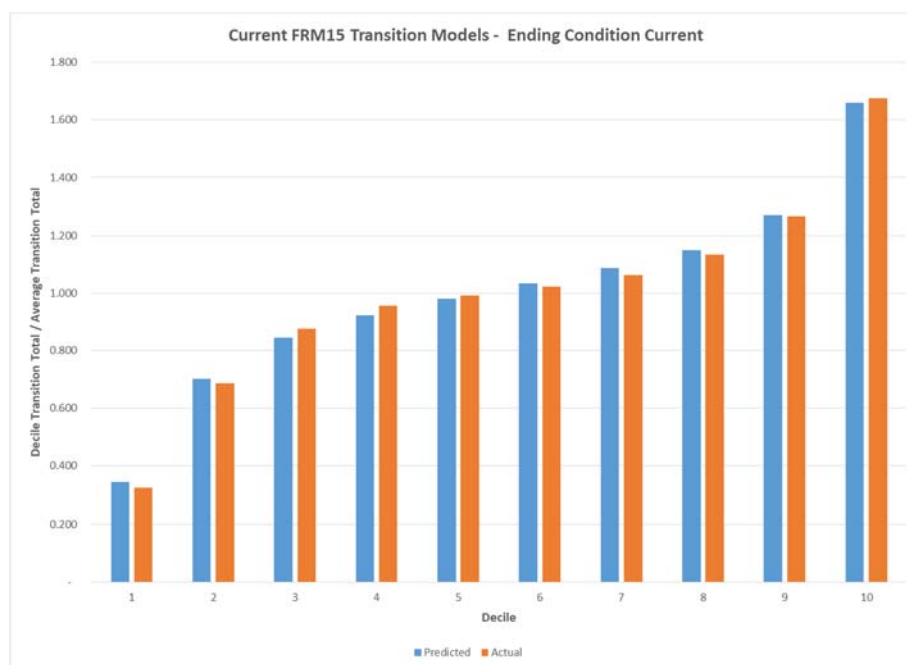
Figure 20: Current FRM15 Transition Model Validation - Ending Condition Default
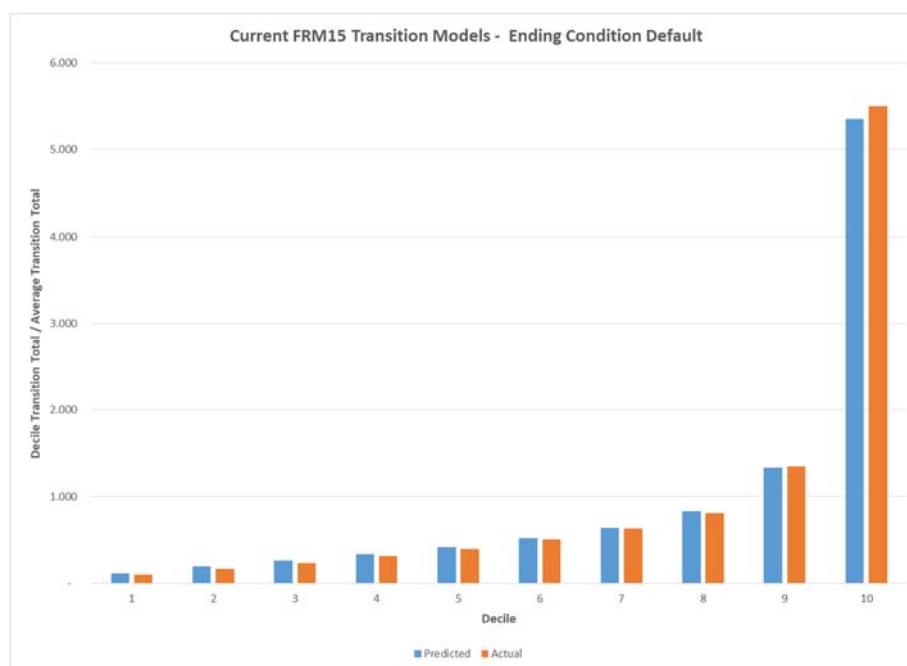
Figure 21: Current FRM15 Transition Model Validation - Ending Condition Cure with Modification
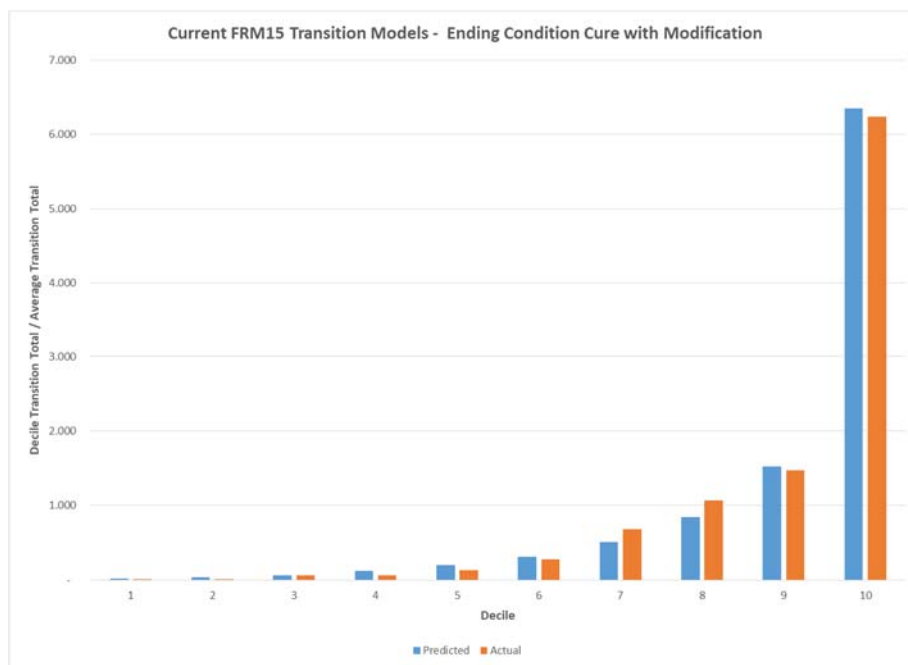
Figure 22: Current FRM15 Transition Model Validation - Ending Condition Self-Cure
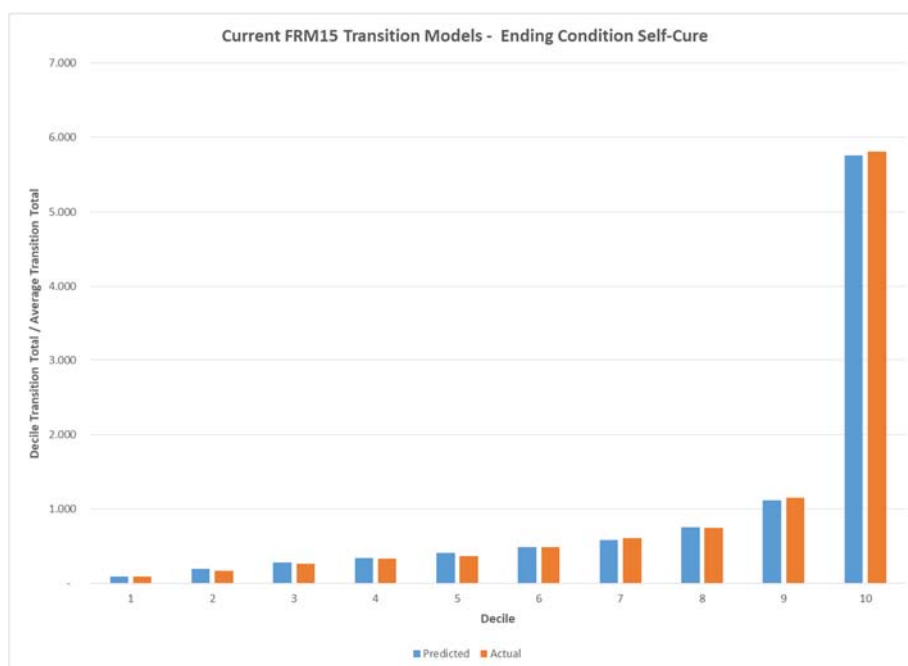
Figure 23: Current FRM15 Transition Model Validation - Ending Condition Prepayment
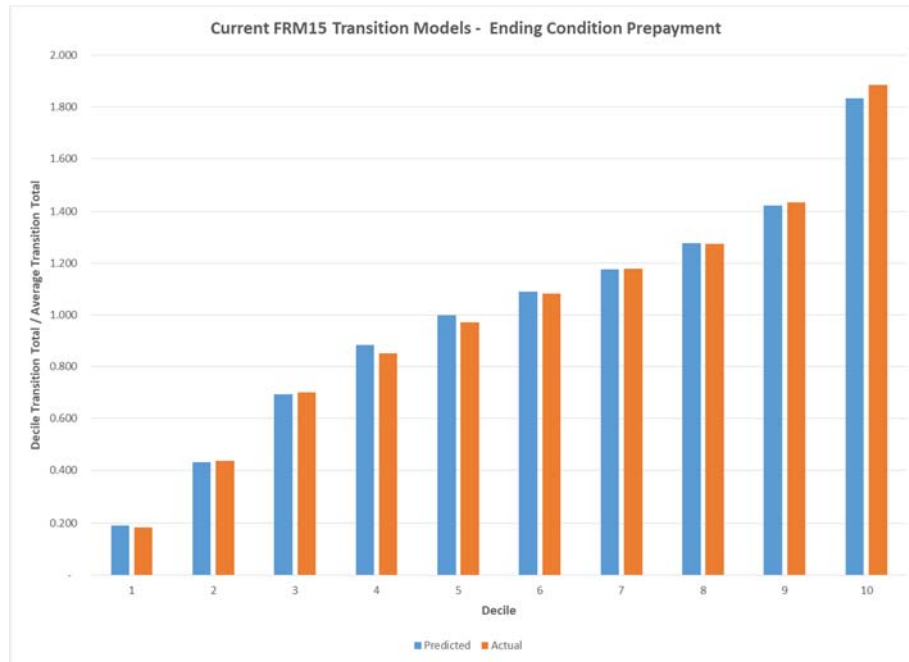
Figure 24: Current FRM15 Transition Model Validation - Ending Condition Streamlined Refinance
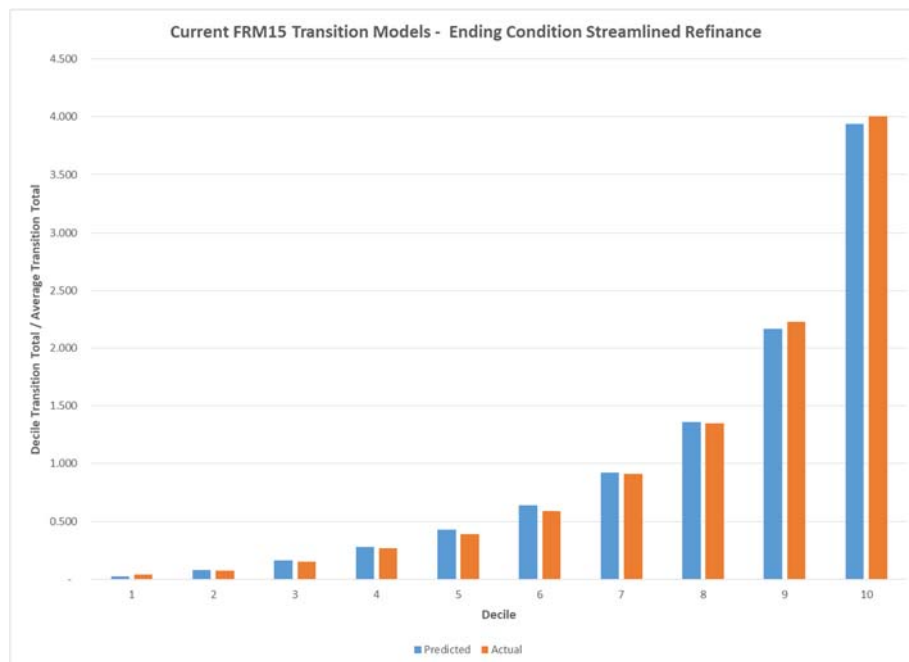
Current ARM Transition Models

The validation charts by ending condition for the ARM model are shown below.

Figure 25: Current ARM Transition Model Validation - Ending Condition Current
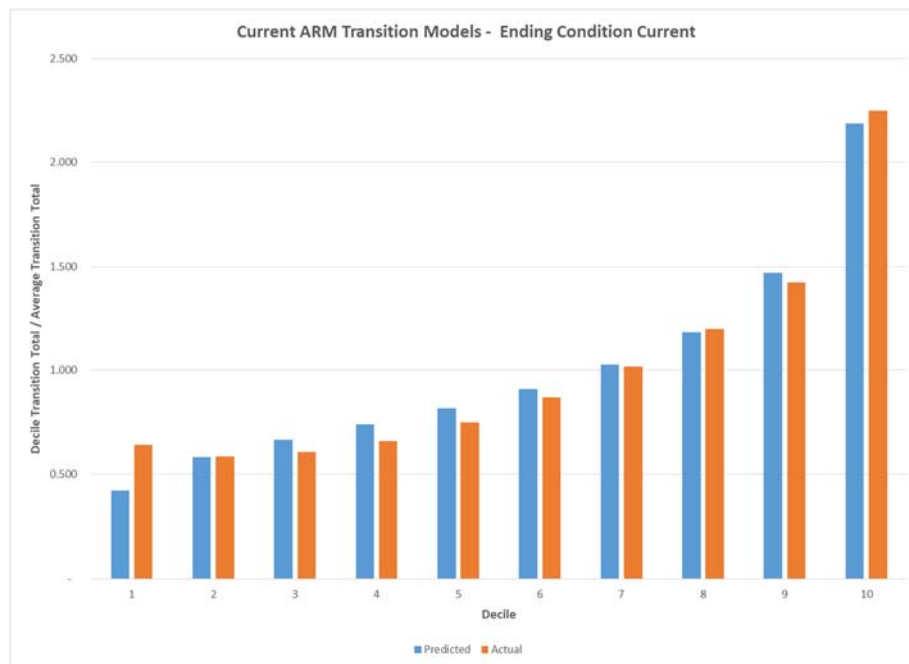
Figure 26: Current ARM Transition Model Validation - Ending Condition Default
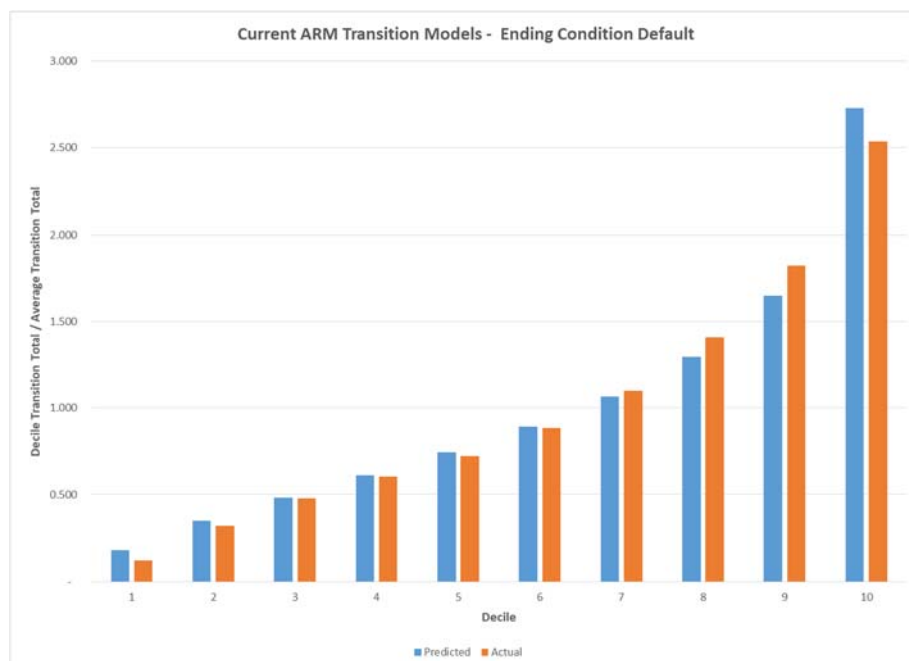
Figure 27: Current ARM Transition Model Validation - Ending Condition Cure with Modification
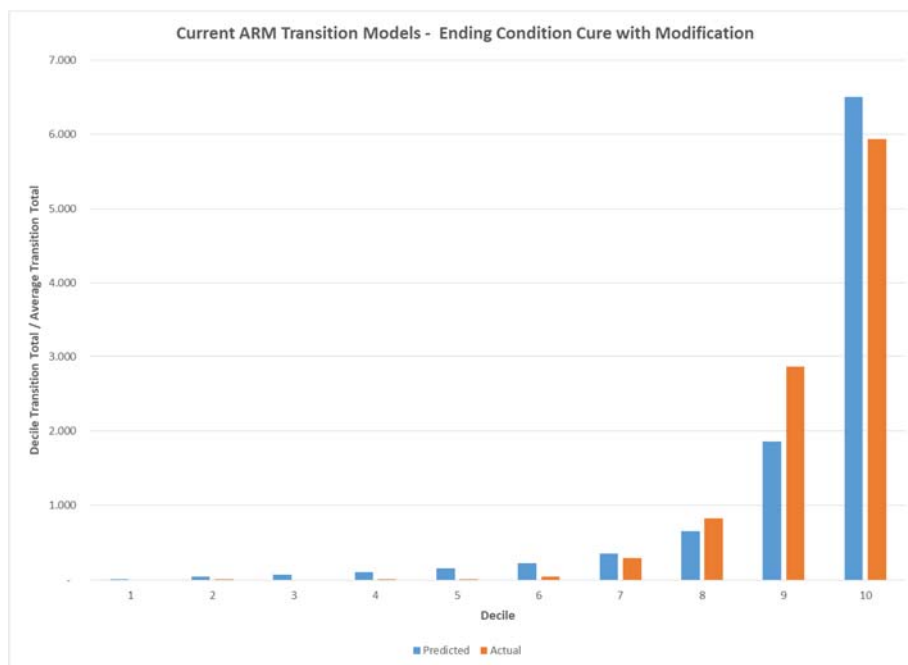
Figure 28: Current ARM Transition Model Validation - Ending Condition Self-Cure
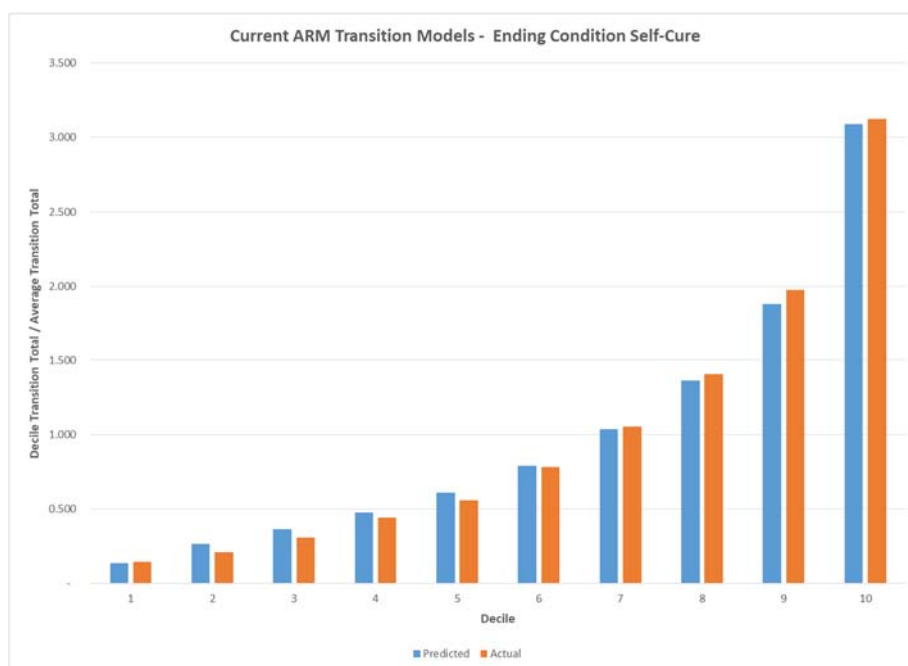
Figure 29: Current ARM Transition Model Validation - Ending Condition Prepayment
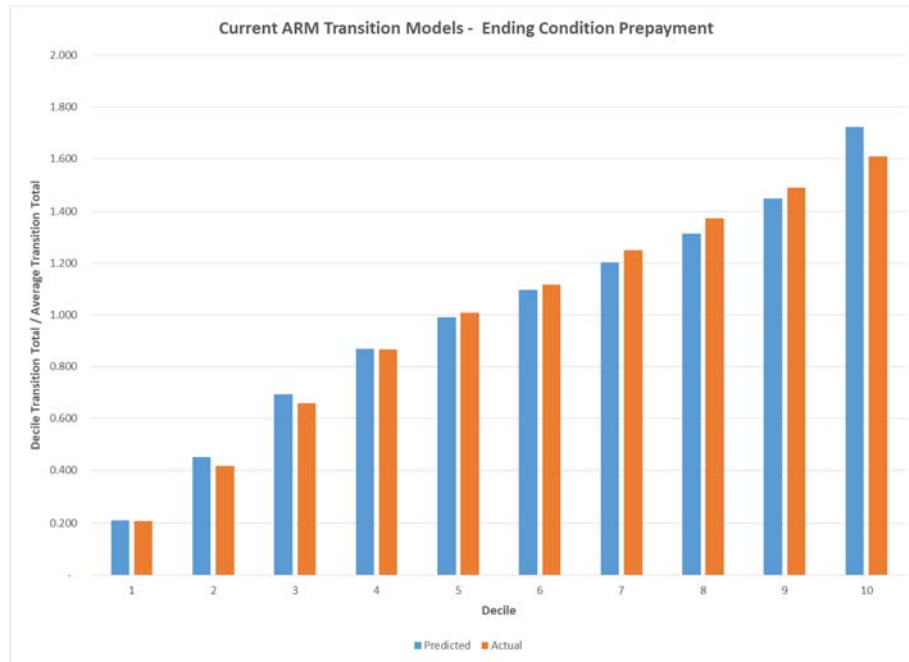
Figure 30: Current ARM Transition Model Validation - Ending Condition Streamlined Refinance
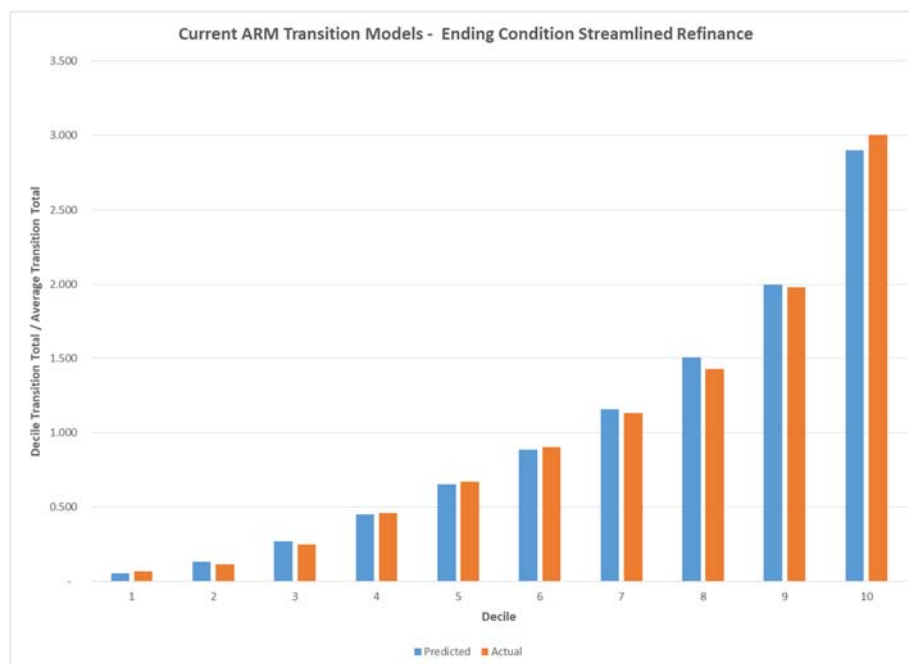
Default FRM30 Transition Models

The validation charts by ending condition for the FRM30 model are shown below.

Figure 31: Default FRM30 Transition Model Validation - Ending Condition Claim
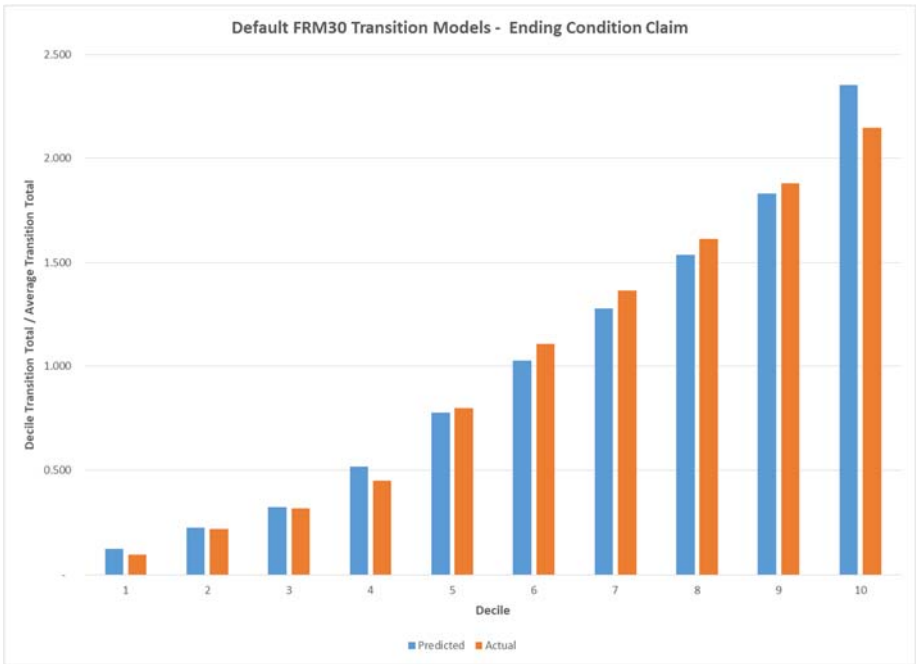
Figure 32: Default FRM30 Transition Model Validation - Ending Condition Default
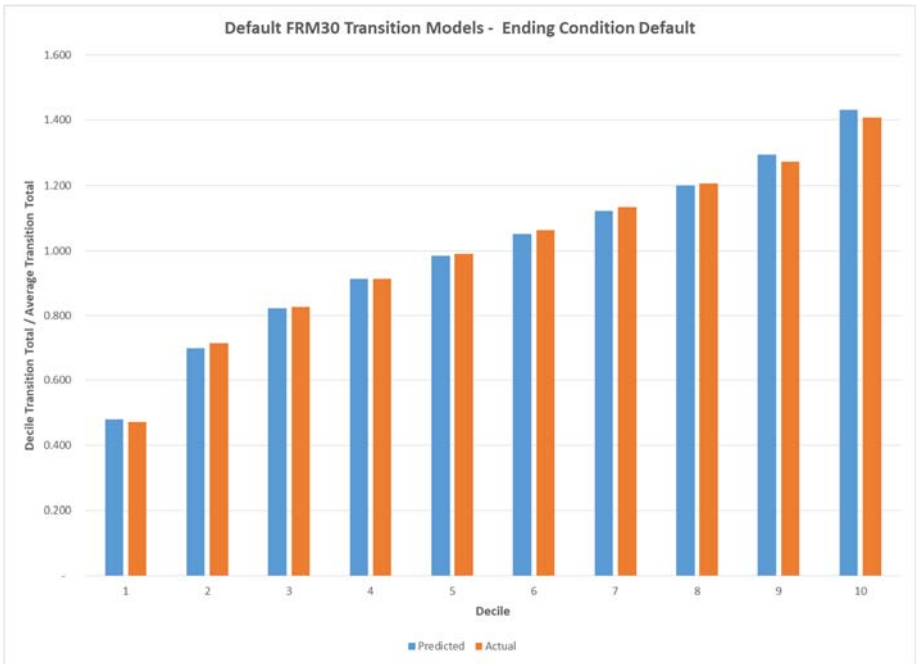
Figure 33: Default FRM30 Transition Model Validation - Ending Condition Cure with Modification
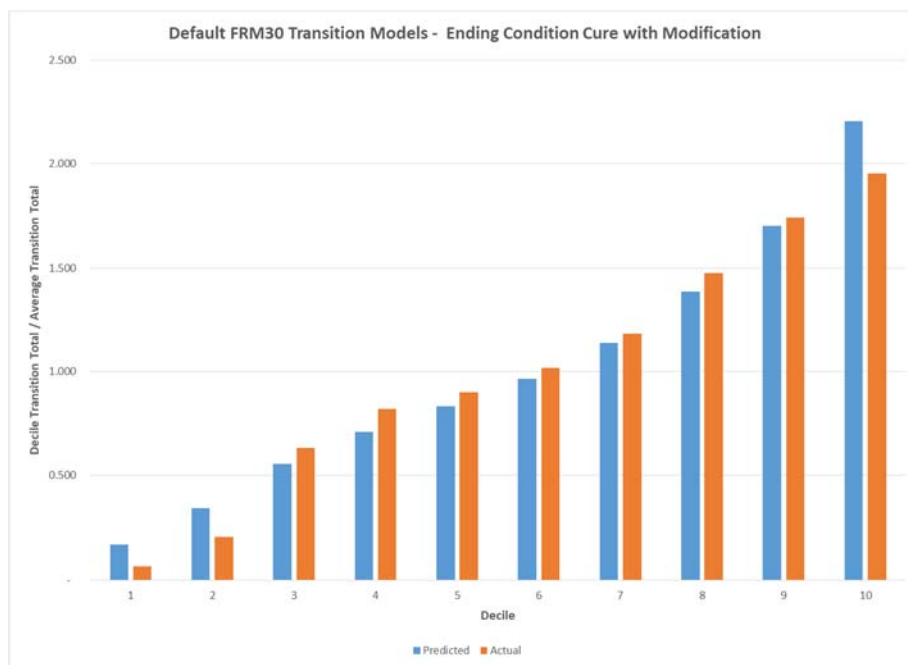
Figure 34: Default FRM30 Transition Model Validation - Ending Condition Self-Cure
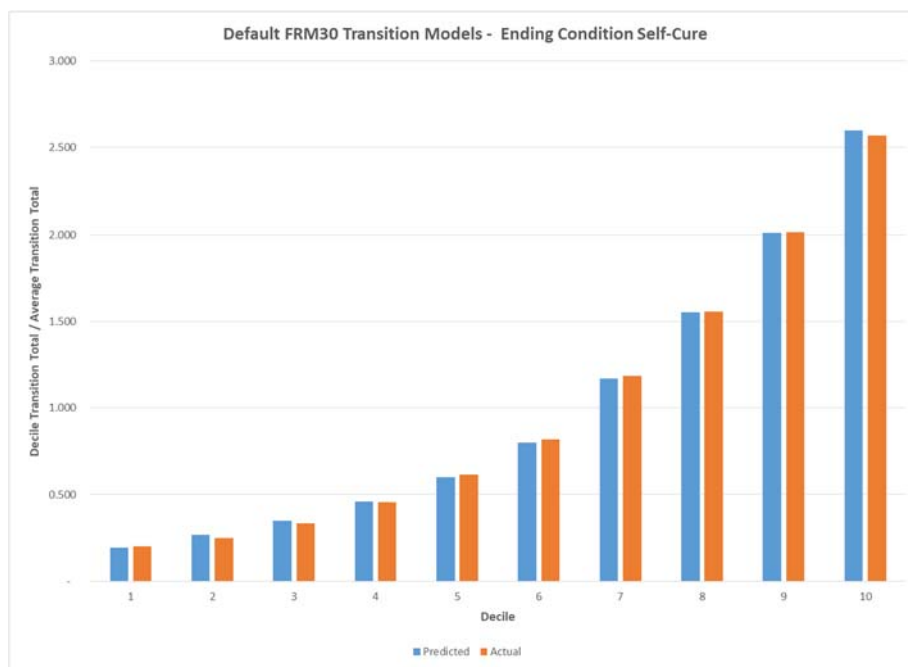
Figure 35: Default FRM30 Transition Model Validation - Ending Condition Refinance
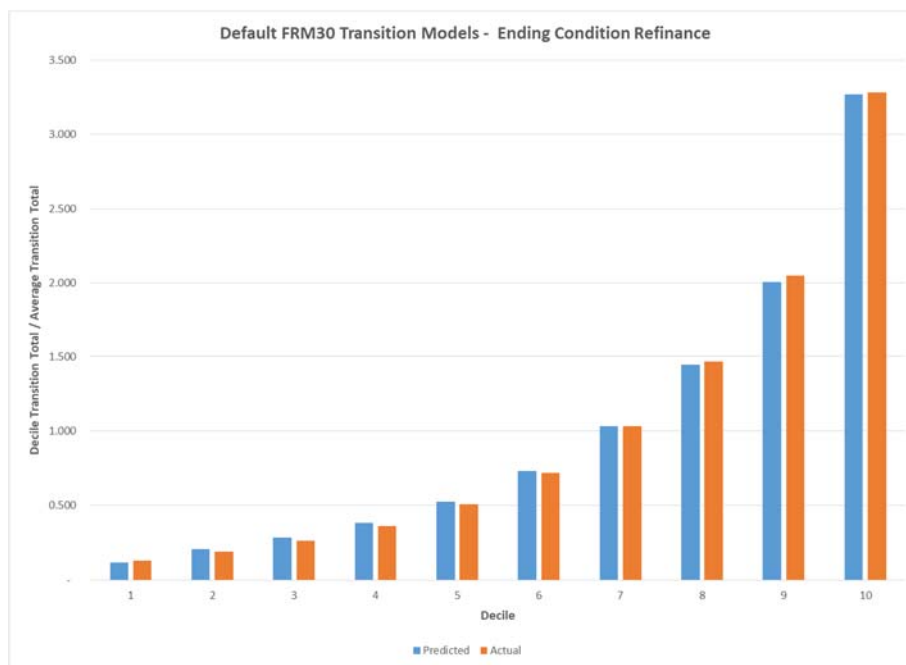
Default FRM15 Transition Models

The validation charts by ending condition for the FRM15 model are shown below.

Figure 36: Default FRM15 Transition Model Validation - Ending Condition Claim
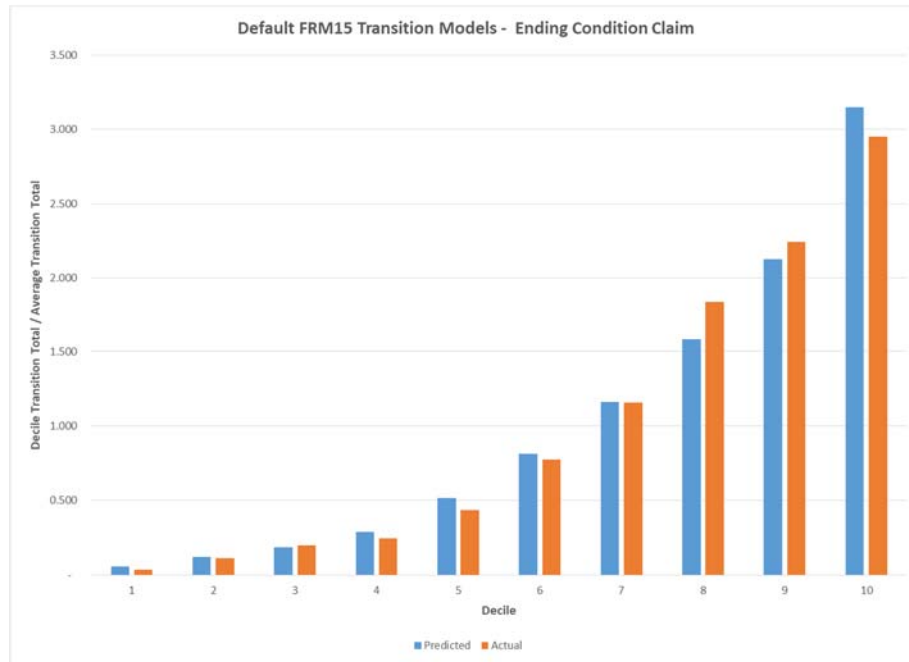
Figure 37: Default FRM15 Transition Model Validation - Ending Condition Default
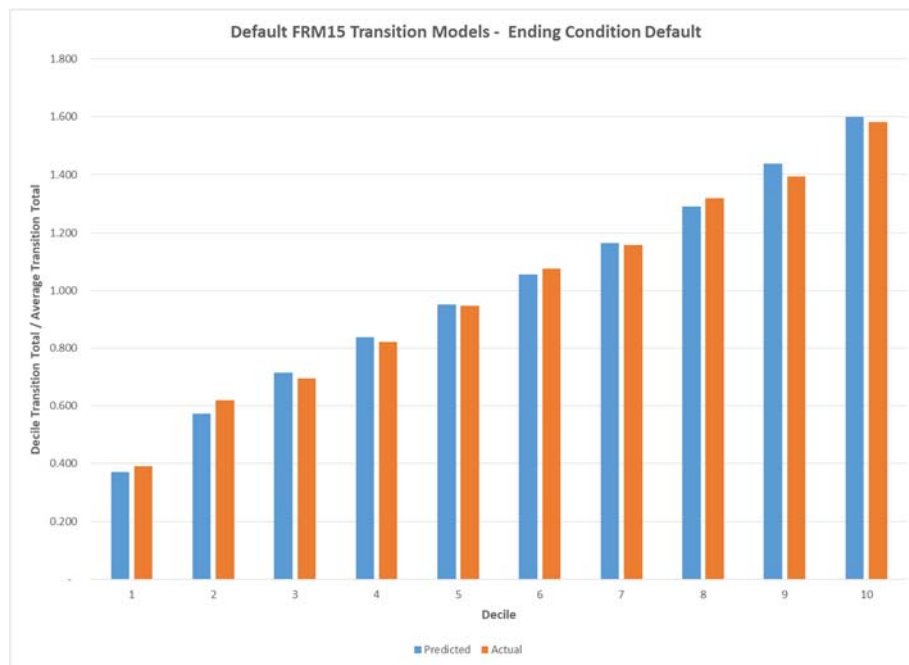
Figure 38: Default FRM15 Transition Model Validation - Ending Condition Cure with Modification
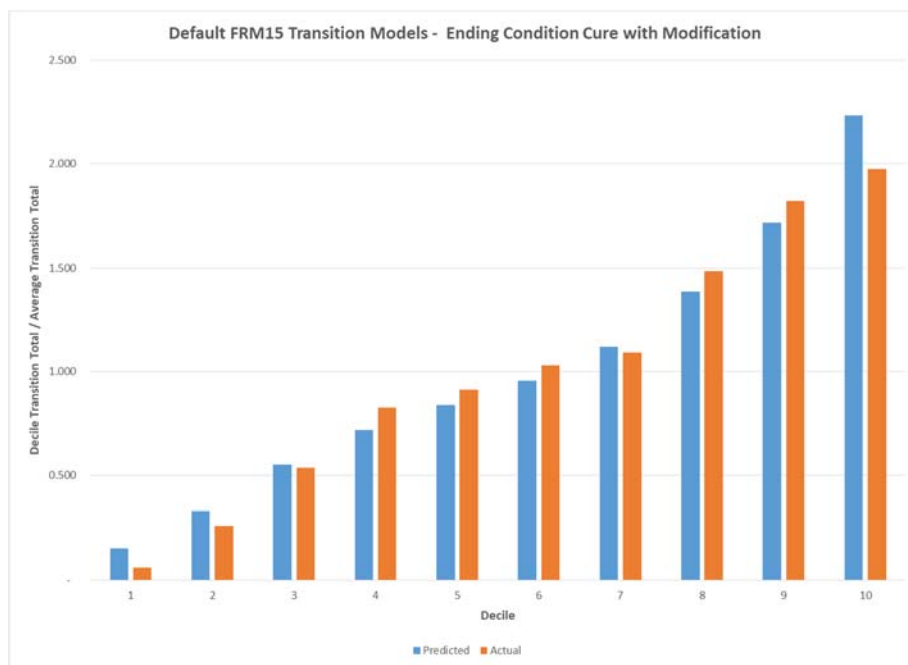
Figure 39: Default FRM15 Transition Model Validation - Ending Condition Self-Cure
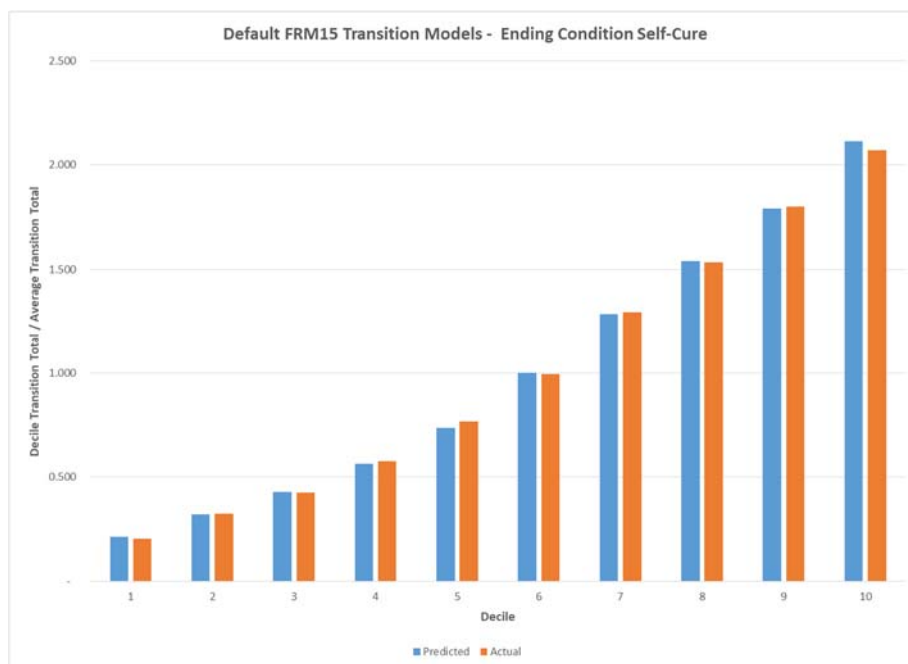
Figure 40: Default FRM15 Transition Model Validation - Ending Condition Refinance
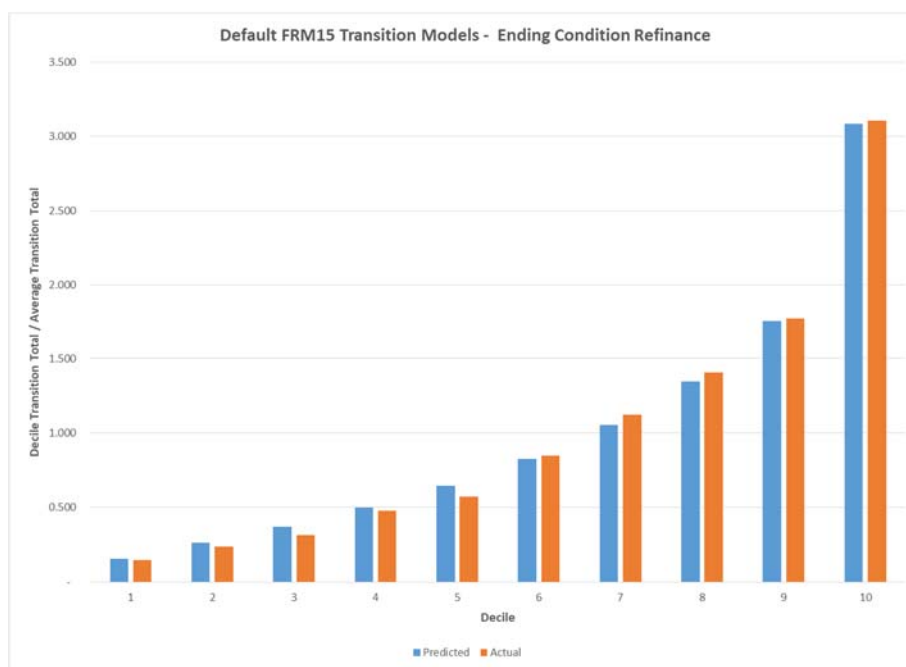
Default ARM Transition Models

The validation charts by ending condition for the ARM model are shown below.

Figure 41: Default ARM Transition Model Validation - Ending Condition Claim
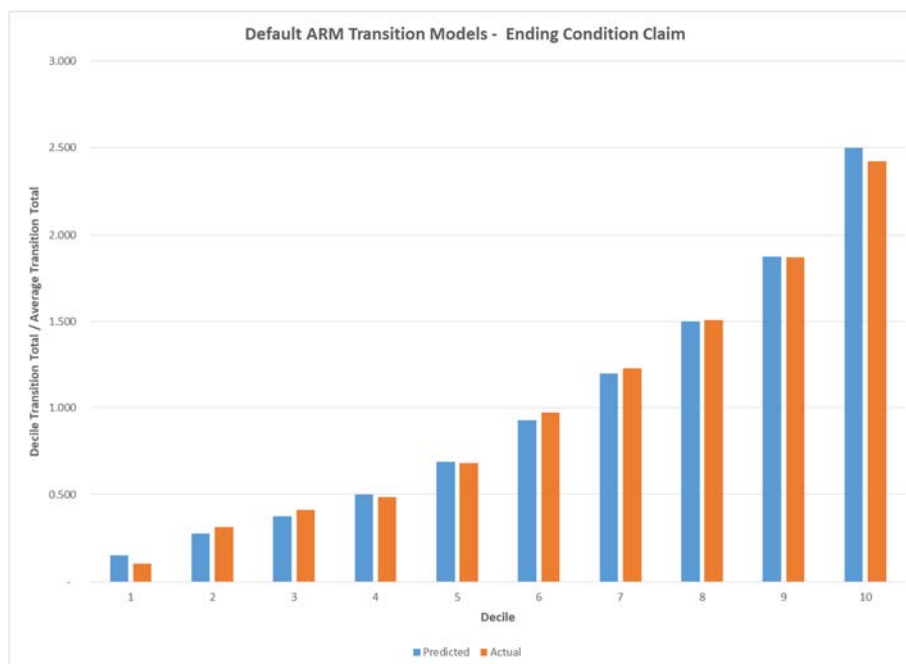
Figure 42: Default ARM Transition Model Validation - Ending Condition Default
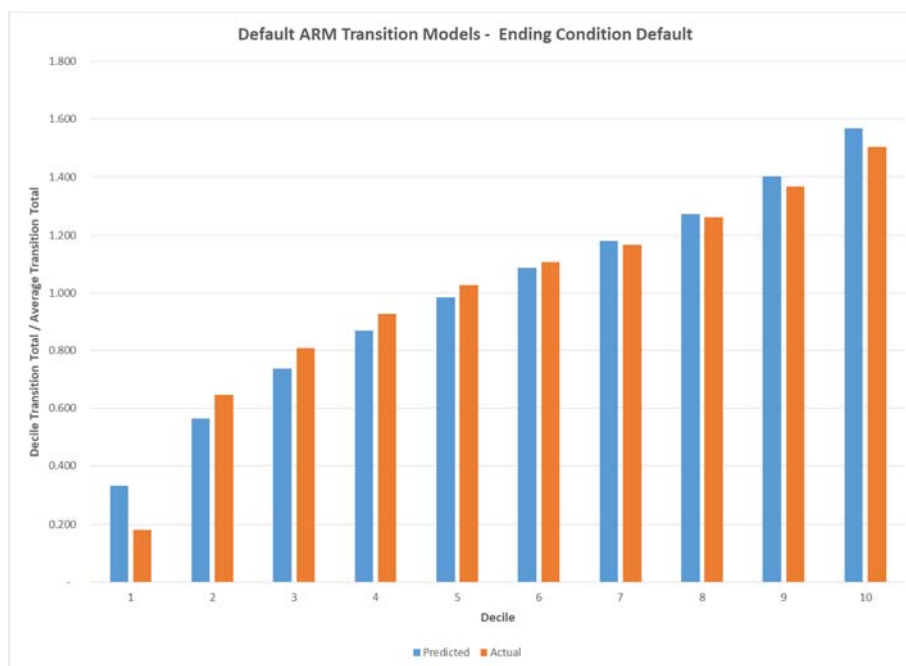
Figure 43: Default ARM Transition Model Validation - Ending Condition Cure with Modification
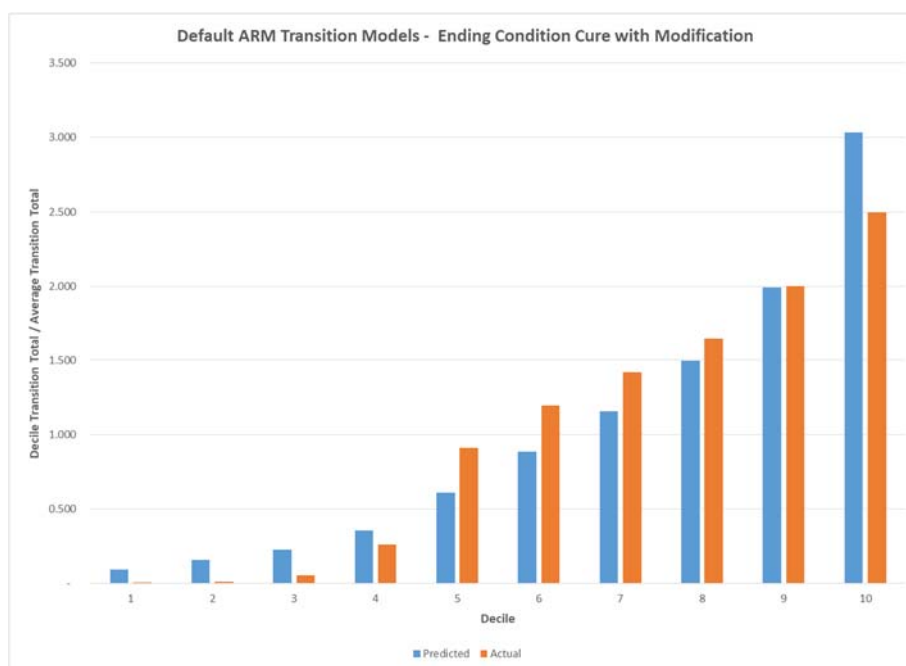
Figure 44: Default ARM Transition Model Validation - Ending Condition Self-Cure
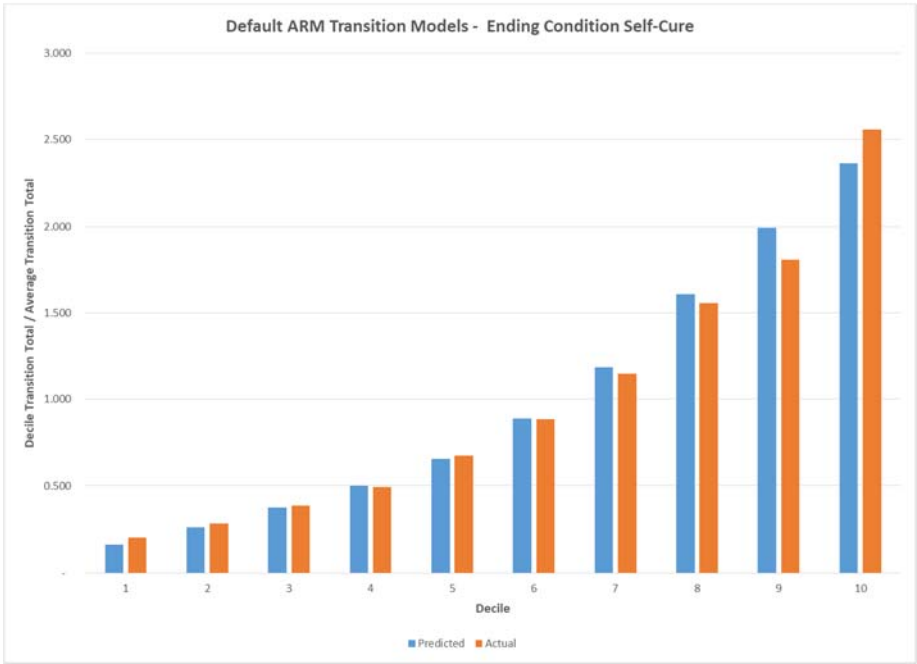
Figure 45: Default ARM Transition Model Validation - Ending Condition Refinance
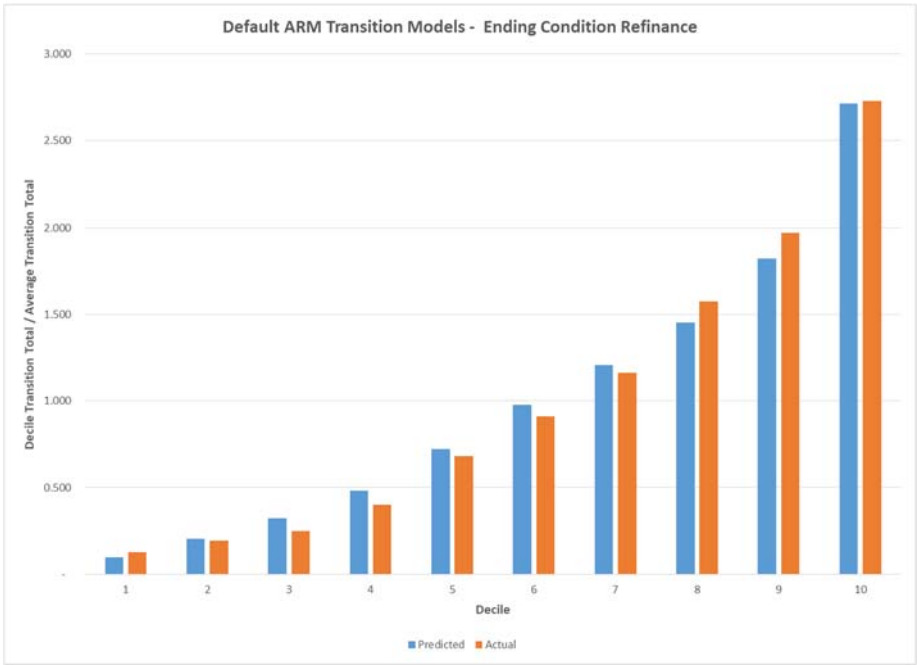
Appendix C: Loss Severity Models

This appendix describes the loss severity models used in this analysis. One of the primary sources of variation in the MMIF 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 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 real estate owned, or 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 as a result of the mortgage default; and
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 in order 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 38 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. This is 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%. Since then, the percentage of PFS has decreased to under 9%.

There was a significant volume of note (non-performing mortgage) sales from claim fiscal year 2003 through claim fiscal year 2006. From claim fiscal year 2007 to claim fiscal year 2012, there were few 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. For forecasting purposes, we use a note sale override to incorporate recent note sale transactions. 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 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.

Table 38: Percentage of Claim Termination Types by Fiscal Claim Year

Claim Year	Conveyance (REO)	Note Sales	Third Party Sales (TPS)	Pre Foreclosure Sale (PFS)
1999	94.87%	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	83.30%	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%	6.83%
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%	23.85%
2013	56.74%	17.65%	6.87%	18.74%
2014	42.70%	27.28%	15.39%	14.63%
2015	54.36%	16.27%	18.16%	11.21%
2016	50.65%	11.77%	27.73%	9.84%
2017	40.14%	6.49%	44.47%	8.89%
2018	49.17%	0.03%	42.23%	8.57%

Table 39 shows the average net loss for the combined foreclosure (REO and TPS) and PFS claims by claim fiscal year for 1991 to 2018. 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 has decreased.

Table 39: Historical Average Net Loss

Claim Year	Average Net Loss
1991	61,076
1992	62,675
1993	65,877
1994	68,629
1995	70,921
1996	73,613
1997	78,308
1998	81,260
1999	84,223
2000	85,865
2001	87,042
2002	88,196
2003	91,631
2004	94,027
2005	96,584
2006	97,913
2007	101,695
2008	109,991
2009	118,359
2010	128,359
2011	129,458
2012	129,632
2013	134,766
2014	133,345
2015	125,269
2016	117,565
2017	99,868
2018	93,927

Net Loss Severity Model Specification

As described above, there are several components of the total loss amount, and each component is influenced by a number of 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 period 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 38, 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 has been lengthened and foreclosure claims have been delayed, while the PFS process has remained relatively stable. From fiscal year 2009 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 gross loss severity conditional on claim being an REO, TPS or PFS claim
3. Model of recovery amount conditional on claim being a foreclosure REO claim

The net loss severity model follows the flowchart in Figure 46.

Figure 46: Net Loss Severity Model Structure
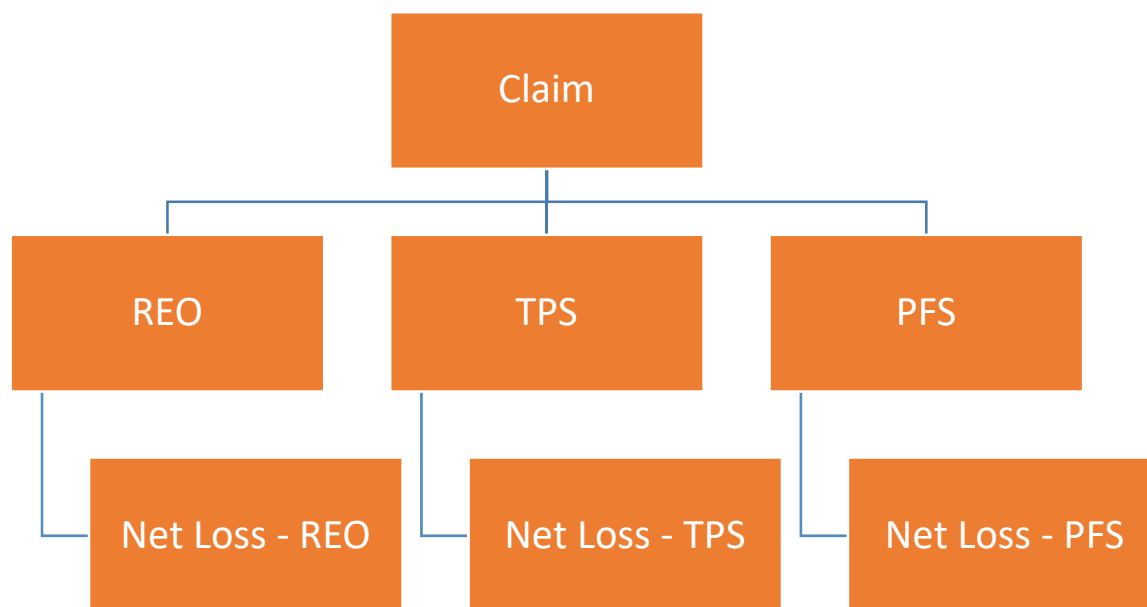
First, we estimate the probability that a claim is settled by the REO, TPS, or PFS process. To model the first-stage choice event, we used a multinomial logistic model to estimate the probability of the claim settlement type.

Second, we estimate the gross loss severity 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 gross 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 as a way 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 MMIF is the expected value of net loss of the different claim types:

$$\text{Net Loss} = Probability\ of\ REO * (\text{GrossLoss}_{REO} - \text{Recovery}) + Probablity\ of\ TPS * \text{NetLoss}_{TPS}$$
$$+ Probablity\ of\ PFS * \text{NetLoss}_{PFS}$$

The probabilities of REO, TPS or PFS are predicted from the multinomial loss selection model. The GrossLoss_{REO}, NetLoss_{PFS}, NetLoss_{TPS} and Recovery are predicted from the loss severity models described above.

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 second quarter of fiscal year 2018. In total, there are over 2.6 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 a second random sample 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 assist, 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

The explanatory variables used in the loss severity model are the same as those used in the mortgage status transition models.

Model Parameters

Loss Mitigation Binomial Model

The model parameters for the binomial model to estimate whether a claim is a HAMP claim are below.

Table 40: Loss Mitigation Binomial Model Parameters

Parameter		starget_type	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		HAMP	1	-9.8861	0.5409	334.0339	<.0001
credit_score_group	0	HAMP	1	0.1244	0.0476	6.8347	0.0089
credit_score_group	5	HAMP	1	-0.1457	0.0528	7.6142	0.0058
credit_score_group	6	HAMP	1	-0.2261	0.0432	27.4094	<.0001
credit_score_group	7	HAMP	1	-0.1851	0.0433	18.2334	<.0001
Vloansize_raw_grp		HAMP	1	0.00266	0.000083	1036.6879	<.0001
prior_default_cnt_grp	1-2	HAMP	1	0.0411	0.0147	7.8119	0.0052
prior_default_cnt_grp	3+	HAMP	1	-0.0884	0.0204	18.7343	<.0001
prior_modific_cnt_grp	1-2	HAMP	1	0.2465	0.0156	248.5442	<.0001
prior_modific_cnt_grp	3+	HAMP	1	0.4935	0.0287	295.1552	<.0001
Season	fall	HAMP	1	0.1508	0.0143	110.7779	<.0001
Season	spring	HAMP	1	0.131	0.015	76.1185	<.0001
Season	summer	HAMP	1	-0.00736	0.015	0.2398	0.6244
State	AL	HAMP	1	-0.2557	0.0429	35.5091	<.0001
State	AR	HAMP	1	-0.1727	0.0584	8.7306	0.0031
State	AZ	HAMP	1	-0.1299	0.0437	8.8503	0.0029
State	CA	HAMP	1	0.1926	0.0312	38.041	<.0001
State	CO	HAMP	1	-0.0594	0.0465	1.6337	0.2012
State	CT	HAMP	1	0.2958	0.0469	39.7605	<.0001
State	FL	HAMP	1	0.11	0.0277	15.7014	<.0001
State	GA	HAMP	1	0.0324	0.0266	1.4761	0.2244
State	IA	HAMP	1	-0.371	0.066	31.5864	<.0001
State	ID	HAMP	1	0.2849	0.08	12.6935	0.0004
State	IL	HAMP	1	0.04	0.029	1.8987	0.1682
State	IN	HAMP	1	-0.4495	0.0348	167.0551	<.0001
State	KS	HAMP	1	-0.1463	0.0633	5.3396	0.0208
State	KY	HAMP	1	-0.00404	0.0488	0.0068	0.9341
State	LA	HAMP	1	-0.1432	0.0418	11.7502	0.0006
State	MD	HAMP	1	-0.0677	0.0327	4.2859	0.0384
State	ME	HAMP	1	0.2044	0.1068	3.6648	0.0556
State	MI	HAMP	1	-0.2099	0.0375	31.3598	<.0001
State	MN	HAMP	1	-0.219	0.0502	19.0411	<.0001

Parameter		starget_type	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	MO	HAMP	1	-0.2314	0.0407	32.2855	<.0001
State	MS	HAMP	1	-0.2089	0.0586	12.7004	0.0004
State	Mid_Atlntc	HAMP	1	-0.2785	0.0533	27.2988	<.0001
State	Mtn_Wst	HAMP	1	-0.0464	0.072	0.4156	0.5191
State	NC	HAMP	1	-0.0292	0.0319	0.8367	0.3603
State	NE	HAMP	1	-0.3754	0.0839	20.0389	<.0001
State	NJ	HAMP	1	0.279	0.0319	76.6825	<.0001
State	NM	HAMP	1	-0.0186	0.0621	0.0897	0.7646
State	NV	HAMP	1	0.0867	0.0588	2.1766	0.1401
State	NY	HAMP	1	0.0817	0.0305	7.173	0.0074
State	Nw_Engld	HAMP	1	-0.0167	0.0417	0.1598	0.6893
State	OH	HAMP	1	-0.2349	0.0299	61.9121	<.0001
State	OK	HAMP	1	-0.1369	0.0496	7.6228	0.0058
State	OR	HAMP	1	0.0844	0.0703	1.4384	0.2304
State	PA	HAMP	1	-0.1658	0.0287	33.3281	<.0001
State	SC	HAMP	1	-0.19	0.0443	18.4183	<.0001
State	TN	HAMP	1	-0.0767	0.0376	4.1675	0.0412
State	UT	HAMP	1	-0.088	0.0518	2.8887	0.0892
State	VA	HAMP	1	-0.0658	0.0356	3.4055	0.065
State	WA	HAMP	1	0.0303	0.048	0.3977	0.5283
State	WI	HAMP	1	-0.136	0.0533	6.5118	0.0107
State	isld	HAMP	1	0.2841	0.0512	30.7513	<.0001
Mproduct	ARM	HAMP	1	-0.0144	0.0461	0.0975	0.7548
Mproduct	ARMSR	HAMP	1	0.5574	0.0719	60.1386	<.0001
Mproduct	FRM15	HAMP	1	-1.1331	0.0546	430.7821	<.0001
Mproduct	FRM15SR	HAMP	1	-0.4934	0.106	21.6549	<.0001
Mproduct	FRM30SR	HAMP	1	0.5775	0.0274	443.6667	<.0001
Debt to Income Ratio	z_VALID	HAMP	1	0.036	0.00066	2981.8227	<.0001
Spread at Origination		HAMP	1	-0.1592	0.0115	191.5476	<.0001
Down payment assist	govt	HAMP	1	0.0324	0.0364	0.7926	0.3733
Down payment assist	non-profit	HAMP	1	0.0276	0.0217	1.6182	0.2033
Down payment assist	relative	HAMP	1	-0.0398	0.015	7.0445	0.008
Period Piecewise1		HAMP	1	1.5465	0.09	295.1752	<.0001
Period Piecewise2		HAMP	1	-0.0633	0.00127	2474.579	<.0001
Period Piecewise3		HAMP	1	-0.0336	0.00178	357.6565	<.0001
Period Piecewise4		HAMP	1	-0.0166	0.00175	90.4576	<.0001
Mcohort_group	08to13	HAMP	1	0.5616	0.0228	604.3654	<.0001
Mcohort_group	96to07	HAMP	1	0.8523	0.0358	566.3549	<.0001

Parameter		starget_type	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Mcohort_group	pre96	HAMP	1	0.9597	0.0764	157.7266	<.0001

Loss Mitigation HAMP Severity Model

The model parameters for the HAMP claim severity model are shown below.

Table 41: Loss Mitigation HAMP Severity Model Parameters

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	5.423	0.0359	5.3527	5.4933	22853.6	<.0001
Unpaid Balance (log)		1	0.9735	0.0057	0.9623	0.9848	28992.8	<.0001
Down payment assist	govt	1	0.0191	0.0164	-0.013	0.0512	1.36	0.2431
Down payment assist	non-profit	1	-0.0327	0.0106	-0.0534	-0.012	9.6	0.0019
Down payment assist	relative	1	-0.0146	0.0066	-0.0274	-0.0017	4.91	0.0267
Down payment assist	z_na_other	0	0	0	0	0	.	.
Episode Duration 20+	yes	1	-0.2253	0.0223	-0.2691	-0.1815	101.61	<.0001
Episode Duration 20+	z_no	0	0	0	0	0	.	.
Number of Units	2+	1	0.0835	0.0155	0.0531	0.1139	29	<.0001
Number of Units	z_1	0	0	0	0	0	.	.
Mproduct	ARM	1	0.0421	0.0168	0.0092	0.075	6.29	0.0121
Mproduct	ARMSR	1	0.1519	0.0286	0.0959	0.2078	28.29	<.0001
Mproduct	FRM15	1	0.1377	0.0302	0.0786	0.1969	20.83	<.0001
Mproduct	FRM15SR	1	0.6069	0.058	0.4932	0.7206	109.43	<.0001
Mproduct	FRM30SR	1	0.1214	0.0133	0.0954	0.1475	83.76	<.0001
Mproduct	z_FRM30	0	0	0	0	0	.	.
Refinance indicator	Y	1	-0.0266	0.0073	-0.0409	-0.0122	13.13	0.0003
Refinance indicator	z_N	0	0	0	0	0	.	.
Season	fall	1	-0.0196	0.0064	-0.0322	-0.007	9.28	0.0023
Season	spring	1	-0.0221	0.0065	-0.0349	-0.0093	11.47	0.0007
Season	summer	1	0.0058	0.0067	-0.0073	0.0189	0.76	0.3846
Season	z_winter	0	0	0	0	0	.	.
State	AL	1	-0.1704	0.0209	-0.2114	-0.1295	66.49	<.0001
State	AR	1	-0.187	0.0282	-0.2423	-0.1317	43.91	<.0001
State	AZ	1	-0.1306	0.0194	-0.1686	-0.0925	45.32	<.0001
State	CA	1	0.0408	0.0122	0.0168	0.0647	11.11	0.0009
State	CO	1	-0.0564	0.0198	-0.0952	-0.0175	8.08	0.0045
State	CT	1	0.0388	0.0183	0.0029	0.0747	4.48	0.0342
State	FL	1	0.0132	0.0122	-0.0107	0.037	1.17	0.279

State								
State	GA	1	-0.0682	0.0121	-0.0919	-0.0446	31.89	<.0001
State	IA	1	-0.0569	0.0326	-0.1207	0.007	3.05	0.0809
State	ID	1	-0.1235	0.0332	-0.1885	-0.0585	13.87	0.0002
State	IL	1	0.0433	0.0128	0.0182	0.0684	11.43	0.0007
State	IN	1	-0.1372	0.0174	-0.1713	-0.1031	62.19	<.0001
State	KS	1	-0.1062	0.0299	-0.1647	-0.0476	12.62	0.0004
State	KY	1	-0.1572	0.0227	-0.2017	-0.1128	48.08	<.0001
State	LA	1	-0.0227	0.0198	-0.0614	0.0161	1.31	0.2517
State	MD	1	-0.0358	0.0138	-0.0629	-0.0088	6.76	0.0093
State	ME	1	-0.0025	0.0443	-0.0893	0.0843	0	0.9546
State	MI	1	-0.0776	0.018	-0.1129	-0.0424	18.64	<.0001
State	MN	1	-0.0465	0.0222	-0.09	-0.0031	4.4	0.0359
State	MO	1	-0.0932	0.0195	-0.1313	-0.0551	22.95	<.0001
State	MS	1	-0.0873	0.0285	-0.1431	-0.0316	9.42	0.0021
State	Mid_Atlntc	1	-0.1105	0.0242	-0.1579	-0.063	20.78	<.0001
State	Mtn_Wst	1	-0.0835	0.0314	-0.145	-0.0219	7.06	0.0079
State	NC	1	-0.1041	0.0146	-0.1328	-0.0754	50.62	<.0001
State	NE	1	-0.0557	0.0412	-0.1364	0.025	1.83	0.1763
State	NJ	1	0.0647	0.0128	0.0396	0.0898	25.5	<.0001
State	NM	1	-0.046	0.028	-0.1009	0.009	2.69	0.1009
State	NV	1	-0.0498	0.0244	-0.0976	-0.002	4.17	0.0412
State	NY	1	0.0495	0.0129	0.0242	0.0748	14.7	0.0001
State	Nw_Engld	1	-0.0288	0.0171	-0.0623	0.0048	2.82	0.093
State	OH	1	-0.0389	0.0143	-0.067	-0.0108	7.36	0.0067
State	OK	1	-0.0645	0.0239	-0.1113	-0.0178	7.31	0.0068
State	OR	1	0.0001	0.0288	-0.0563	0.0566	0	0.996
State	PA	1	0	0.0133	-0.0261	0.0261	0	0.9992
State	SC	1	-0.1138	0.0208	-0.1544	-0.0731	30.05	<.0001
State	TN	1	-0.0886	0.0175	-0.123	-0.0542	25.48	<.0001
State	UT	1	-0.0341	0.022	-0.0772	0.009	2.41	0.1208
State	VA	1	-0.0798	0.0154	-0.11	-0.0497	26.96	<.0001
State	WA	1	-0.0206	0.0197	-0.0592	0.018	1.09	0.2962
State	WI	1	-0.021	0.0245	-0.0689	0.027	0.73	0.3914
State	isld	1	-0.0979	0.0219	-0.1408	-0.055	20.01	<.0001
State	z_TX	0	0	0	0	0	.	.
Duration of Default Episode		1	0.0282	0.0007	0.0269	0.0295	1830.81	<.0001
Debt to Income Ratio	z_VALID	1	0.0065	0.0003	0.006	0.007	566.19	<.0001
Debt to Income Ratio	0	0	0	0	0	0	.	.
credit_score_group	0	1	0.0318	0.0187	-0.0049	0.0684	2.88	0.0895
credit_score_group	5	1	-0.0631	0.0223	-0.1068	-0.0193	7.98	0.0047
credit_score_group	6	1	-0.0579	0.0169	-0.091	-0.0248	11.76	0.0006

credit_score_group	7	1	-0.0181	0.0169	-0.0511	0.0149	1.15	0.2828
credit_score_group	8	0	0	0	0	0	0	.	.
Mcohort_group	08to13	1	-0.1614	0.0077	-0.1766	-0.1463	435.96	<.0001
Mcohort_group	96to07	1	-0.0931	0.0124	-0.1174	-0.0688	56.35	<.0001
Mcohort_group	pre96	1	0.5644	0.037	0.4919	0.6369	232.75	<.0001
Mcohort_group	z_post13	0	0	0	0	0	0	.	.
prior_default_cnt_grp	1-2	1	-0.0175	0.0063	-0.0299	-0.0051	7.6	0.0058
prior_default_cnt_grp	3+	1	-0.0379	0.0096	-0.0567	-0.0191	15.62	<.0001
prior_default_cnt_grp	z_0	0	0	0	0	0	0	.	.
prior_modific_cnt_grp	1-2	1	-0.0637	0.0072	-0.0778	-0.0496	78.41	<.0001
prior_modific_cnt_grp	3+	1	-0.0723	0.0139	-0.0995	-0.0452	27.23	<.0001
prior_modific_cnt_grp	z_0	0	0	0	0	0	0	.	.
Mortgage Spread	1	1	-0.0146	0.0033	-0.0211	-0.0081	19.49	<.0001
Spread at Origination		1	0.0161	0.006	0.0043	0.0278	7.16	0.0074
Yield Curve Slope	1	1	-0.0021	0.0006	-0.0033	-0.0008	10.43	0.0012
Scale		1	2.2888	0.0106	2.2681	2.3096		

Claims Logistic Model

The model parameters for the multinomial model to predict the claim type are shown below.

Table 42: Claims Logistic Model Parameters

Parameter		starget_type3	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		PRE	1	1.3525	0.1759	59.1243	<.0001
Intercept		TPS	1	-0.6797	0.433	2.464	0.1165
credit_score_group	0	PRE	1	-0.7757	0.0278	777.6915	<.0001
credit_score_group	0	TPS	1	-1.2603	0.0343	1347.5562	<.0001
credit_score_group	5	PRE	1	-0.9792	0.0348	791.6973	<.0001
credit_score_group	5	TPS	1	-0.6502	0.0413	247.6532	<.0001
credit_score_group	6	PRE	1	-0.8238	0.0248	1101.3017	<.0001
credit_score_group	6	TPS	1	-0.4688	0.0314	222.3315	<.0001
credit_score_group	7	PRE	1	-0.4514	0.0248	331.3032	<.0001
credit_score_group	7	TPS	1	-0.1759	0.0316	30.9375	<.0001
Vloansize_raw_grp		PRE	1	0.00789	0.00008	9778.1315	<.0001
Vloansize_raw_grp		TPS	1	0.00447	0.000098	2076.8213	<.0001
prior_default_cnt_grp	1-2	PRE	1	-0.4549	0.015	918.9785	<.0001
prior_default_cnt_grp	1-2	TPS	1	-0.0995	0.0141	49.5065	<.0001
prior_default_cnt_grp	3+	PRE	1	-0.4627	0.027	294.649	<.0001
prior_default_cnt_grp	3+	TPS	1	-0.1856	0.0213	75.6784	<.0001
prior_modific_cnt_grp	1-2	PRE	1	0.5513	0.0182	914.5016	<.0001

Parameter		starget_type3	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
prior_modific_cnt_grp	1-2	TPS	1	0.2738	0.0162	285.227	<.0001
prior_modific_cnt_grp	3+	PRE	1	1.0033	0.0477	442.4375	<.0001
prior_modific_cnt_grp	3+	TPS	1	0.6682	0.036	344.8963	<.0001
loan to value ratio	65-99	PRE	1	-0.1532	0.0129	141.1873	<.0001
loan to value ratio	65-99	TPS	1	-0.0711	0.0141	25.4878	<.0001
loan to value ratio	lt65	PRE	1	-0.4159	0.1448	8.246	0.0041
loan to value ratio	lt65	TPS	1	-1.0015	0.1031	94.3327	<.0001
Season	fall	PRE	1	0.2071	0.0135	236.1251	<.0001
Season	fall	TPS	1	0.142	0.0147	92.8752	<.0001
Season	spring	PRE	1	0.2389	0.0133	324.1205	<.0001
Season	spring	TPS	1	0.179	0.0146	151.0015	<.0001
Season	summer	PRE	1	0.2254	0.0134	283.7747	<.0001
Season	summer	TPS	1	0.2579	0.0144	319.2625	<.0001
State	AL	PRE	1	-0.982	0.0515	363.4506	<.0001
State	AL	TPS	1	-0.4651	0.0358	168.4427	<.0001
State	AR	PRE	1	-0.3121	0.0577	29.2903	<.0001
State	AR	TPS	1	-0.565	0.0519	118.4144	<.0001
State	AZ	PRE	1	0.3826	0.0277	191.4062	<.0001
State	AZ	TPS	1	0.0611	0.033	3.4433	0.0635
State	CA	PRE	1	0.1156	0.0286	16.3655	<.0001
State	CA	TPS	1	-0.9253	0.0401	533.6894	<.0001
State	CO	PRE	1	0.2029	0.0312	42.248	<.0001
State	CO	TPS	1	-0.9588	0.0494	377.207	<.0001
State	CT	PRE	1	0.1962	0.0446	19.3433	<.0001
State	CT	TPS	1	-2.6555	0.0968	752.5058	<.0001
State	FL	PRE	1	1.0848	0.0251	1863.2988	<.0001
State	FL	TPS	1	0.246	0.0261	89.0596	<.0001
State	GA	PRE	1	0.0839	0.0255	10.8056	0.001
State	GA	TPS	1	0.1161	0.0243	22.8716	<.0001
State	IA	PRE	1	0.1355	0.061	4.9416	0.0262
State	IA	TPS	1	0.1185	0.0528	5.0278	0.0249
State	ID	PRE	1	0.6117	0.0465	173.1487	<.0001
State	ID	TPS	1	-0.2922	0.0655	19.9108	<.0001
State	IL	PRE	1	0.3563	0.0282	159.5777	<.0001
State	IL	TPS	1	-0.1273	0.0281	20.592	<.0001
State	IN	PRE	1	-0.00651	0.0344	0.0358	0.85
State	IN	TPS	1	0.0891	0.0294	9.1931	0.0024
State	KS	PRE	1	-0.0626	0.0517	1.4647	0.2262
State	KS	TPS	1	-1.7926	0.0808	491.9231	<.0001

Parameter		starget_type3	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	KY	PRE	1	-0.0479	0.0459	1.0898	0.2965
State	KY	TPS	1	-0.7609	0.0489	242.4506	<.0001
State	LA	PRE	1	-0.4377	0.0615	50.5869	<.0001
State	LA	TPS	1	-0.6743	0.0509	175.2139	<.0001
State	MD	PRE	1	0.2051	0.036	32.5116	<.0001
State	MD	TPS	1	-0.8184	0.0417	384.3137	<.0001
State	ME	PRE	1	0.8415	0.0876	92.23	<.0001
State	ME	TPS	1	-0.9742	0.1279	58.0386	<.0001
State	MI	PRE	1	0.0224	0.0279	0.645	0.4219
State	MI	TPS	1	-0.6375	0.0297	461.4009	<.0001
State	MN	PRE	1	-0.0805	0.0386	4.3515	0.037
State	MN	TPS	1	-0.9347	0.0498	352.2602	<.0001
State	MO	PRE	1	-0.0585	0.0334	3.0662	0.0799
State	MO	TPS	1	-0.2928	0.033	78.8743	<.0001
State	MS	PRE	1	-0.776	0.0706	120.7062	<.0001
State	MS	TPS	1	-0.472	0.0512	85.1143	<.0001
State	Mid_Atlntc	PRE	1	0.2999	0.058	26.7736	<.0001
State	Mid_Atlntc	TPS	1	-0.635	0.0682	86.8067	<.0001
State	Mtn_Wst	PRE	1	-0.6419	0.0613	109.7824	<.0001
State	Mtn_Wst	TPS	1	-1.7305	0.0871	394.7674	<.0001
State	NC	PRE	1	-0.2091	0.0354	34.812	<.0001
State	NC	TPS	1	-0.0337	0.0307	1.2011	0.2731
State	NE	PRE	1	0.201	0.0733	7.5245	0.0061
State	NE	TPS	1	-0.41	0.0798	26.3747	<.0001
State	NJ	PRE	1	1.0959	0.0375	856.1644	<.0001
State	NJ	TPS	1	-0.1665	0.0418	15.8414	<.0001
State	NM	PRE	1	0.2836	0.0571	24.6378	<.0001
State	NM	TPS	1	-0.6039	0.065	86.3455	<.0001
State	NV	PRE	1	0.87	0.035	616.2378	<.0001
State	NV	TPS	1	0.0476	0.0456	1.0902	0.2964
State	NY	PRE	1	1.1245	0.043	684.7055	<.0001
State	NY	TPS	1	-0.1362	0.0439	9.6282	0.0019
State	Nw_Engld	PRE	1	0.4751	0.041	134.1372	<.0001
State	Nw_Engld	TPS	1	-0.9439	0.0587	258.8017	<.0001
State	OH	PRE	1	0.1205	0.0284	18.0113	<.0001
State	OH	TPS	1	-0.4491	0.0278	261.4998	<.0001
State	OK	PRE	1	-0.0125	0.0468	0.0708	0.7901
State	OK	TPS	1	-0.4739	0.0443	114.3006	<.0001
State	OR	PRE	1	0.4521	0.0463	95.5074	<.0001

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| Parameter		starget_type3	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
State	OR	TPS	1	-1.0426	0.0748	194.5081	<.0001
State	PA	PRE	1	0.4032	0.0352	131.3723	<.0001
State	PA	TPS	1	-0.1625	0.033	24.2421	<.0001
State	SC	PRE	1	-0.0677	0.0494	1.879	0.1705
State	SC	TPS	1	-0.2379	0.0461	26.6848	<.0001
State	TN	PRE	1	-0.2764	0.0362	58.3183	<.0001
State	TN	TPS	1	-0.314	0.0328	91.8984	<.0001
State	UT	PRE	1	0.7724	0.0355	472.9665	<.0001
State	UT	TPS	1	-0.5888	0.0554	113.1288	<.0001
State	VA	PRE	1	-0.2854	0.0351	66.0039	<.0001
State	VA	TPS	1	-0.8759	0.0394	493.6141	<.0001
State	WA	PRE	1	-0.0997	0.0348	8.2192	0.0041
State	WA	TPS	1	-0.5877	0.0406	209.4317	<.0001
State	WI	PRE	1	-0.1386	0.0455	9.2836	0.0023
State	WI	TPS	1	-0.5998	0.0486	152.2084	<.0001
State	isld	PRE	1	-1.5852	0.1286	151.9782	<.0001
State	isld	TPS	1	-4.1435	0.2388	301.0996	<.0001
Mproduct	ARM	PRE	1	-0.4649	0.0351	175.1353	<.0001
Mproduct	ARM	TPS	1	0.2673	0.0393	46.1943	<.0001
Mproduct	ARMSR	PRE	1	0.0357	0.0458	0.608	0.4355
Mproduct	ARMSR	TPS	1	1.269	0.0572	492.2203	<.0001
Mproduct	FRM15	PRE	1	-0.3651	0.0607	36.2057	<.0001
Mproduct	FRM15	TPS	1	0.0995	0.0543	3.359	0.0668
Mproduct	FRM15SR	PRE	1	-0.2389	0.1189	4.039	0.0445
Mproduct	FRM15SR	TPS	1	0.8481	0.1066	63.3515	<.0001
Mproduct	FRM30SR	PRE	1	0.3511	0.0233	227.1989	<.0001
Mproduct	FRM30SR	TPS	1	1.2591	0.0252	2493.6503	<.0001
Refinance indicator	Y	PRE	1	-0.00433	0.02	0.0471	0.8282
Refinance indicator	Y	TPS	1	-0.1329	0.0228	33.8627	<.0001
Debt to Income Ratio	z_VALID	PRE	1	0.000856	0.000551	2.4177	0.12
Debt to Income Ratio	z_VALID	TPS	1	0.0068	0.000603	127.194	<.0001
Spread at Origination		PRE	1	-0.2522	0.0102	615.8912	<.0001
Spread at Origination		TPS	1	-0.0926	0.0103	80.2814	<.0001
Down payment assist	govt	PRE	1	0.0294	0.0366	0.6465	0.4214
Down payment assist	govt	TPS	1	0.0861	0.0363	5.6222	0.0177
Down payment assist	non-profit	PRE	1	-0.0697	0.0157	19.6815	<.0001
Down payment assist	non-profit	TPS	1	-0.0596	0.0171	12.211	0.0005
Down payment assist	relative	PRE	1	-0.00207	0.0175	0.014	0.9057
Down payment assist	relative	TPS	1	0.0987	0.0177	31.1523	<.0001

Parameter		starget_type3	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
First time buyer	N	PRE	1	0.0392	0.016	6.0347	0.014
First time buyer	N	TPS	1	-0.0997	0.0176	31.9636	<.0001
Period Piecewise1		PRE	1	-0.5026	0.0285	310.764	<.0001
Period Piecewise1		TPS	1	-0.0149	0.0723	0.0425	0.8367
Period Piecewise2		PRE	1	-0.027	0.000844	1021.5743	<.0001
Period Piecewise2		TPS	1	0.1287	0.00113	13020.0888	<.0001
Period Piecewise3		PRE	1	-0.00749	0.00137	29.8592	<.0001
Period Piecewise3		TPS	1	0.1015	0.0012	7171.7968	<.0001
Period Piecewise4		PRE	1	-0.014	0.00376	13.9795	0.0002
Period Piecewise4		TPS	1	0.0409	0.00167	597.5802	<.0001
Period Piecewise5		PRE	1	-0.0339	0.0142	5.6878	0.0171
Period Piecewise5		TPS	1	0.0585	0.0045	169.4415	<.0001
Mcohort_group	08to13	PRE	1	-0.00519	0.0405	0.0164	0.8981
Mcohort_group	08to13	TPS	1	-2.7635	0.0331	6957.4469	<.0001
Mcohort_group	96to07	PRE	1	-0.3765	0.0422	79.6426	<.0001
Mcohort_group	96to07	TPS	1	-4.8409	0.0374	16760.9858	<.0001
Mcohort_group	pre96	PRE	1	-0.7644	0.1447	27.8851	<.0001
Mcohort_group	pre96	TPS	1	-7.0521	0.0862	6686.2418	<.0001

Conveyance Severity Model

The model parameters for the Conveyance severity model are shown below.

Table 43: Conveyance Severity Model Parameters

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	7.3319	0.0027	7.3265	7.3373	7123776	<.0001
Prior_modific	yes	1	0.0726	0.0005	0.0716	0.0736	20947.8	<.0001
Prior_modific	z_n	0	0	0	0	0	.	.
Duration of Default Episode		1	0.0112	0	0.0112	0.0113	140645	<.0001
Unpaid Balance (log)		1	0.9246	0.0003	0.9241	0.9252	1.19E+07	<.0001
Mproduct	ARM	1	0.0105	0.0005	0.0095	0.0116	391.07	<.0001
Mproduct	ARMSR	1	0.0026	0.0013	0.0001	0.0052	4.1	0.0428
Mproduct	FRM15	1	0.0673	0.001	0.0652	0.0693	4121.23	<.0001
Mproduct	FRM15SR	1	0.1153	0.0021	0.1112	0.1194	3009.21	<.0001
Mproduct	FRM30SR	1	-0.0034	0.0006	-0.0045	-0.0022	31.62	<.0001
Mproduct	z_FRM30	0	0	0	0	0	.	.
Down payment assist	govt	1	-0.0065	0.0009	-0.0083	-0.0046	46.25	<.0001
Down payment assist	non-profit	1	-0.004	0.0004	-0.0048	-0.0031	77.91	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Down payment assist	relative	1	-0.0023	0.0005	-0.0032	-0.0014	22.79	<.0001
Down payment assist	z_na_other	0	0	0	0	0	.	.
First time buyer	N	1	-0.0007	0.0003	-0.0014	-0.0001	5.03	0.025
First time buyer	z_Y	0	0	0	0	0	.	.
Number of Units	2+	1	0.0271	0.0006	0.0258	0.0283	1801.98	<.0001
Number of Units	z_1	0	0	0	0	0	.	.
Mprior_default	no	1	-0.0321	0.0003	-0.0327	-0.0316	13005.5	<.0001
Mprior_default	z_y	0	0	0	0	0	.	.
State	AL	1	-0.011	0.0008	-0.0127	-0.0094	177.1	<.0001
State	AR	1	-0.0045	0.0011	-0.0065	-0.0024	17.89	<.0001
State	AZ	1	0.007	0.0007	0.0056	0.0083	107.98	<.0001
State	CA	1	0.0496	0.0005	0.0486	0.0506	9481.66	<.0001
State	CO	1	0.0313	0.0007	0.03	0.0326	2290.87	<.0001
State	CT	1	0.0805	0.0014	0.0778	0.0833	3236.77	<.0001
State	FL	1	0.0521	0.0005	0.051	0.0532	9085.87	<.0001
State	GA	1	0.0038	0.0006	0.0027	0.0049	46.33	<.0001
State	IA	1	0.0455	0.0014	0.0427	0.0482	1031.19	<.0001
State	ID	1	0.0053	0.0014	0.0025	0.008	13.96	0.0002
State	IL	1	0.0932	0.0006	0.092	0.0945	21315.1	<.0001
State	IN	1	0.0292	0.0007	0.0278	0.0305	1898.64	<.0001
State	KS	1	0.0262	0.0011	0.024	0.0284	543.79	<.0001
State	KY	1	0.0308	0.0011	0.0287	0.033	784.8	<.0001
State	LA	1	0.0266	0.0009	0.0248	0.0283	903.62	<.0001
State	MD	1	0.0855	0.0008	0.0839	0.0872	10638.8	<.0001
State	ME	1	0.0596	0.0029	0.054	0.0652	432.67	<.0001
State	MI	1	0.0372	0.0006	0.0361	0.0384	3727.96	<.0001
State	MN	1	0.0583	0.0009	0.0566	0.06	4467.74	<.0001
State	MO	1	-0.0064	0.0008	-0.0079	-0.0049	71.71	<.0001
State	MS	1	-0.0238	0.001	-0.0258	-0.0218	542.61	<.0001
State	Mid_Atlntc	1	0.0492	0.0016	0.0462	0.0523	992.52	<.0001
State	Mtn_Wst	1	0.0063	0.0009	0.0044	0.0081	44.94	<.0001
State	NC	1	0.0027	0.0008	0.0012	0.0042	12.05	0.0005
State	NE	1	0.0081	0.0017	0.0048	0.0115	23.08	<.0001
State	NJ	1	0.178	0.001	0.176	0.1799	31991	<.0001
State	NM	1	0.0087	0.0015	0.0059	0.0116	35.7	<.0001
State	NV	1	0.0316	0.001	0.0296	0.0336	940.66	<.0001
State	NY	1	0.1455	0.0008	0.144	0.1471	34116.9	<.0001
State	Nw_Engld	1	0.0665	0.0015	0.0636	0.0694	2033.15	<.0001
State	OH	1	0.0747	0.0006	0.0735	0.0758	16276.1	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
State	OK	1	0.0168	0.0008	0.0153	0.0182	492.87	<.0001
State	OR	1	0.0252	0.0015	0.0223	0.0282	287.54	<.0001
State	PA	1	0.1323	0.0008	0.1308	0.1338	30352.5	<.0001
State	SC	1	0.0134	0.001	0.0115	0.0154	179.6	<.0001
State	TN	1	-0.0056	0.0007	-0.0069	-0.0042	69.36	<.0001
State	UT	1	0.0183	0.001	0.0163	0.0203	329.75	<.0001
State	VA	1	0.0101	0.0008	0.0086	0.0116	173.48	<.0001
State	WA	1	0.0231	0.0009	0.0212	0.0249	606.11	<.0001
State	WI	1	0.0528	0.0012	0.0505	0.055	2089.09	<.0001
State	isld	1	0.0432	0.0016	0.0402	0.0463	768.25	<.0001
State	z_TX	0	0	0	0	0	.	.
Mcohort_group	08to13	1	-0.0395	0.002	-0.0435	-0.0355	375.74	<.0001
Mcohort_group	96to07	1	-0.0338	0.002	-0.0378	-0.0298	273.12	<.0001
Mcohort_group	pre96	1	-0.0124	0.0021	-0.0165	-0.0084	36.02	<.0001
Mcohort_group	z_post13	0	0	0	0	0	.	.
credit_score_group	0	1	0.0177	0.0014	0.015	0.0203	170.22	<.0001
credit_score_group	5	1	-0.0033	0.0015	-0.0063	-0.0003	4.57	0.0325
credit_score_group	6	1	-0.0075	0.0013	-0.0101	-0.0049	31.14	<.0001
credit_score_group	7	1	-0.0019	0.0014	-0.0046	0.0008	1.97	0.1604
credit_score_group	8	0	0	0	0	0	.	.
Mortgage Spread	1	1	0.0129	0.0001	0.0128	0.0131	31596	<.0001
Spread at Origination		1	-0.0174	0.0001	-0.0176	-0.0172	21020.3	<.0001
Refinance indicator	Y	1	-0.0026	0.0005	-0.0037	-0.0015	22.63	<.0001
Refinance indicator	z_N	0	0	0	0	0	.	.
Scale		1	103.6793	0.1617	103.3629	103.9966		

Conveyance Recovery Severity Model

The model parameters for the Conveyance Recovery severity model are shown below.

Table 44: Conveyance R Severity Model Parameters

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	6.2885	0.0063	6.2763	6.3008	1010724	<.0001
Unpaid Balance (log)		1	1.077	0.0014	1.0743	1.0798	590333	<.0001
Down payment assist	govt	1	-0.1995	0.0048	-0.2089	-0.19	1716.88	<.0001
Down payment assist	non-profit	1	-0.2961	0.0022	-0.3005	-0.2918	17897.9	<.0001
Down payment assist	relative	1	-0.0476	0.0024	-0.0523	-0.0429	396.91	<.0001
Down payment assist	z_na_other	0	0	0	0	0	.	.

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Number of Units	2+	1	-0.1345	0.0039	-0.1422	-0.1268	1175.21	<.0001
Number of Units	z_1	0	0	0	0	0	.	.
Mproduct	ARM	1	0.0782	0.0026	0.0731	0.0833	918.32	<.0001
Mproduct	ARMSR	1	0.2259	0.0065	0.213	0.2387	1194.49	<.0001
Mproduct	FRM15	1	0.1729	0.0064	0.1605	0.1854	740.76	<.0001
Mproduct	FRM15SR	1	0.5176	0.0111	0.4958	0.5394	2164.21	<.0001
Mproduct	FRM30SR	1	0.2021	0.003	0.1962	0.2079	4579.63	<.0001
Mproduct	z_FRM30	0	0	0	0	0	.	.
Season	fall	1	-0.0129	0.0017	-0.0163	-0.0095	54.41	<.0001
Season	spring	1	-0.0081	0.0017	-0.0115	-0.0047	22.1	<.0001
Season	summer	1	-0.0283	0.0017	-0.0317	-0.0249	268.23	<.0001
Season	z_winter	0	0	0	0	0	.	.
State	AL	1	-0.1583	0.0046	-0.1672	-0.1494	1208.16	<.0001
State	AR	1	-0.1216	0.0058	-0.1329	-0.1102	442.13	<.0001
State	AZ	1	-0.0572	0.004	-0.0651	-0.0493	201.52	<.0001
State	CA	1	-0.033	0.0029	-0.0387	-0.0273	129.94	<.0001
State	CO	1	0.022	0.0043	0.0136	0.0305	26.07	<.0001
State	CT	1	-0.2249	0.0074	-0.2395	-0.2103	912.14	<.0001
State	FL	1	0.0088	0.0031	0.0027	0.0149	8.08	0.0045
State	GA	1	-0.0902	0.003	-0.0961	-0.0842	878.29	<.0001
State	IA	1	-0.1612	0.0083	-0.1774	-0.145	378.93	<.0001
State	ID	1	-0.021	0.0083	-0.0372	-0.0047	6.4	0.0114
State	IL	1	-0.2039	0.0037	-0.2112	-0.1967	3050.65	<.0001
State	IN	1	-0.2046	0.0037	-0.2117	-0.1974	3135.13	<.0001
State	KS	1	-0.1239	0.0061	-0.1358	-0.1121	419.16	<.0001
State	KY	1	-0.1113	0.006	-0.123	-0.0996	349.07	<.0001
State	LA	1	-0.0591	0.0053	-0.0695	-0.0486	122.3	<.0001
State	MD	1	-0.0354	0.0045	-0.0442	-0.0266	62.23	<.0001
State	ME	1	-0.3189	0.0151	-0.3485	-0.2893	445.66	<.0001
State	MI	1	-0.5255	0.0034	-0.5322	-0.5189	24010.1	<.0001
State	MN	1	-0.0486	0.0051	-0.0586	-0.0386	91.3	<.0001
State	MO	1	-0.2201	0.0041	-0.2282	-0.212	2827.12	<.0001
State	MS	1	-0.1267	0.0059	-0.1382	-0.1152	465.18	<.0001
State	Mid_Atlntc	1	-0.1269	0.0087	-0.1439	-0.1099	214.08	<.0001
State	Mtn_Wst	1	-0.0275	0.0071	-0.0413	-0.0136	15.12	0.0001
State	NC	1	-0.0627	0.0041	-0.0706	-0.0547	236.95	<.0001
State	NE	1	-0.0628	0.0094	-0.0812	-0.0443	44.55	<.0001
State	NJ	1	0.0013	0.0056	-0.0097	0.0122	0.05	0.8202
State	NM	1	-0.0338	0.008	-0.0495	-0.0181	17.84	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
State	NV	1	0.0096	0.0064	-0.0029	0.0221	2.27	0.1317
State	NY	1	-0.1824	0.0043	-0.1909	-0.1739	1760.04	<.0001
State	Nw_Engld	1	-0.1921	0.0078	-0.2074	-0.1769	611.72	<.0001
State	OH	1	-0.2889	0.0033	-0.2954	-0.2824	7599.94	<.0001
State	OK	1	-0.0773	0.0048	-0.0867	-0.0679	259.73	<.0001
State	OR	1	0.0706	0.009	0.0529	0.0883	61.36	<.0001
State	PA	1	-0.1764	0.0042	-0.1847	-0.1681	1753.49	<.0001
State	SC	1	-0.1043	0.0057	-0.1155	-0.0932	334.23	<.0001
State	TN	1	-0.0548	0.0037	-0.062	-0.0475	216.94	<.0001
State	UT	1	0.0755	0.0062	0.0634	0.0877	148.58	<.0001
State	VA	1	-0.0667	0.0041	-0.0748	-0.0585	259.05	<.0001
State	WA	1	0.0268	0.0058	0.0155	0.0382	21.43	<.0001
State	WI	1	-0.2592	0.0069	-0.2726	-0.2458	1429.76	<.0001
State	isld	1	0.1281	0.0098	0.1088	0.1474	169.22	<.0001
State	z_TX	0	0	0	0	0	.	.
Duration of Default Episode		1	-0.0056	0.0001	-0.0059	-0.0053	1608.41	<.0001
prior_default_cnt_grp	1-2	1	0.0788	0.0015	0.0759	0.0817	2769.67	<.0001
prior_default_cnt_grp	3+	1	0.12	0.0029	0.1143	0.1256	1745.12	<.0001
prior_default_cnt_grp	z_0	0	0	0	0	0	.	.
prior_modific_cnt_grp	1-2	1	-0.1581	0.0027	-0.1634	-0.1528	3405.28	<.0001
prior_modific_cnt_grp	3+	1	-0.0433	0.0084	-0.0597	-0.0269	26.73	<.0001
prior_modific_cnt_grp	z_0	0	0	0	0	0	.	.
loan to value ratio	65-99	1	0.0813	0.0015	0.0784	0.0843	2958.13	<.0001
loan to value ratio	lt65	1	0.1862	0.0038	0.1788	0.1937	2404.97	<.0001
loan to value ratio	z_100	0	0	0	0	0	.	.
Refinance indicator	Y	1	-0.3781	0.0026	-0.3831	-0.373	21483.6	<.0001
Refinance indicator	z_N	0	0	0	0	0	.	.
Scale		1	4.0949	0.0069	4.0813	4.1085		

Third Party Sales Severity Model

The model parameters for the Third Party Sales severity model are shown below.

Table 45: Third Party Sales Severity Model Parameters

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	6.8905	0.0324	6.8269	6.954	45189.2	<.0001
Unpaid Balance (log)		1	0.6697	0.0055	0.659	0.6804	15004.7	<.0001
Down payment assist	govt	1	0.0722	0.0169	0.0391	0.1052	18.33	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Down payment assist	non-profit	1	0.173	0.008	0.1574	0.1886	471.38	<.0001
Down payment assist	relative	1	-0.0272	0.008	-0.0429	-0.0114	11.48	0.0007
Down payment assist	z_na_other	0	0	0	0	0	.	.
Episode Duration 20+	yes	1	-0.0666	0.0125	-0.091	-0.0422	28.54	<.0001
Episode Duration 20+	z_no	0	0	0	0	0	.	.
Judicial State	1	1	0.1872	0.0495	0.0902	0.2841	14.31	0.0002
Judicial State	z_0	0	0	0	0	0	.	.
Number of Units	2+	1	0.2053	0.0186	0.1689	0.2416	122.24	<.0001
Number of Units	z_1	0	0	0	0	0	.	.
Mproduct	ARM	1	-0.0342	0.0163	-0.0663	-0.0022	4.39	0.0361
Mproduct	ARMSR	1	-0.0934	0.0255	-0.1434	-0.0434	13.42	0.0002
Mproduct	FRM15	1	-0.0401	0.0246	-0.0884	0.0083	2.64	0.1041
Mproduct	FRM15SR	1	0.0176	0.0508	-0.0819	0.1171	0.12	0.7292
Mproduct	FRM30SR	1	-0.0601	0.0113	-0.0822	-0.0379	28.22	<.0001
Mproduct	z_FRM30	0	0	0	0	0	.	.
Refinance indicator	Y	1	0.1998	0.0083	0.1836	0.2161	580.88	<.0001
Refinance indicator	z_N	0	0	0	0	0	.	.
State	AL	1	0.4034	0.0166	0.3709	0.436	589.24	<.0001
State	AR	1	0.2851	0.0242	0.2378	0.3325	139.25	<.0001
State	AZ	1	0.2069	0.0151	0.1774	0.2365	188.29	<.0001
State	CA	1	-0.0476	0.0187	-0.0841	-0.011	6.5	0.0108
State	CO	1	0.011	0.0215	-0.0311	0.0531	0.26	0.6074
State	CT	1	0.4775	0.0707	0.3388	0.6162	45.56	<.0001
State	FL	1	0.2461	0.0507	0.1466	0.3455	23.51	<.0001
State	GA	1	0.3358	0.011	0.3143	0.3574	933.65	<.0001
State	IA	1	0.2003	0.0547	0.093	0.3076	13.38	0.0003
State	ID	1	0.1244	0.0307	0.0643	0.1846	16.44	<.0001
State	IL	1	0.5687	0.051	0.4687	0.6686	124.27	<.0001
State	IN	1	0.1638	0.0512	0.0634	0.2642	10.22	0.0014
State	KS	1	0.0065	0.0648	-0.1204	0.1334	0.01	0.9199
State	KY	1	0.0518	0.0547	-0.0554	0.1589	0.9	0.3438
State	LA	1	0.2018	0.055	0.0941	0.3095	13.48	0.0002
State	MD	1	0.6256	0.0185	0.5893	0.6619	1142.58	<.0001
State	ME	1	0.4341	0.0785	0.2802	0.588	30.55	<.0001
State	MI	1	0.5882	0.0143	0.5602	0.6161	1700.49	<.0001
State	MN	1	0.1841	0.0238	0.1373	0.2308	59.58	<.0001
State	MO	1	0.3817	0.0153	0.3517	0.4116	622.98	<.0001
State	MS	1	0.348	0.0239	0.3012	0.3947	212.58	<.0001
State	Mid_Atlntc	1	0.3887	0.0427	0.305	0.4724	82.86	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
State	Mtn_Wst	1	0.1933	0.0372	0.1204	0.2662	27	<.0001
State	NC	1	0.2348	0.0139	0.2076	0.262	287.15	<.0001
State	NE	1	0.0026	0.0373	-0.0705	0.0756	0	0.9454
State	NJ	1	0.6442	0.0524	0.5416	0.7469	151.22	<.0001
State	NM	1	0.143	0.0577	0.0298	0.2561	6.13	0.0133
State	NV	1	0.2546	0.0202	0.215	0.2941	158.86	<.0001
State	NY	1	0.4631	0.053	0.3593	0.5669	76.49	<.0001
State	Nw_Engld	1	0.3877	0.0277	0.3334	0.4419	196.41	<.0001
State	OH	1	0.3278	0.0511	0.2276	0.4279	41.15	<.0001
State	OK	1	-0.0047	0.0535	-0.1096	0.1002	0.01	0.93
State	OR	1	0.1067	0.0357	0.0367	0.1767	8.93	0.0028
State	PA	1	0.4306	0.0515	0.3296	0.5316	69.79	<.0001
State	SC	1	0.0742	0.0537	-0.031	0.1794	1.91	0.1668
State	TN	1	0.1712	0.0152	0.1413	0.201	126.45	<.0001
State	UT	1	-0.0771	0.0244	-0.1249	-0.0293	9.98	0.0016
State	VA	1	0.3414	0.0184	0.3053	0.3774	345.03	<.0001
State	WA	1	0.1837	0.0183	0.1479	0.2195	101.22	<.0001
State	WI	1	0.3523	0.0545	0.2455	0.4592	41.77	<.0001
State	isld	1	-0.0765	0.1229	-0.3174	0.1645	0.39	0.5339
State	z_TX	0	0	0	0	0	.	.
Duration of Default Episode		1	0.0233	0.0005	0.0222	0.0243	1973.35	<.0001
Debt to Income Ratio	z_VALID	1	-0.0015	0.0003	-0.002	-0.001	33.11	<.0001
Debt to Income Ratio	0	0	0	0	0	0	.	.
credit_score_group	0	1	0.0394	0.015	0.0099	0.0688	6.86	0.0088
credit_score_group	5	1	0.1252	0.0189	0.0883	0.1622	44.11	<.0001
credit_score_group	6	1	0.0728	0.014	0.0454	0.1003	27.01	<.0001
credit_score_group	7	1	0.0145	0.0141	-0.0131	0.042	1.06	0.3031
credit_score_group	8	0	0	0	0	0	.	.
Mcohort_group	08to13	1	0.2248	0.0116	0.2021	0.2475	376.44	<.0001
Mcohort_group	96to07	1	0.2879	0.0128	0.2628	0.3131	502.17	<.0001
Mcohort_group	pre96	1	0.4152	0.0209	0.3743	0.4562	394.63	<.0001
Mcohort_group	z_post13	0	0	0	0	0	.	.
prior_default_cnt_grp	1-2	1	-0.0271	0.0065	-0.0397	-0.0144	17.63	<.0001
prior_default_cnt_grp	3+	1	-0.0307	0.0097	-0.0498	-0.0116	9.9	0.0017
prior_default_cnt_grp	z_0	0	0	0	0	0	.	.
prior_modific_cnt_grp	1-2	1	0.1146	0.0074	0.1001	0.1292	238.34	<.0001
prior_modific_cnt_grp	3+	1	0.2934	0.0157	0.2627	0.3242	349.2	<.0001
prior_modific_cnt_grp	z_0	0	0	0	0	0	.	.
loan to value ratio	65-99	1	-0.0246	0.0063	-0.037	-0.0122	15.16	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
loan to value ratio	lt65	1	-0.1317	0.0436	-0.217	-0.0463	9.14	0.0025
loan to value ratio	z_100	0	0	0	0	0	.	.
Scale		1	3.3016	0.0188	3.2649	3.3387		

Pre-Foreclosure Sale Severity Model

The model parameters for the Pre-Foreclosure Sale severity model are shown below.

Table 46: Pre-Foreclosure Sale Severity Model

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	5.8616	0.0248	5.813	5.9103	55863.8	<.0001
Prior_modific	yes	1	0.19	0.0053	0.1796	0.2005	1264.09	<.0001
Prior_modific	z_n	0	0	0	0	0	.	.
Duration of Default Episode		1	0.042	0.0005	0.041	0.043	6416.1	<.0001
Unpaid Balance (log)		1	0.8206	0.0044	0.812	0.8292	35100.9	<.0001
Down payment assist	govt	1	0.1565	0.0142	0.1287	0.1843	121.54	<.0001
Down payment assist	non-profit	1	0.1751	0.0057	0.1638	0.1864	929.19	<.0001
Down payment assist	relative	1	-0.0127	0.0063	-0.025	-0.0004	4.06	0.0438
Down payment assist	z_na_other	0	0	0	0	0	.	.
Episode Duration 20+	yes	1	-0.1841	0.0233	-0.2297	-0.1384	62.5	<.0001
Episode Duration 20+	z_no	0	0	0	0	0	.	.
First time buyer	N	1	-0.059	0.0051	-0.0691	-0.049	132.13	<.0001
First time buyer	z_Y	0	0	0	0	0	.	.
Number of Units	2+	1	0.2894	0.0129	0.264	0.3147	501.22	<.0001
Number of Units	z_1	0	0	0	0	0	.	.
Season	fall	1	-0.0194	0.0048	-0.0288	-0.0099	16.13	<.0001
Season	spring	1	-0.0179	0.0047	-0.0271	-0.0087	14.58	0.0001
Season	summer	1	-0.0346	0.0048	-0.0439	-0.0253	52.76	<.0001
Season	z_winter	0	0	0	0	0	.	.
State	AL	1	0.0678	0.0216	0.0254	0.1102	9.84	0.0017
State	AR	1	0.0353	0.0239	-0.0115	0.0821	2.18	0.1395
State	AZ	1	0.3844	0.0096	0.3656	0.4032	1602.3	<.0001
State	CA	1	0.3163	0.0088	0.2991	0.3335	1306.18	<.0001
State	CO	1	0.1133	0.0102	0.0933	0.1334	123.01	<.0001
State	CT	1	0.2925	0.0159	0.2613	0.3237	338.04	<.0001
State	FL	1	0.3729	0.0088	0.3556	0.3902	1779.61	<.0001
State	GA	1	0.287	0.0096	0.2682	0.3058	896.86	<.0001
State	IA	1	0.016	0.0238	-0.0306	0.0627	0.45	0.5001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
State	ID	1	0.1565	0.0164	0.1244	0.1886	91.15	<.0001
State	IL	1	0.3592	0.0101	0.3394	0.3789	1271.43	<.0001
State	IN	1	0.0716	0.0123	0.0475	0.0957	33.83	<.0001
State	KS	1	-0.0322	0.0202	-0.0719	0.0074	2.54	0.1113
State	KY	1	0.0067	0.0179	-0.0285	0.0419	0.14	0.7083
State	LA	1	0.0253	0.024	-0.0217	0.0724	1.11	0.2914
State	MD	1	0.3006	0.0123	0.2765	0.3248	594.56	<.0001
State	ME	1	0.1695	0.03	0.1107	0.2283	31.96	<.0001
State	MI	1	0.5698	0.011	0.5482	0.5913	2680.62	<.0001
State	MN	1	0.2547	0.0148	0.2256	0.2838	294.52	<.0001
State	MO	1	0.2128	0.0132	0.1869	0.2388	258.68	<.0001
State	MS	1	-0.0275	0.0277	-0.0817	0.0267	0.99	0.3194
State	Mid_Atlntc	1	0.2108	0.0218	0.1681	0.2534	93.72	<.0001
State	Mtn_Wst	1	-0.0973	0.0213	-0.139	-0.0555	20.83	<.0001
State	NC	1	-0.0022	0.0135	-0.0286	0.0243	0.03	0.8731
State	NE	1	-0.16	0.0279	-0.2147	-0.1053	32.88	<.0001
State	NJ	1	0.4114	0.0117	0.3886	0.4343	1244.69	<.0001
State	NM	1	-0.0039	0.0216	-0.0463	0.0384	0.03	0.8558
State	NV	1	0.4239	0.0117	0.4011	0.4468	1324.02	<.0001
State	NY	1	0.2585	0.0123	0.2345	0.2826	443.72	<.0001
State	Nw_Engld	1	0.2589	0.0139	0.2317	0.2861	347.24	<.0001
State	OH	1	0.2462	0.0103	0.2259	0.2664	567.07	<.0001
State	OK	1	-0.0506	0.0173	-0.0846	-0.0167	8.56	0.0034
State	OR	1	0.1242	0.0158	0.0932	0.1553	61.57	<.0001
State	PA	1	0.1529	0.0128	0.1278	0.178	142.38	<.0001
State	SC	1	0.048	0.0194	0.0101	0.086	6.15	0.0131
State	TN	1	0.0256	0.0143	-0.0025	0.0537	3.18	0.0743
State	UT	1	0.0724	0.011	0.0508	0.094	43.08	<.0001
State	VA	1	0.1395	0.0131	0.1138	0.1653	113.11	<.0001
State	WA	1	0.1793	0.012	0.1558	0.2029	223.03	<.0001
State	WI	1	0.1379	0.0176	0.1033	0.1724	61.11	<.0001
State	isld	1	0.155	0.0473	0.0623	0.2477	10.74	0.001
State	z_TX	0	0	0	0	0	.	.
credit_score_group	0	1	-0.0338	0.0089	-0.0513	-0.0163	14.4	0.0001
credit_score_group	5	1	0.1143	0.0133	0.0883	0.1403	74.2	<.0001
credit_score_group	6	1	0.0609	0.0088	0.0436	0.0781	47.92	<.0001
credit_score_group	7	1	0.0245	0.0087	0.0074	0.0416	7.92	0.0049
credit_score_group	8	0	0	0	0	0	.	.
loan to value ratio	65-99	1	-0.0473	0.0042	-0.0556	-0.0389	123.77	<.0001

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
loan to value ratio	lt65	1	-0.0823	0.0138	-0.1094	-0.0552	35.5	<.0001
loan to value ratio	z_100	0	0	0	0	0	.	.
Debt to Income Ratio	z_VALID	1	-0.0004	0.0002	-0.0007	-0.0001	7.38	0.0066
Debt to Income Ratio	0	0	0	0	0	0	.	.
Mortgage Spread	1	1	0.1133	0.0019	0.1096	0.117	3558.05	<.0001
Spread at Origination		1	-0.0952	0.0032	-0.1014	-0.0889	898.91	<.0001
Yield Curve Slope	1	1	0.0147	0.0003	0.0141	0.0152	2875.64	<.0001
Refinance indicator	Y	1	0.3169	0.006	0.3052	0.3286	2823.25	<.0001
Refinance indicator	z_N	0	0	0	0	0	.	.
Scale		1	4.0951	0.0185	4.0589	4.1316		

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 1.0 for the final type of claim and 0.0 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 1.0 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 Binomial Model are shown below.

Figure 47: Loss Mitigation Binomial Model Validation
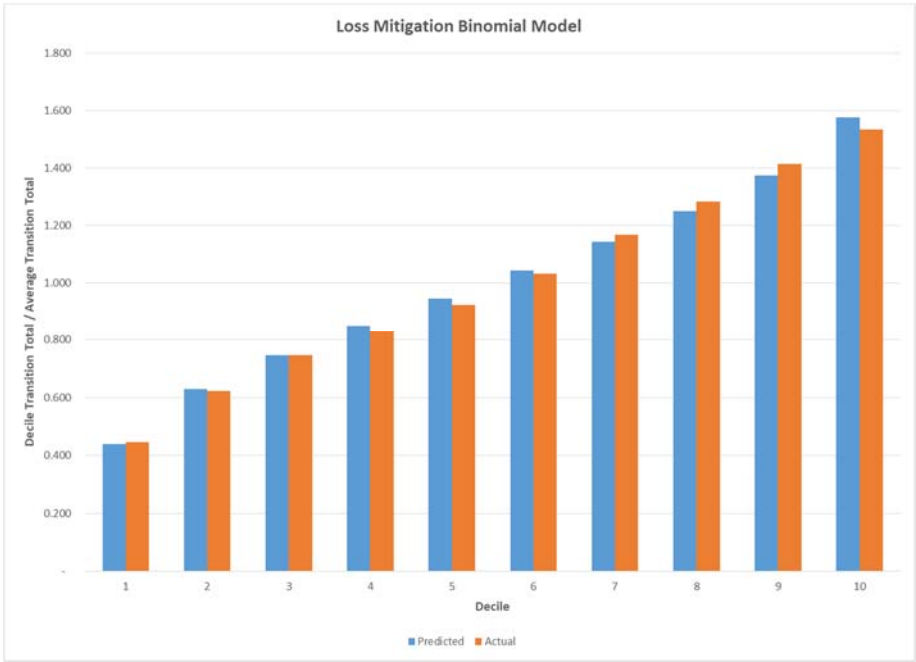
Figure 48: Loss Mitigation Claim Severity Model Validation
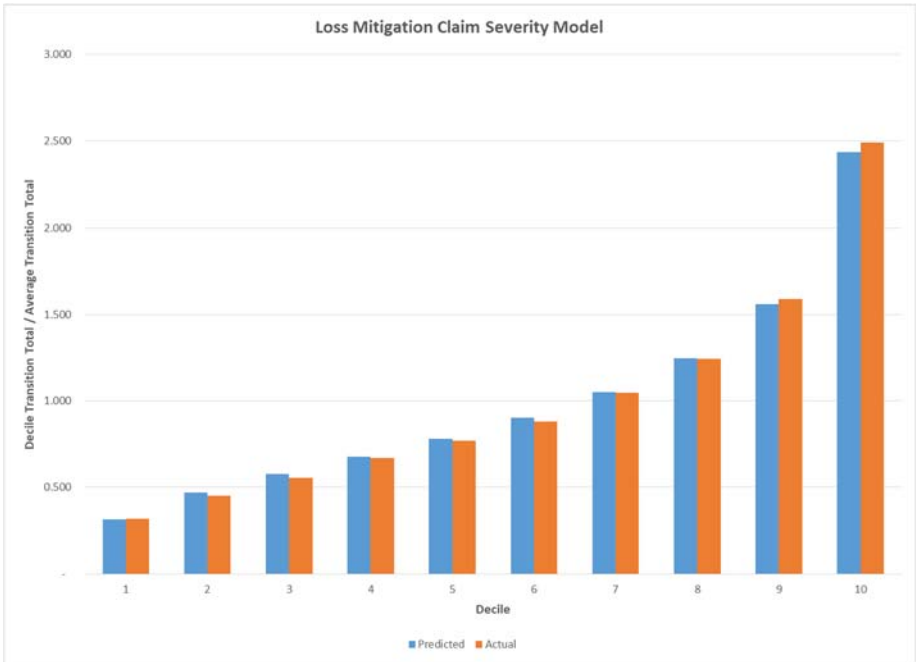
Claim Type Model

The validation charts for the Claim Type model are shown below.

Figure 49: Conveyance Claim Type Model Validation Chart
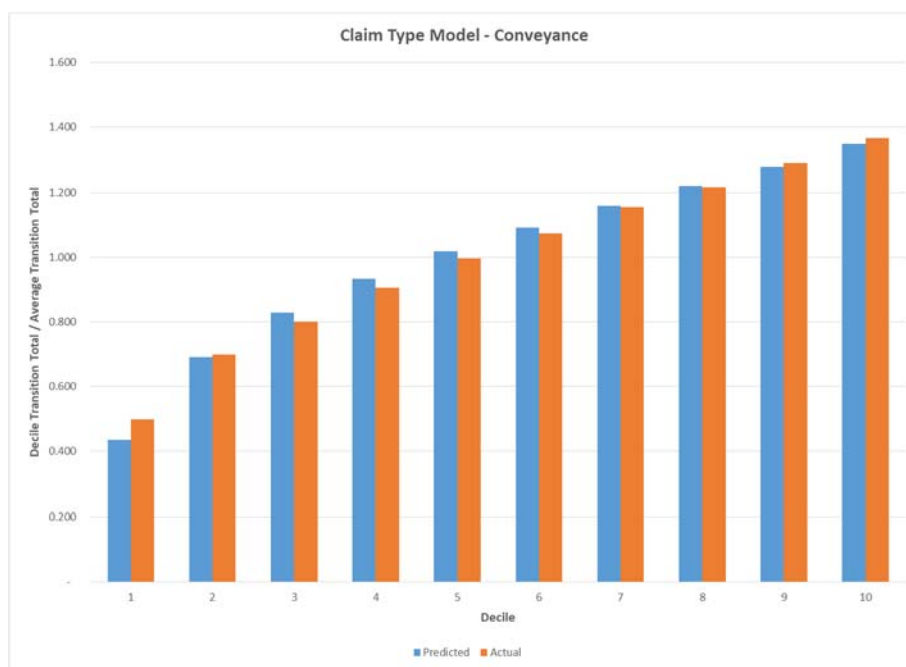
Figure 50: PFS Claim Type Model Validation Chart
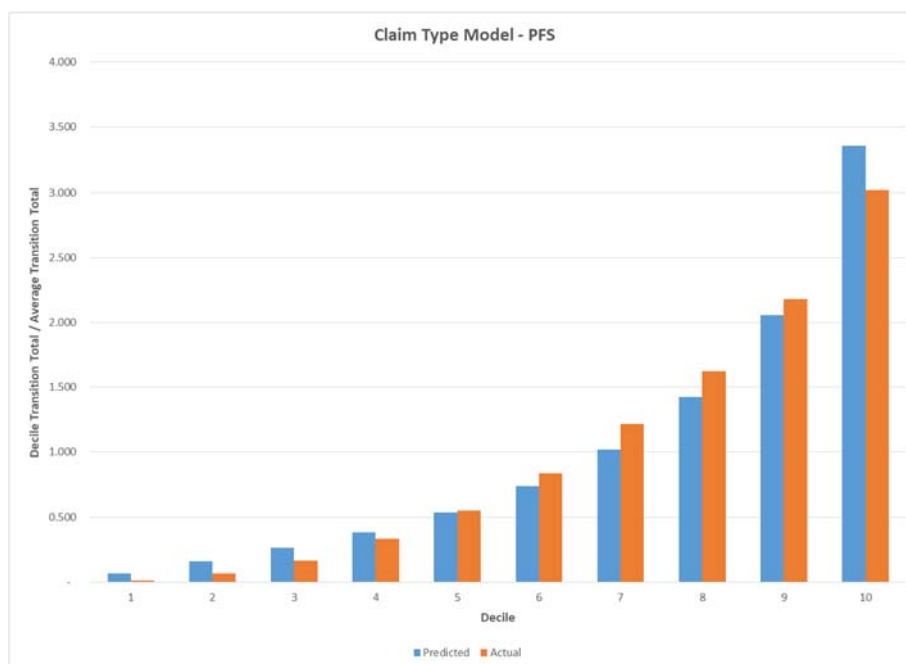
Figure 51: TPS Claim Type Model Validation Chart
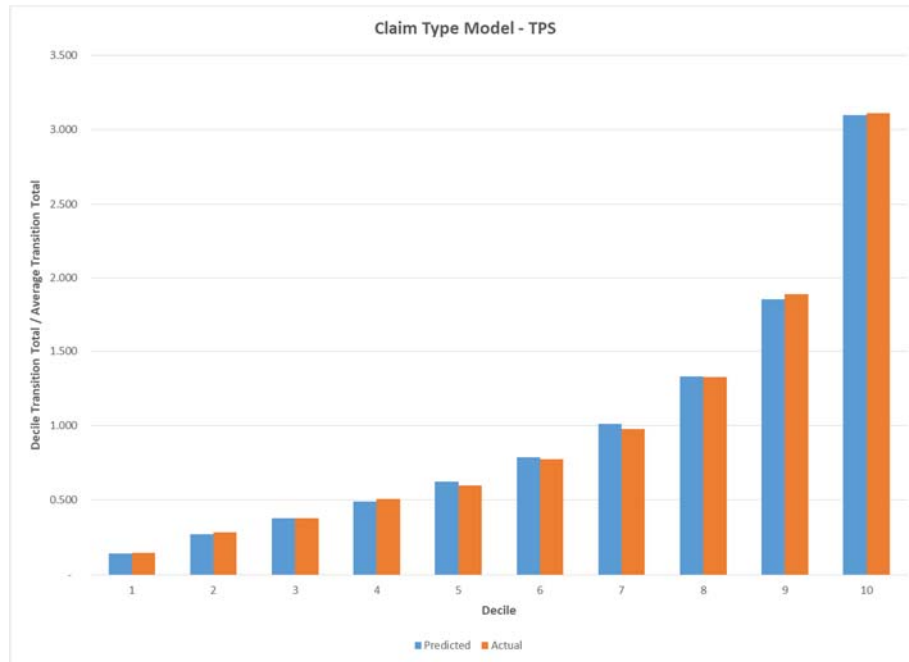
Claim Type Severity Models

The validation charts for the Claim Type Severity Models are shown below.

Figure 52: Conveyance Loss Severity Model Validation
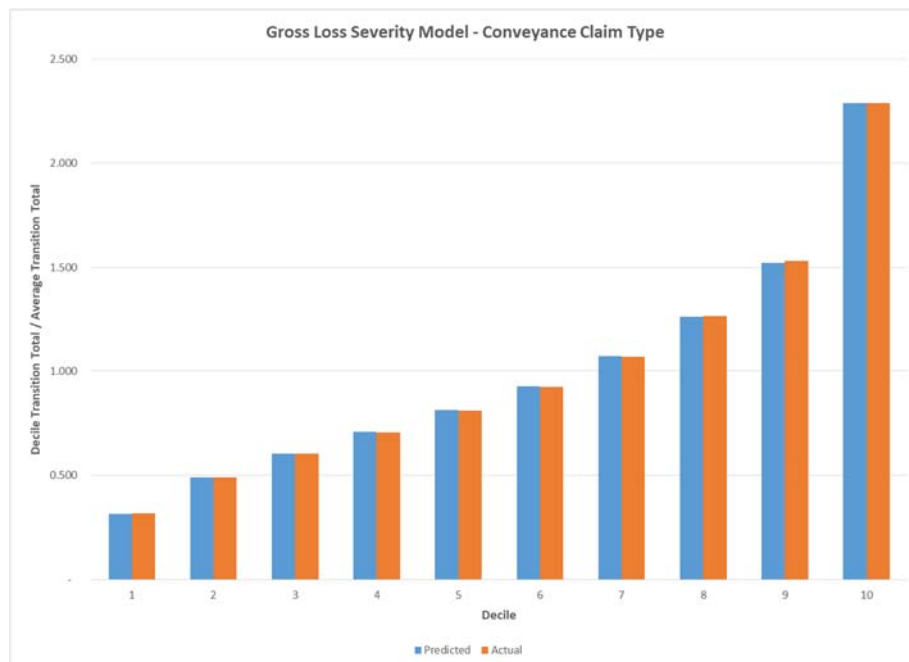
Figure 53: PFS Loss Severity Model Validation
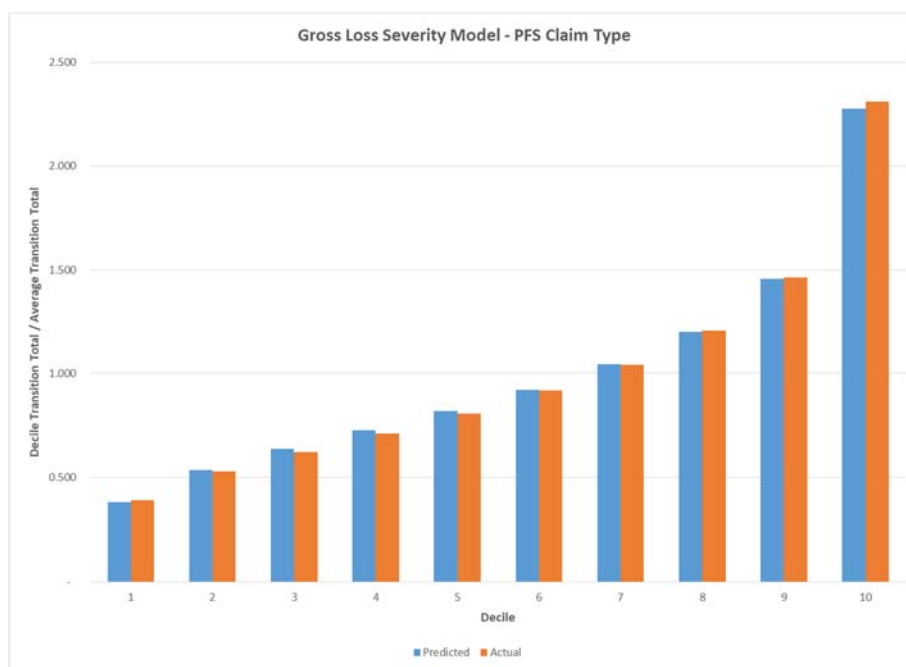
Figure 54: TPS Loss Severity Model Validation
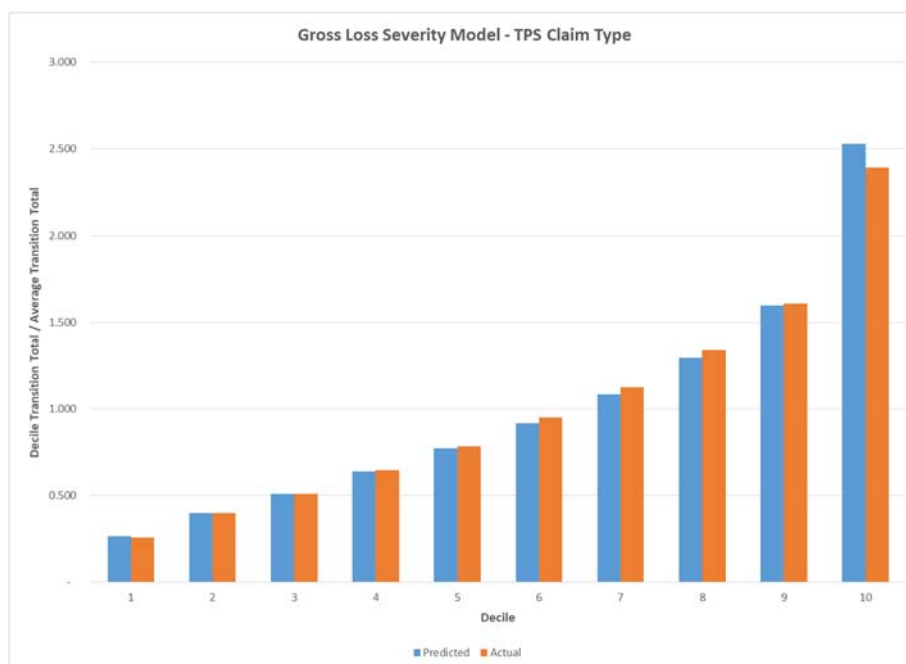
Appendix D: Economic Scenarios

To measure the possible variation in MMIF's Cash Flow NPV on the existing portfolio, we developed a baseline projection using OMB Economic Assumptions and also projections for ten additional deterministic economic scenarios from Moody's. For this analysis, we used the Moody's July 2018 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
- 1-year CMT rate
- 3-year CMT rate
- 5-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
- Exceptionally Strong Growth
- Stronger Near-Term Rebound
- Slower Near-Term Growth
- Moderate Recession
- Protracted Slump
- Below-Trend Long-Term 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 55 shows the future movements of the HPI under the baseline and the alternative economic scenarios. In the Moody's Baseline scenario, the HPI increases over the entire projection period, and the rate of change is consistently between 2.5% and 3.5%. The mortgage interest rate increases and settles at a long-term average of about 5.9%. The unemployment rate decreases to 3.4% over the next year, and then increases to a long-term average of around 5.0%.

Figure 55: Paths of the Future National House Price Index in Different Scenarios
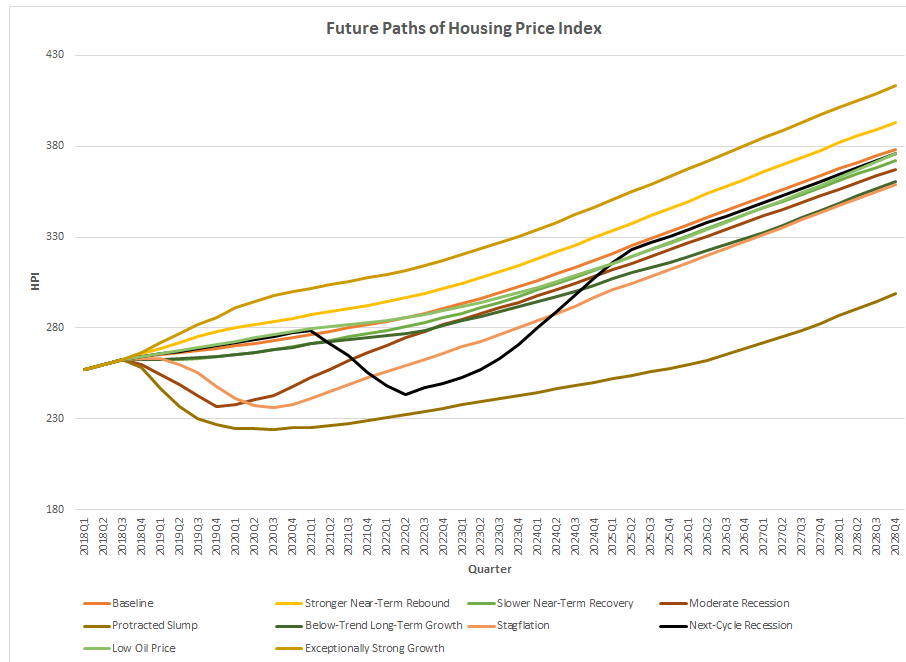
Figure 56 shows the forecasted mortgage rate of 30-year fixed-rate mortgages for the ten Moody's scenarios. Moody's Baseline forecast for the 30-year fixed interest rate shows that the mortgage interest rate increases to just under 5.6% by 2022, holds steady though 2024, then increases to a long-term average rate of around 5.7%. For the Moody's projections, we use the 30-year fixed rate as this represents the majority of the mortgage products sold.

Figure 56: Paths of the Future Mortgage Rate
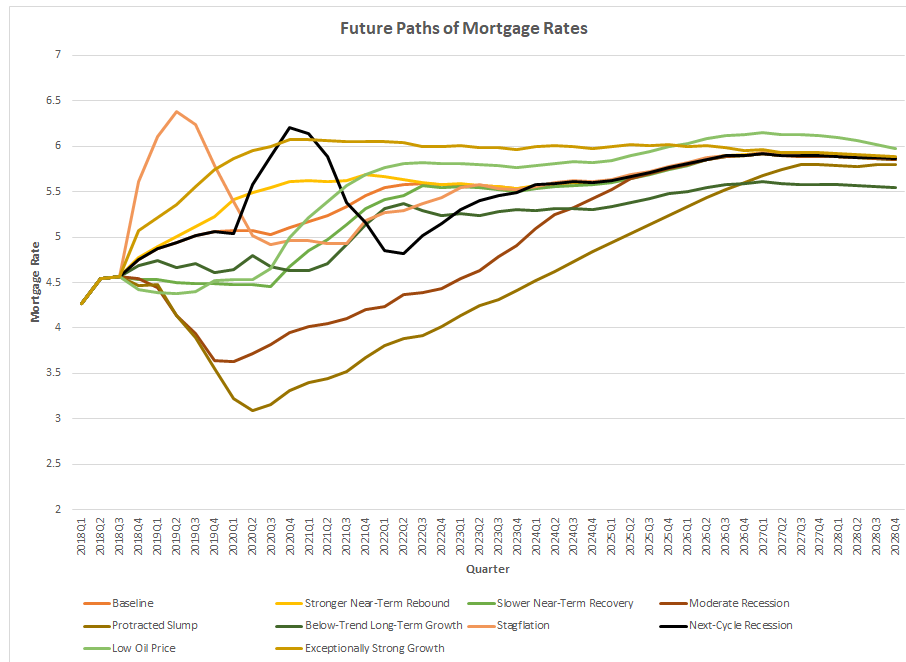
Figure 57 shows the forecasted unemployment rate under alternative economic scenarios. The Moody's Baseline forecast projects that the unemployment rate will decrease to 3.4% in 2019, and then increases to a long-term average of just over 5%.

Figure 57: Paths of Future National Unemployment Rate
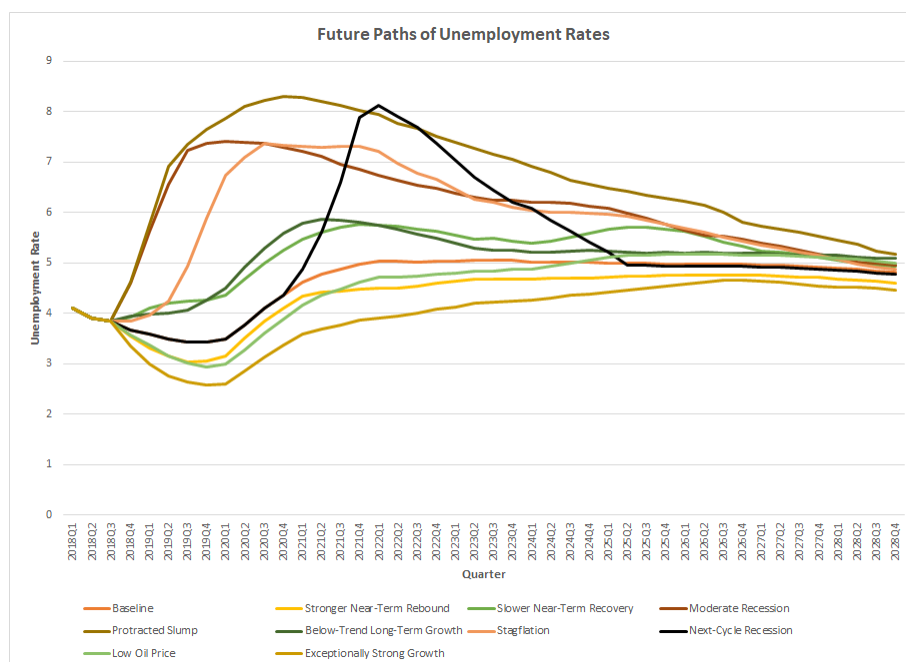
Stochastic Simulation

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:

- 1-Year Treasury Rates
- 3-Month Treasury Rates
- 6-Month Treasury Rates
- 2-Year Treasury Rates
- 3-Year Treasury Rates
- 5-Year Treasury Rates
- 7-Year Treasury Rates
- 10-Year Treasury Rates
- 20-Year Treasury Rates
- 30-Year Treasury Rates
- 30-Year Fixed Rate Mortgage (FRM) Rates
- FHFA National Purchase Only House Price Index (HPI-PO)
- Unemployment Rates
- Gross Domestic Product (GDP)

Historical Data

A. Interest Rates

Figure 58 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 1-year Treasury rate (tr1y), 10-year Treasury rate (tr10y) and the 30-year fixed rate mortgage 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 as a way to influence interest rates after this period of time. The 1-year Treasury rate (tr1y) was around 5% in CY 1971 and increased steadily to its peak of 16.31% in CY 1981 Q3. After that, it followed a decreasing trend and reached an all-time low of 0.10% in CY 2014 Q2. Since then rates have started a slow upward trend.

Figure 58: Historical Interest Rates (%)
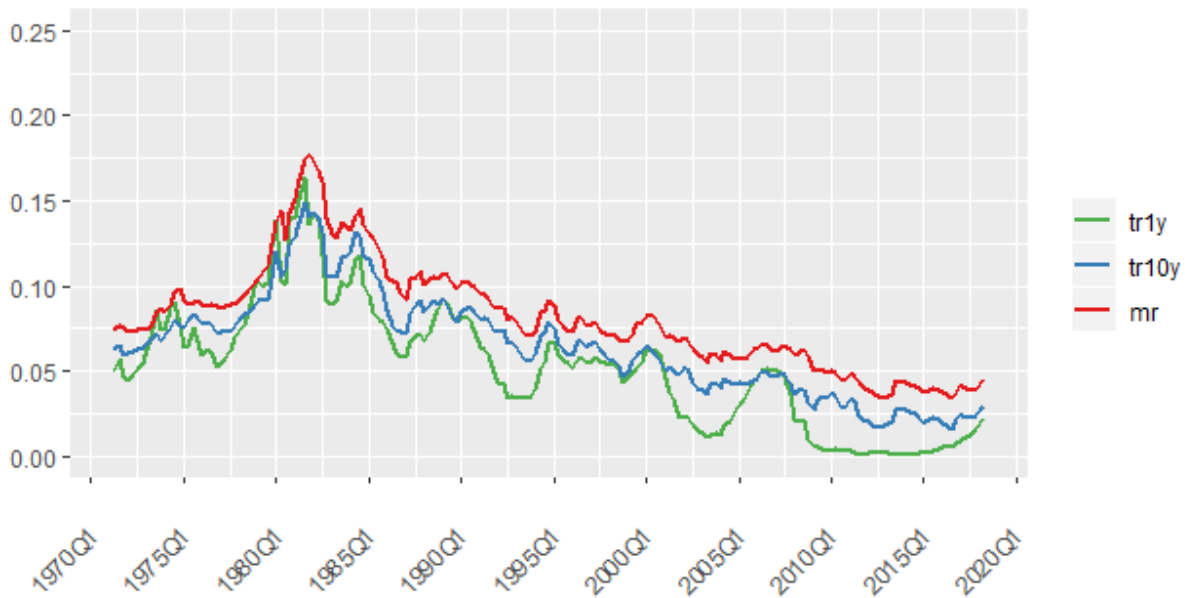
Figure 59 shows historical interest rate spreads, including the spread between 10-year and 1-year Treasury rates (tr10y_s) and the spread between the 30-year mortgage rate and the 10-year Treasury rate (mr10y_s). Both spreads have a mostly positive value with long cycles. Lower, and negative spreads typically correspond with economic downturns, like during the late 70's through early 80's. Also note, the spread of the mortgage rate over the 10-year Treasury rate is always positive, reflecting the premium for credit risk.

Figure 59: Historical Interest Rate Spreads (%)
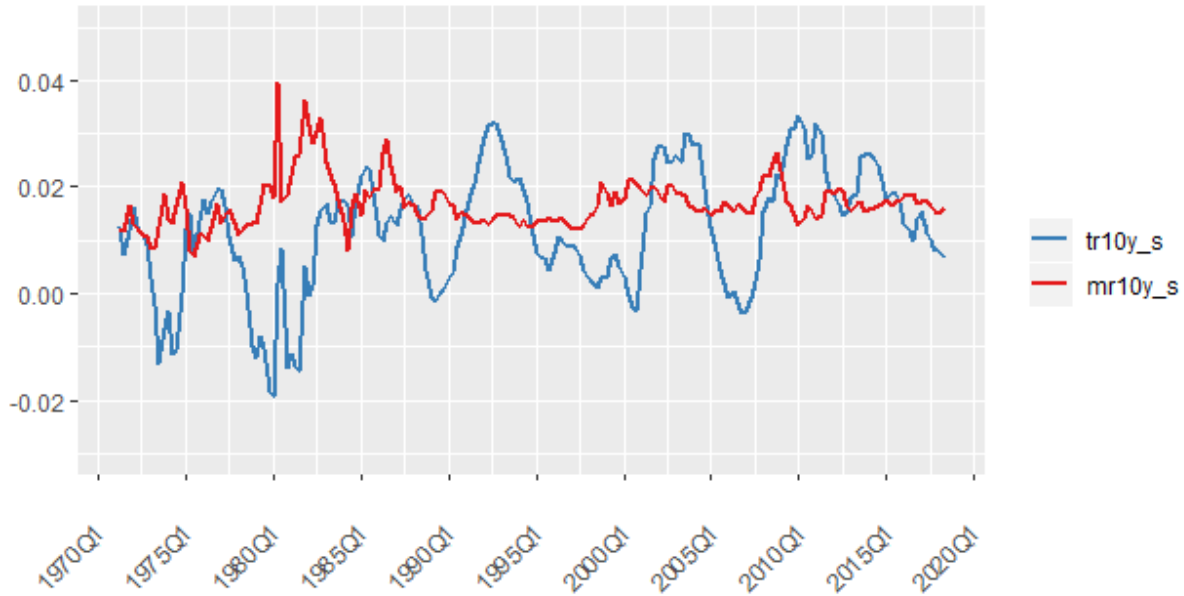
B. House Price Appreciation Rates

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:

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

Figure 60 shows the national quarterly HPA from CY 1991 Q1 to CY 2018 Q2. The long-term average quarterly HPA is around 0.87% (3.30% annual rate).

Figure 60: Historical National HPI and Quarterly HPA
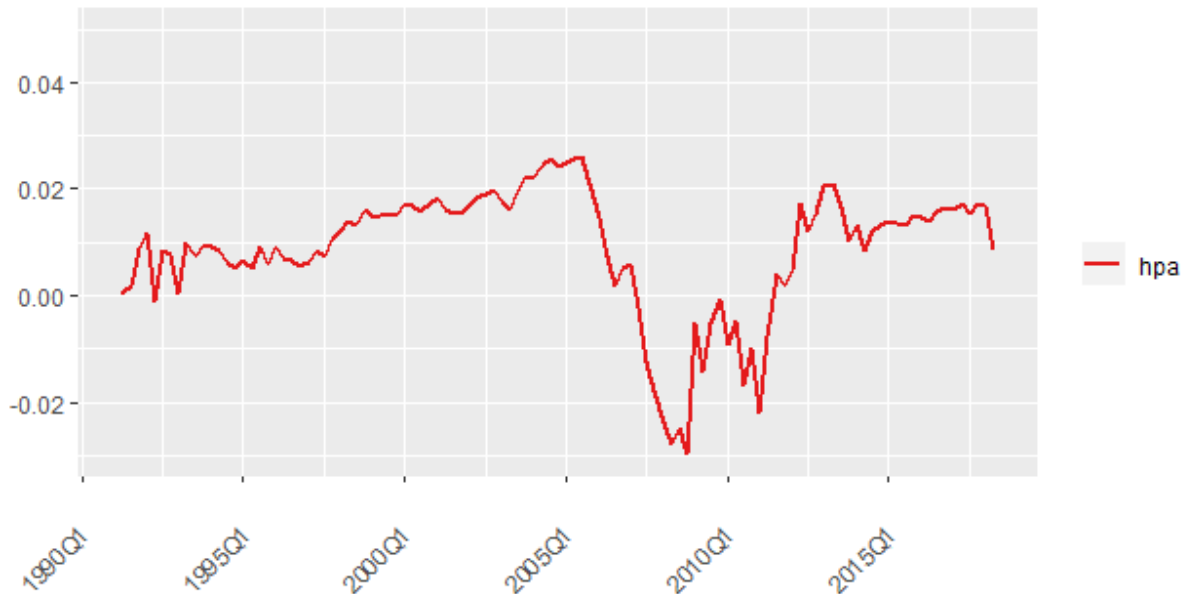
The HPI increased steadily before 2004, and the quarterly appreciation rate was around 1.14%. Then house prices rose sharply starting in 2004. The average quarterly house price appreciation rate was 1.88% during the subprime mortgage expansion period from 2004 to 2006, and reached its peak of 2.59% in CY 2005 Q2. After 2006, the average growth rate of house price became negative until 2011 when appreciation returns to a positive value. Table 47 shows the quarterly HPA by selected historical time periods.

Table 47: Average Quarterly HPA by Time Span

Period	Average Quarterly HPA
1991 – 2003	1.13%
2004 – 2006	1.87%
2007 – 2010	-1.23%
2011 – 2018	1.15%

Modeling Techniques

The primary modeling techniques used in these simulations include

- Auto Regressive Moving Average (ARMA)
- General Auto Regressive Conditional Heteroscedasticity (GARCH)

ARMA models are typically specified as ARMA(p,q) where p is the auto regressive component of the series, and q is the moving average.

GARCH models are typically specified as GARCH($p,q)$ where p is the auto regressive component of σ_t^2, and q is the AR component of the error term.

Description and examples of using an ARMA-GARCH model for time series analysis includes Engle and Mezrich (1995).

1-Year Treasury Rate

In this section, we present some historical statistics on the 1-year Treasury rate, and then describe the estimation model for the stochastic process, and finally report the parameter estimates and their standard errors.

Table 48 shows the summary statistics of the historical 1-year Treasury rates for two periods, one from 1971 and the other from 1992, as well as the simulated series. We can see that in the last 25 years, interest rates have been much more stable than in the past.

Table 48: Statistics for the 1-Year Treasury Rates

Statistics	Since 1953	Since 1992	Simulations
Mean	4.86%	2.46%	2.93%
Standard Deviation	3.28%	2.27%	2.48%
Max	16.31%	6.71%	17.26%
95- Percentile	10.30%	5.94%	9.75%
90- Percentile	9.02%	5.65%	7.18%
50- Percentile	4.72%	2.33%	2.58%
25-Percentile	2.39%	0.53%	1.89%
10- Percentile	0.52%	0.16%	0.93%
5- Percentile	0.19%	0.13%	0.33%
Min	0.10%	0.10%	0.01%

An ARMA(2,4) parameterization was used to model the 1-Year Treasury rate (*r1*) difference from the previous period and estimated it using data from CY 1953 Q1 to CY 2018 Q2. The process takes the following form:

$$r_{1,t} = x_1 r_{1,ar1} + x_2 r_{1,ar2} + x_3 w_{1,ma1} + x_4 w_{1,ma2} + x_5 w_{1,ma3} + x_6 w_{1,ma4} + \sigma_t dZ_1 \qquad (2)$$

Where Z_1 is an independent Wiener random process with distribution N(0,.5), and where the variance (σ) of the residual term follows a GARCH(1,1) process:

$$\sigma_t{}^2 = \beta_0 + \beta_1 \varepsilon^2{}_{t-1} + \beta_2 \sigma^2{}_{t-1} \qquad (3)$$

Where ε is the error term, which equals $\sigma_t dZ_1$ from equation (2).

Full information maximum likelihood (FIML) method was used to estimate the parameters in equations (2) and (3). The results are presented in Table 49.

Table 49: Estimation Results for 1-Year Treasury Rate Model

Parameter	Estimate	Std Dev	t-value	prob>t
x_1	0.2585	0.3296	0.7841	0.4330
x_2	-0.1196	0.2902	-0.4120	0.6803
x_3	0.2269	0.3088	0.7347	0.4625
x_4	0.0256	0.1826	0.1403	0.8884
x_4	0.2484	0.1337	1.8576	0.0632
x_5	0.1968	0.0789	2.4955	0.0126
β0	0.0000	0.0000	0.0358	0.9714
β1	0.3172	0.0420	7.5521	0.0000
β2	0.6818	0.0370	18.4040	0.0000
Pearson's GOF	0.9380			

The model based on these parameters is used to simulate the 1-year Treasury rates for the forecast period starting in FY 2018 Q3. The model was fit using Akaike Information Criterion (AIC) and Pearson's goodness-of-fit test.

A lower bound of 0.01 percent was applied to the simulated future 1-year Treasury rates to avoid negative rates in the simulation.

Additional Interest Rate Models

Additional interest rate models were developed. All are transformed as a spread (difference) between the current maturity length and prior. Table 50 describes these spreads and models.

Table 50: Model Specification for Additional Interest Rates

Variable	Variable Transformation	Model Specification	*Notes
3-month	$S_{3m} = r_{3m} - r_{6m}$	AR(1)-GARCH(1,1)	
6-month	$S_{6m} = r_{6m} - r_{1y}$	ARMA(4,2)-GARCH(1,1)	
1-year	r_{1y}	ARMA(2,4)-GARCH(1,1)	*Base Interest Rate
2-year	$S_{2y} = r_{2y} - r_{1y}$	ARMA(1,2)-ARCH(1)	
3-year	$S_{3y} = r_{3y} - r_{2y}$	ARMA(2,1)-ARCH(1)	
5-year	$S_{5y} = r_{5y} - r_{2y}$	ARMA(2,1)-ARCH(1)	
7-year	$S_{7y} = r_{7y} - r_{5y}$	ARMA(2,1)-ARCH(1)	
10-year	$S_{10y} = r_{10y} - r_{7y}$	ARMA(2,1)-ARCH(1)	
20-year	$S_{20y} = r_{20y} - r_{10y}$	AR (2)	*dataset for 1980 forward producing a weaker model
30-year	$S_{30y} = r_{30y} - r_{10y}$	ARMA(1,1)-GARCH(1,1)	*used 10 year rate for spread
30-year FRM	$S_{mr} = r_{mr} - r_{30y}$	AR(1)-ARCH(1)	

All models also used Akaike Information Criterion (AIC) and/or Pearson's goodness-of-fit test to determine the best fitting model.

A lower bound of 0.01 percent was applied to the simulated future Treasury rates to avoid negative rates in the simulation.

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Figure 61: Interest Rate Sample Simulation
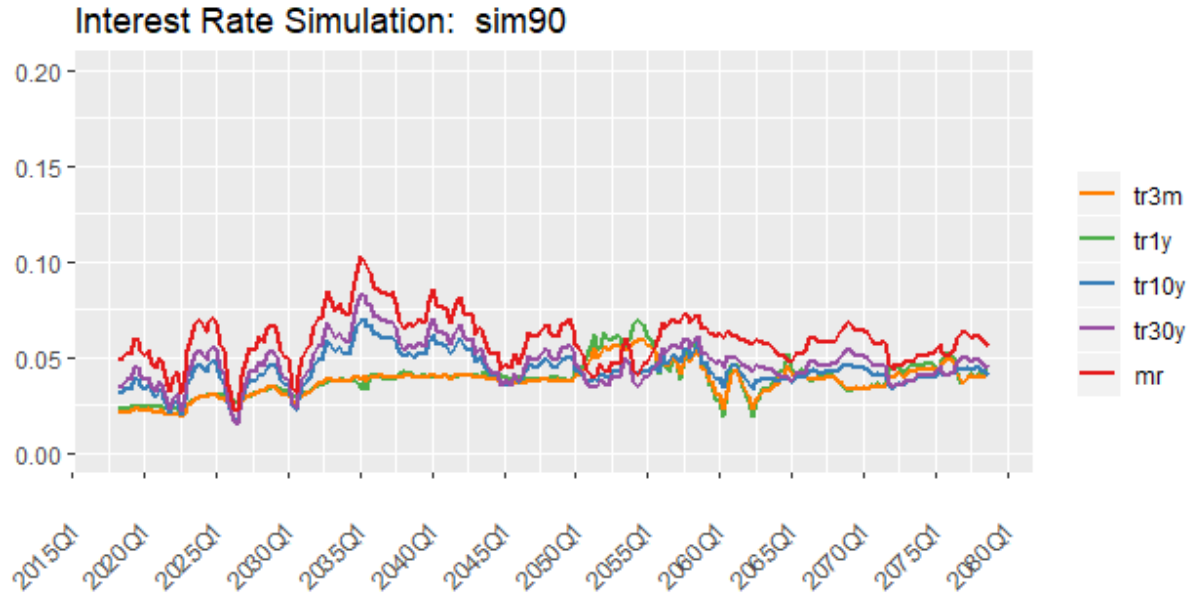
House Price Appreciation Rate (HPA)

A. National HPA

The national HPA series was fit using an ARMA(1,1)-GARCH(1,1). The 1-year, 10-year, and mortgage rates at time *t* and *t-1* were also included as external regressors for a model formula:

$$HPA_t = \mu + x_1 HPA_{ar1} + x_2 w_{1,ma1} + x_3 r_{1,t} + x_4 r_{1,t-1} + x_5 r_{10,t} + x_6 r_{10,t-1} + x_7 mr_t + x_8 mr_{t-1} + \sigma_t dZ_1 \qquad (4)$$

Where Z_1 is an independent Wiener random process with distribution N(0,1), and where the variance (σ) of the residual term follows a GARCH(1,1) process:

$$\sigma_t^2 = \beta_0 + \beta_1 \varepsilon^2_{t-1} + \beta_2 \sigma^2_{t-1} \qquad (5)$$

The model specification and variable inclusions were determined by achieving appropriate coefficient signs and significance, and overall model fit. FIML was used to estimate parameters in equations (4) and (5). The results are shown in Table 51.

Table 51: Estimation Results for the National HPA Model

Parameter	Estimate	Std Dev	t-value	prob>t
μ	0.0252	0.0068	3.7051	0.0002
x_1	0.9382	0.0288	32.6179	0.0000
x_2	-0.2899	0.1044	-2.7771	0.0055
x_3	-0.0740	0.0675	-1.0960	0.2731
x_4	-0.1391	0.0678	-2.0525	0.0401
x_5	0.1167	0.1928	0.6054	0.5449
x_6	-0.1933	0.1708	-1.1315	0.2578
x_7	-0.1600	0.0939	-1.7031	0.0885
x_8	-0.0954	0.0865	-1.1028	0.2701
$\beta0$	0.0000	0.0000	0.3245	0.7456
$\beta1$	0.4479	0.1483	3.0207	0.0025
$\beta2$	0.5511	0.0956	5.7675	0.0000
Pearson's GOF	0.7848			

We used these parameters to simulate future HPAs from FY 2018 Q3.

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 ith 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 ith 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.[43]

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 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.

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[43] The dispersion of each MSA remains constant among all alternative Moody's forecast scenarios.

Unemployment Rate

A. National Unemployment Rate

In our unemployment rate model, the unemployment rate depends on the prior unemployment rate, mortgage rates and Treasury rates.

We used quarterly data from CY 1971 to CY 2018 Q2 to estimate the national unemployment rate. The model we adopted was:

$$ue_t = \mu + x_1 ue_{ar1} + x_2 ue_{ar2} + x_3 ue_{ar3} + x_4 r_t + x_5 s_{mr} + \varepsilon_t \qquad (8)$$

where r_t is the 1-year Treasury rate,

s_{mr} is the 30-year mortgage rate to 10-year treasury rate spread,

ue_{ari} is the unemployment rate auto regressive component at the ith interval.

The model specification and variable inclusions were determined by achieving appropriate coefficient signs and significance, and overall model fit. FIML was used to estimate parameters in equation (8). The results are shown in Table 52.

Table 52: Estimation Results for the National Unemployment Rate Model

Parameter	Estimate	Std Error
μ	0.0685	0.0057
x_1	1.6273	0.0736
x_2	-0.6042	0.1346
x_3	-0.0508	0.0740
x_4	-0.1395	0.0219
x_5	-0.0065	0.0406

From the simulated interest rates and house prices, we applied the parameters shown in Table 52 to calculate the corresponding national unemployment rate. Based on historical statistics, the national unemployment rate was capped at 20% with a floor at 2%.

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 ith MSA or State level and the national level from Moody's July base-case forecast at each time t:

$$Disp_{i,t}^{Base} = ue_{i,t}^{Base} / ue_{national,t}^{Base} \qquad (9)$$

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 ith MSA at time t was computed as:

$$ue_{i,t}^{j} = ue_{national,t}^{j} * Disp_{i,t}^{Base} \qquad (10)$$

For the simulation, we capped the unemployment rate at the local level at 30% with a floor at 1%.

Gross Domestic Product

In the Gross Domestic Product (GDP) model, the GDP depends on the prior GDP, unemployment, mortgage and Treasury rates.

We used quarterly data from CY 1971 to CY 2018 Q2 to estimate the national unemployment rate. The model tested for integration, so first difference transformations were used prior to estimations. The model adopted was an ARMA(1,2):

$$GDP_t = x_1 GDP_{ar1} + x_2 GDP_{ma1} + x_3 GDP_{ma2} + x_4 r_t + x_5 s_{mr,t} + x_6 ue_t + \varepsilon_t \qquad (11)$$

where, r_t is the 1-year Treasury rate,

$s_{mr,t}$ is the 30-year mortgage rate to 10-year treasury rate spread,

ue_t is the unemployment rate,

GDP_{ar1} is the unemployment rate auto regressive component,

GDP_{mai} is the unemployment rate moving average component at the ith interval.

The model specification and variable inclusions were determined by achieving appropriate coefficient signs and significance, and overall model fit. FIML was used to estimate parameters in equation (11). The results are shown in Table 53.

Table 53: Estimation Results for the National Gross Domestic Product Model

Parameter	Estimate	Std Error
x_1	0.7290	0.1242
x_2	-1.3563	0.1519
x_3	0.3858	0.1383
x_4	1223.90	760.00
X_5	-1317.81	928.72
X_6	-216.00	736.72

Simulation Selection/Moody's Baseline

A total of 1000 simulations paths were generated using all of the economic variable models described. This was to create a large sample pool. From this pool a sample was drawn of 100 simulated series.

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It was desired that these simulations center around the ten Moody's June 2018 forecasts used within this analysis. Using a least squares method (12) the Moody's forecasts were compared to the simulated paths to sample 10 simulations.

$$score_{v,s} = min(\sum_1^p (vm_t - vs_t)^2) \hspace{3cm} (12)$$

where vm_t is the Moody's forecasted economic variable value at time t,

vs_t is the stochastic simulated economic variable forecasted value at time t,

p is the number of periods compared.

The first 40 periods (10 years) of the series were used for p, as the Moody's forecasts converge to a mean value after this time period. Each economic variable (v) was scored for each simulation (s) and then ranked in a scoring algorithm, and then selecting the 10 best models for each of the 10 Moody's forecasts to provide 100 simulated paths that most closely center on each of these forecasts.

Appendix E: Cash Flow Analysis

Introduction

The calculation of the Cash Flow NPV of the MMIF 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 MMIF's various cash flow sources. The cash flow projection model uses projections from predictive models as discussed in Appendix B (Transition Models), Appendix C (Loss Severity Models), and the economic scenarios described in Appendix D. We developed predictive models for conditional transition probabilities for individual mortgages depending on a number of 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 54: Cash Flow Components

Cash Inflows	Cash Out Flows
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 revenue to the MMIF is insurance premiums. If the MMIF'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 mortgage mortgages insured by the MMIF 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 on a monthly basis 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 policy years 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 receive 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 on a monthly basis, 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 actually 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 considered to be "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 MMIF'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. Traditionally, in most cases, FHA takes possession of the foreclosed property and sells the property to partially recover the loss. This particular type of 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 PFS, TPS and REO. 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 net loss is determined.

Loss Mitigation Expenses

FHA initiated a loss mitigation program in 1996 in an effort 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.

Loan mitigation cases increased significantly from fiscal year 2007 to fiscal year 2014. There were 80,622 loss mitigation claims in fiscal year 2007 which increased to 178,635 cases in fiscal year 2014. The amount FHA paid in these cases and curtailments was $542 million in fiscal year 2007, which increased to $4.72 billion in fiscal year 2015. Loss mitigation payments made by FHA include administrative fees and costs of title searches, recording fees and subordinated mortgage note amounts.

As discussed in Appendix C, we have developed models to project loss mitigation expenses.

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: 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.

1. **Claim Rate**: number of claims divided by the number of originations for the cohort

2. **Non-Claim Termination**: number of terminations that were not by reason of maturity or claim divided by the number of originations for the cohort

3. **Loss**: Net loss severity divided by the origination volume for the cohort

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Claim Rate - FRM30

Fiscal Year	\\ QUARTERS OF MATURITY \\ 4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0001	0.0035	0.0117	0.0151	0.0136	0.0099	0.0072	0.0061	0.0046	0.0033	0.0023	0.0015	0.0010	0.0008	0.0006	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
1991	0.0001	0.0029	0.0099	0.0120	0.0100	0.0078	0.0069	0.0053	0.0038	0.0027	0.0017	0.0012	0.0008	0.0007	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
1992	0.0001	0.0021	0.0070	0.0089	0.0084	0.0084	0.0072	0.0057	0.0037	0.0025	0.0018	0.0012	0.0009	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
1993	0.0001	0.0021	0.0064	0.0092	0.0108	0.0099	0.0077	0.0053	0.0032	0.0023	0.0016	0.0011	0.0007	0.0005	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
1994	0.0000	0.0020	0.0061	0.0088	0.0097	0.0082	0.0058	0.0037	0.0027	0.0019	0.0013	0.0009	0.0005	0.0004	0.0003	0.0004	0.0004	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000
1995	0.0001	0.0029	0.0107	0.0161	0.0152	0.0114	0.0076	0.0054	0.0049	0.0032	0.0019	0.0013	0.0009	0.0008	0.0008	0.0008	0.0008	0.0006	0.0006	0.0005	0.0005	0.0006	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001
1996	0.0001	0.0036	0.0128	0.0169	0.0143	0.0100	0.0077	0.0064	0.0043	0.0027	0.0017	0.0012	0.0010	0.0009	0.0010	0.0009	0.0009	0.0008	0.0006	0.0008	0.0007	0.0005	0.0004	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001
1997	0.0001	0.0039	0.0123	0.0144	0.0118	0.0101	0.0084	0.0058	0.0038	0.0023	0.0016	0.0014	0.0012	0.0010	0.0011	0.0009	0.0009	0.0009	0.0006	0.0005	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1998	0.0001	0.0038	0.0109	0.0120	0.0116	0.0103	0.0071	0.0045	0.0029	0.0021	0.0017	0.0017	0.0017	0.0016	0.0014	0.0015	0.0012	0.0012	0.0011	0.0007	0.0005	0.0006	0.0005	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
1999	0.0001	0.0036	0.0096	0.0121	0.0127	0.0090	0.0056	0.0034	0.0024	0.0019	0.0018	0.0018	0.0016	0.0015	0.0012	0.0012	0.0011	0.0007	0.0006	0.0007	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2000	0.0002	0.0054	0.0162	0.0198	0.0139	0.0081	0.0049	0.0033	0.0027	0.0022	0.0022	0.0019	0.0017	0.0016	0.0013	0.0013	0.0012	0.0008	0.0006	0.0007	0.0005	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2001	0.0001	0.0052	0.0164	0.0170	0.0115	0.0072	0.0049	0.0040	0.0034	0.0036	0.0032	0.0028	0.0026	0.0020	0.0019	0.0017	0.0011	0.0009	0.0010	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
2002	0.0001	0.0047	0.0128	0.0120	0.0083	0.0058	0.0048	0.0044	0.0045	0.0040	0.0037	0.0036	0.0026	0.0025	0.0022	0.0013	0.0011	0.0013	0.0011	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001
2003	0.0000	0.0040	0.0090	0.0081	0.0064	0.0059	0.0057	0.0068	0.0059	0.0058	0.0063	0.0045	0.0036	0.0031	0.0019	0.0010	0.0017	0.0016	0.0013	0.0011	0.0008	0.0006	0.0005	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002
2004	0.0005	0.0067	0.0118	0.0125	0.0122	0.0136	0.0117	0.0117	0.0125	0.0095	0.0077	0.0066	0.0041	0.0023	0.0034	0.0030	0.0024	0.0020	0.0017	0.0013	0.0011	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004
2005	0.0004	0.0060	0.0153	0.0190	0.0209	0.0233	0.0199	0.0198	0.0212	0.0153	0.0126	0.0105	0.0067	0.0035	0.0051	0.0043	0.0038	0.0033	0.0029	0.0024	0.0019	0.0016	0.0013	0.0013	0.0012	0.0009	0.0008	0.0008	0.0007	0.0007
2006	0.0002	0.0064	0.0201	0.0283	0.0333	0.0266	0.0260	0.0282	0.0202	0.0159	0.0133	0.0085	0.0049	0.0053	0.0048	0.0037	0.0032	0.0027	0.0024	0.0022	0.0016	0.0014	0.0012	0.0011	0.0010	0.0007	0.0007	0.0007	0.0006	0.0006
2007	0.0002	0.0085	0.0277	0.0389	0.0296	0.0323	0.0407	0.0266	0.0197	0.0164	0.0110	0.0060	0.0061	0.0055	0.0043	0.0036	0.0031	0.0026	0.0023	0.0018	0.0017	0.0016	0.0012	0.0011	0.0010	0.0008	0.0007	0.0007	0.0006	0.0006
2008	0.0001	0.0073	0.0258	0.0261	0.0312	0.0422	0.0274	0.0195	0.0159	0.0103	0.0055	0.0061	0.0051	0.0042	0.0035	0.0030	0.0024	0.0022	0.0021	0.0016	0.0014	0.0012	0.0010	0.0010	0.0008	0.0007	0.0006	0.0005	0.0005	0.0005
2009	0.0001	0.0048	0.0113	0.0173	0.0262	0.0202	0.0146	0.0121	0.0081	0.0045	0.0054	0.0047	0.0036	0.0029	0.0024	0.0020	0.0017	0.0015	0.0014	0.0011	0.0010	0.0008	0.0007	0.0007	0.0005	0.0004	0.0004	0.0004	0.0003	0.0003
2010	0.0001	0.0020	0.0066	0.0130	0.0127	0.0111	0.0091	0.0065	0.0039	0.0057	0.0051	0.0041	0.0033	0.0026	0.0021	0.0018	0.0016	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003
2011	0.0001	0.0019	0.0058	0.0071	0.0071	0.0065	0.0051	0.0031	0.0056	0.0051	0.0041	0.0033	0.0027	0.0020	0.0017	0.0014	0.0012	0.0011	0.0010	0.0009	0.0008	0.0007	0.0005	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
2012	0.0001	0.0014	0.0034	0.0046	0.0053	0.0043	0.0028	0.0061	0.0057	0.0048	0.0040	0.0032	0.0025	0.0020	0.0017	0.0014	0.0012	0.0011	0.0011	0.0009	0.0008	0.0007	0.0005	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003	0.0002
2013	0.0001	0.0011	0.0029	0.0043	0.0044	0.0031	0.0065	0.0060	0.0052	0.0044	0.0035	0.0028	0.0022	0.0019	0.0015	0.0014	0.0013	0.0010	0.0010	0.0007	0.0006	0.0005	0.0004	0.0004	0.0003	0.0002	0.0003	0.0003	0.0003	0.0002
2014	0.0000	0.0010	0.0034	0.0051	0.0039	0.0080	0.0068	0.0056	0.0049	0.0041	0.0033	0.0027	0.0022	0.0017	0.0015	0.0013	0.0012	0.0010	0.0009	0.0008	0.0006	0.0006	0.0005	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002
2015	0.0000	0.0006	0.0028	0.0033	0.0088	0.0079	0.0067	0.0061	0.0054	0.0045	0.0038	0.0031	0.0024	0.0021	0.0018	0.0015	0.0013	0.0012	0.0011	0.0009	0.0008	0.0007	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002
2016	0.0000	0.0007	0.0022	0.0089	0.0086	0.0077	0.0069	0.0062	0.0056	0.0047	0.0039	0.0032	0.0026	0.0022	0.0018	0.0016	0.0014	0.0012	0.0012	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003
2017	0.0000	0.0006	0.0084	0.0087	0.0074	0.0067	0.0059	0.0053	0.0048	0.0042	0.0033	0.0028	0.0024	0.0020	0.0017	0.0015	0.0013	0.0011	0.0011	0.0009	0.0007	0.0006	0.0006	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
2018	0.0000	0.0036	0.0061	0.0059	0.0060	0.0058	0.0052	0.0048	0.0043	0.0038	0.0033	0.0027	0.0023	0.0019	0.0016	0.0015	0.0013	0.0012	0.0011	0.0009	0.0007	0.0007	0.0006	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Non-Claim Termination Rate - FRM30

Fiscal Year	QUARTERS OF MATURITY																													
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0012	0.0110	0.0524	0.1325	0.0834	0.0071	0.0080	0.0014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0011	0.0285	0.1282	0.1017	0.0072	0.0093	0.0047	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0043	0.0525	0.0762	0.0066	0.0084	0.0045	0.0111	0.0072	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0029	0.0025	0.0024
1993	0.0074	0.0296	0.0047	0.0042	0.0025	0.0082	0.0117	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0004	0.0003	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0012	0.0035	0.0032	0.0030	0.0026
1994	0.0013	0.0068	0.0095	0.0062	0.0112	0.0110	0.0019	0.0006	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0004	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0036	0.0028	0.0028	0.0027	0.0023
1995	0.0114	0.0452	0.0196	0.0430	0.0293	0.0033	0.0050	0.0036	0.0000	0.0000	0.0000	0.0004	0.0005	0.0005	0.0004	0.0002	0.0002	0.0002	0.0003	0.0001	0.0001	0.0001	0.0001	0.0010	0.0033	0.0026	0.0026	0.0026	0.0027	0.0021
1996	0.0020	0.0166	0.0494	0.0399	0.0044	0.0069	0.0113	0.0058	0.0000	0.0001	0.0002	0.0004	0.0006	0.0007	0.0005	0.0003	0.0003	0.0005	0.0002	0.0002	0.0001	0.0001	0.0010	0.0036	0.0031	0.0030	0.0027	0.0028	0.0026	0.0023
1997	0.0067	0.0571	0.0590	0.0068	0.0096	0.0161	0.0190	0.0052	0.0001	0.0003	0.0005	0.0008	0.0008	0.0005	0.0004	0.0004	0.0005	0.0003	0.0002	0.0002	0.0002	0.0012	0.0036	0.0032	0.0031	0.0029	0.0028	0.0026	0.0025	0.0022
1998	0.0082	0.0331	0.0050	0.0093	0.0200	0.0294	0.0126	0.0029	0.0004	0.0007	0.0013	0.0016	0.0009	0.0006	0.0007	0.0010	0.0005	0.0003	0.0003	0.0003	0.0016	0.0043	0.0037	0.0035	0.0036	0.0032	0.0028	0.0027	0.0027	0.0022
1999	0.0010	0.0131	0.0242	0.0283	0.0368	0.0144	0.0056	0.0013	0.0007	0.0012	0.0015	0.0010	0.0006	0.0007	0.0012	0.0006	0.0004	0.0004	0.0003	0.0008	0.0038	0.0030	0.0028	0.0027	0.0028	0.0025	0.0023	0.0022	0.0021	0.0018
2000	0.0279	0.1614	0.1058	0.0515	0.0180	0.0071	0.0021	0.0010	0.0012	0.0012	0.0006	0.0004	0.0005	0.0007	0.0005	0.0004	0.0003	0.0002	0.0008	0.0027	0.0020	0.0019	0.0018	0.0019	0.0017	0.0016	0.0014	0.0013	0.0013	0.0012
2001	0.0295	0.1229	0.1348	0.0335	0.0107	0.0028	0.0013	0.0023	0.0030	0.0016	0.0012	0.0016	0.0022	0.0010	0.0006	0.0005	0.0004	0.0015	0.0042	0.0035	0.0029	0.0026	0.0025	0.0023	0.0023	0.0021	0.0018	0.0019	0.0018	0.0017
2002	0.0379	0.1559	0.0510	0.0136	0.0038	0.0018	0.0032	0.0046	0.0028	0.0021	0.0032	0.0040	0.0019	0.0010	0.0008	0.0006	0.0020	0.0052	0.0043	0.0040	0.0034	0.0030	0.0028	0.0026	0.0025	0.0022	0.0021	0.0021	0.0020	0.0019
2003	0.0304	0.0324	0.0143	0.0039	0.0021	0.0032	0.0068	0.0045	0.0038	0.0058	0.0128	0.0040	0.0022	0.0017	0.0015	0.0008	0.0089	0.0067	0.0061	0.0058	0.0049	0.0039	0.0037	0.0034	0.0034	0.0030	0.0027	0.0027	0.0027	0.0027
2004	0.0135	0.0348	0.0105	0.0047	0.0059	0.0121	0.0084	0.0066	0.0100	0.0219	0.0105	0.0048	0.0032	0.0025	0.0016	0.0143	0.0105	0.0093	0.0088	0.0080	0.0065	0.0057	0.0054	0.0049	0.0047	0.0044	0.0042	0.0042	0.0043	0.0038
2005	0.0116	0.0131	0.0086	0.0093	0.0178	0.0116	0.0096	0.0173	0.0374	0.0135	0.0076	0.0050	0.0040	0.0018	0.0137	0.0113	0.0102	0.0092	0.0084	0.0077	0.0063	0.0056	0.0051	0.0051	0.0053	0.0051	0.0045	0.0046	0.0048	0.0048
2006	0.0025	0.0226	0.0333	0.0549	0.0255	0.0180	0.0255	0.0450	0.0190	0.0106	0.0069	0.0049	0.0022	0.0115	0.0090	0.0085	0.0075	0.0070	0.0064	0.0057	0.0049	0.0045	0.0041	0.0040	0.0041	0.0041	0.0039	0.0041	0.0041	0.0042
2007	0.0079	0.0710	0.0939	0.0375	0.0217	0.0279	0.0465	0.0211	0.0118	0.0080	0.0066	0.0029	0.0108	0.0083	0.0075	0.0070	0.0064	0.0053	0.0049	0.0047	0.0040	0.0034	0.0034	0.0033	0.0035	0.0036	0.0034	0.0034	0.0035	0.0035
2008	0.0209	0.1601	0.0675	0.0348	0.0462	0.0667	0.0263	0.0135	0.0096	0.0075	0.0031	0.0110	0.0085	0.0073	0.0064	0.0060	0.0052	0.0044	0.0041	0.0037	0.0033	0.0030	0.0029	0.0028	0.0030	0.0030	0.0029	0.0030	0.0030	0.0031
2009	0.0448	0.0628	0.0416	0.0718	0.0863	0.0204	0.0174	0.0163	0.0107	0.0039	0.0228	0.0165	0.0142	0.0118	0.0101	0.0089	0.0074	0.0062	0.0055	0.0048	0.0042	0.0038	0.0036	0.0036	0.0037	0.0037	0.0034	0.0036	0.0036	0.0036
2010	0.0098	0.0251	0.0448	0.0495	0.0062	0.0158	0.0171	0.0115	0.0045	0.0402	0.0287	0.0237	0.0199	0.0162	0.0135	0.0114	0.0096	0.0081	0.0069	0.0063	0.0054	0.0048	0.0048	0.0047	0.0048	0.0047	0.0043	0.0046	0.0046	0.0047
2011	0.0010	0.0372	0.0442	0.0052	0.0142	0.0136	0.0095	0.0041	0.0511	0.0356	0.0297	0.0245	0.0200	0.0156	0.0132	0.0114	0.0095	0.0077	0.0068	0.0062	0.0054	0.0048	0.0047	0.0047	0.0048	0.0047	0.0044	0.0046	0.0047	0.0046
2012	0.0029	0.0280	0.0052	0.0149	0.0127	0.0082	0.0039	0.0668	0.0467	0.0381	0.0316	0.0258	0.0202	0.0159	0.0132	0.0114	0.0093	0.0079	0.0071	0.0067	0.0060	0.0051	0.0050	0.0050	0.0050	0.0050	0.0045	0.0049	0.0050	0.0050
2013	0.0006	0.0049	0.0227	0.0138	0.0092	0.0046	0.0815	0.0617	0.0506	0.0415	0.0340	0.0268	0.0211	0.0166	0.0139	0.0115	0.0097	0.0083	0.0077	0.0073	0.0063	0.0054	0.0053	0.0052	0.0054	0.0052	0.0048	0.0051	0.0054	0.0053
2014	0.0055	0.1472	0.0558	0.0238	0.0073	0.0512	0.0420	0.0392	0.0330	0.0279	0.0224	0.0181	0.0148	0.0117	0.0097	0.0087	0.0075	0.0067	0.0061	0.0059	0.0049	0.0046	0.0044	0.0045	0.0045	0.0044	0.0041	0.0045	0.0047	0.0046
2015	0.0198	0.0760	0.0384	0.0116	0.0778	0.0602	0.0548	0.0505	0.0413	0.0319	0.0256	0.0204	0.0163	0.0128	0.0107	0.0099	0.0085	0.0074	0.0067	0.0065	0.0057	0.0048	0.0047	0.0048	0.0049	0.0050	0.0044	0.0049	0.0050	0.0051
2016	0.0152	0.0419	0.0160	0.1024	0.0806	0.0701	0.0658	0.0587	0.0449	0.0346	0.0277	0.0219	0.0172	0.0137	0.0119	0.0108	0.0092	0.0082	0.0074	0.0070	0.0059	0.0054	0.0053	0.0052	0.0053	0.0053	0.0049	0.0051	0.0055	0.0053
2017	0.0058	0.0280	0.1077	0.0914	0.0824	0.0742	0.0679	0.0582	0.0449	0.0351	0.0280	0.0216	0.0176	0.0144	0.0126	0.0115	0.0100	0.0087	0.0080	0.0074	0.0063	0.0057	0.0056	0.0057	0.0057	0.0056	0.0053	0.0055	0.0057	0.0057
2018	0.0034	0.0641	0.1022	0.0978	0.0914	0.0792	0.0699	0.0595	0.0461	0.0360	0.0276	0.0225	0.0184	0.0153	0.0131	0.0120	0.0104	0.0090	0.0082	0.0077	0.0064	0.0058	0.0057	0.0056	0.0057	0.0058	0.0054	0.0055	0.0058	0.0060

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Loss Rate - FRM30

Fiscal Year	QUARTERS OF MATURITY

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0001	0.0034	0.0123	0.0172	0.0158	0.0115	0.0082	0.0069	0.0051	0.0036	0.0023	0.0015	0.0010	0.0007	0.0005	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
1991	0.0001	0.0028	0.0108	0.0136	0.0117	0.0091	0.0081	0.0061	0.0042	0.0028	0.0017	0.0011	0.0008	0.0006	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1992	0.0001	0.0021	0.0075	0.0099	0.0095	0.0100	0.0085	0.0067	0.0042	0.0027	0.0018	0.0012	0.0007	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1993	0.0001	0.0022	0.0070	0.0104	0.0128	0.0117	0.0088	0.0060	0.0034	0.0024	0.0015	0.0010	0.0006	0.0004	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0020	0.0063	0.0096	0.0111	0.0092	0.0064	0.0039	0.0028	0.0018	0.0012	0.0007	0.0004	0.0003	0.0002	0.0003	0.0003	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0027	0.0110	0.0171	0.0167	0.0124	0.0082	0.0054	0.0047	0.0029	0.0016	0.0011	0.0007	0.0006	0.0006	0.0006	0.0006	0.0004	0.0004	0.0004	0.0004	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
1996	0.0000	0.0034	0.0129	0.0176	0.0152	0.0104	0.0076	0.0061	0.0038	0.0022	0.0014	0.0010	0.0008	0.0007	0.0008	0.0007	0.0006	0.0006	0.0004	0.0006	0.0005	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0001	0.0038	0.0128	0.0149	0.0118	0.0100	0.0080	0.0053	0.0033	0.0020	0.0013	0.0012	0.0010	0.0008	0.0008	0.0006	0.0007	0.0007	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0001	0.0037	0.0111	0.0121	0.0113	0.0098	0.0065	0.0040	0.0025	0.0017	0.0014	0.0014	0.0014	0.0013	0.0011	0.0012	0.0008	0.0009	0.0008	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0001	0.0035	0.0094	0.0119	0.0124	0.0084	0.0050	0.0030	0.0020	0.0016	0.0015	0.0016	0.0015	0.0013	0.0012	0.0009	0.0009	0.0008	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0001	0.0050	0.0153	0.0191	0.0130	0.0073	0.0044	0.0029	0.0024	0.0020	0.0020	0.0017	0.0014	0.0013	0.0010	0.0010	0.0009	0.0006	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0001	0.0045	0.0149	0.0156	0.0104	0.0064	0.0043	0.0036	0.0031	0.0032	0.0028	0.0024	0.0021	0.0015	0.0014	0.0012	0.0007	0.0005	0.0005	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0001	0.0041	0.0115	0.0107	0.0074	0.0052	0.0043	0.0039	0.0040	0.0035	0.0032	0.0030	0.0020	0.0019	0.0015	0.0008	0.0006	0.0007	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0034	0.0080	0.0071	0.0057	0.0054	0.0052	0.0062	0.0054	0.0051	0.0053	0.0037	0.0029	0.0023	0.0012	0.0006	0.0009	0.0008	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2004	0.0005	0.0061	0.0103	0.0112	0.0119	0.0115	0.0128	0.0109	0.0107	0.0110	0.0082	0.0064	0.0052	0.0028	0.0014	0.0021	0.0017	0.0013	0.0010	0.0007	0.0005	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
2005	0.0004	0.0051	0.0138	0.0185	0.0209	0.0233	0.0200	0.0190	0.0201	0.0143	0.0113	0.0088	0.0047	0.0022	0.0031	0.0025	0.0020	0.0017	0.0013	0.0011	0.0007	0.0006	0.0004	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001
2006	0.0001	0.0053	0.0189	0.0280	0.0338	0.0266	0.0255	0.0277	0.0193	0.0146	0.0117	0.0065	0.0035	0.0034	0.0028	0.0021	0.0017	0.0013	0.0011	0.0010	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000
2007	0.0001	0.0075	0.0269	0.0389	0.0289	0.0319	0.0415	0.0264	0.0185	0.0149	0.0088	0.0043	0.0043	0.0036	0.0026	0.0020	0.0016	0.0013	0.0011	0.0008	0.0007	0.0006	0.0004	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000
2008	0.0001	0.0062	0.0237	0.0233	0.0278	0.0390	0.0250	0.0168	0.0133	0.0075	0.0036	0.0031	0.0023	0.0018	0.0014	0.0011	0.0009	0.0008	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000
2009	0.0001	0.0038	0.0092	0.0137	0.0217	0.0168	0.0116	0.0093	0.0053	0.0026	0.0028	0.0022	0.0015	0.0011	0.0009	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2010	0.0000	0.0014	0.0046	0.0096	0.0096	0.0080	0.0060	0.0037	0.0019	0.0029	0.0024	0.0017	0.0013	0.0009	0.0007	0.0006	0.0005	0.0004	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2011	0.0000	0.0011	0.0039	0.0051	0.0050	0.0041	0.0028	0.0014	0.0030	0.0025	0.0018	0.0013	0.0010	0.0007	0.0005	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0007	0.0022	0.0030	0.0032	0.0023	0.0013	0.0034	0.0030	0.0023	0.0018	0.0012	0.0009	0.0007	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0007	0.0019	0.0026	0.0024	0.0015	0.0040	0.0035	0.0028	0.0021	0.0015	0.0012	0.0008	0.0006	0.0005	0.0004	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0006	0.0019	0.0028	0.0020	0.0033	0.0025	0.0018	0.0015	0.0011	0.0009	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0003	0.0013	0.0015	0.0040	0.0032	0.0024	0.0019	0.0016	0.0012	0.0010	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0000	0.0002	0.0008	0.0046	0.0039	0.0030	0.0024	0.0019	0.0016	0.0013	0.0010	0.0008	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0002	0.0046	0.0045	0.0033	0.0026	0.0020	0.0016	0.0014	0.0011	0.0008	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0019	0.0035	0.0030	0.0027	0.0023	0.0018	0.0014	0.0012	0.0010	0.0008	0.0007	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Claim Rate - FRM15

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0000	0.0019	0.0057	0.0079	0.0069	0.0070	0.0049	0.0030	0.0024	0.0014	0.0011	0.0004	0.0002	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0000	0.0013	0.0042	0.0056	0.0064	0.0046	0.0035	0.0025	0.0016	0.0010	0.0003	0.0002	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0007	0.0029	0.0033	0.0029	0.0024	0.0022	0.0015	0.0009	0.0005	0.0003	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0005	0.0020	0.0020	0.0021	0.0017	0.0014	0.0010	0.0006	0.0004	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0006	0.0015	0.0021	0.0020	0.0015	0.0012	0.0007	0.0005	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0008	0.0023	0.0032	0.0030	0.0020	0.0013	0.0012	0.0011	0.0007	0.0002	0.0004	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0007	0.0022	0.0034	0.0032	0.0028	0.0019	0.0014	0.0011	0.0007	0.0006	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0008	0.0026	0.0036	0.0033	0.0019	0.0013	0.0011	0.0011	0.0007	0.0002	0.0000	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0006	0.0022	0.0022	0.0029	0.0021	0.0014	0.0011	0.0005	0.0004	0.0003	0.0003	0.0003	0.0000	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0004	0.0015	0.0017	0.0023	0.0015	0.0010	0.0005	0.0005	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0008	0.0034	0.0052	0.0046	0.0019	0.0022	0.0010	0.0008	0.0008	0.0007	0.0005	0.0000	0.0004	0.0004	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0001	0.0016	0.0042	0.0050	0.0040	0.0029	0.0012	0.0009	0.0017	0.0012	0.0013	0.0006	0.0005	0.0006	0.0006	0.0001	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0001	0.0010	0.0027	0.0024	0.0018	0.0011	0.0011	0.0008	0.0010	0.0009	0.0009	0.0008	0.0005	0.0005	0.0006	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0005	0.0011	0.0012	0.0008	0.0011	0.0011	0.0013	0.0012	0.0011	0.0012	0.0009	0.0006	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0001	0.0007	0.0018	0.0021	0.0018	0.0021	0.0025	0.0024	0.0020	0.0021	0.0017	0.0014	0.0014	0.0006	0.0003	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0001	0.0030	0.0065	0.0059	0.0062	0.0061	0.0043	0.0034	0.0044	0.0033	0.0032	0.0026	0.0018	0.0005	0.0018	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0002	0.0086	0.0129	0.0145	0.0123	0.0084	0.0090	0.0093	0.0063	0.0060	0.0044	0.0043	0.0023	0.0022	0.0026	0.0006	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0001	0.0072	0.0206	0.0182	0.0119	0.0159	0.0190	0.0114	0.0090	0.0088	0.0051	0.0032	0.0021	0.0037	0.0025	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0001	0.0037	0.0107	0.0107	0.0135	0.0196	0.0125	0.0093	0.0073	0.0051	0.0024	0.0029	0.0038	0.0016	0.0017	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0001	0.0018	0.0030	0.0052	0.0084	0.0068	0.0065	0.0043	0.0028	0.0016	0.0019	0.0018	0.0014	0.0008	0.0010	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0005	0.0018	0.0036	0.0033	0.0033	0.0027	0.0020	0.0011	0.0019	0.0016	0.0013	0.0011	0.0007	0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0005	0.0015	0.0018	0.0020	0.0017	0.0013	0.0009	0.0016	0.0016	0.0012	0.0010	0.0007	0.0006	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0003	0.0008	0.0010	0.0012	0.0010	0.0005	0.0015	0.0017	0.0013	0.0010	0.0008	0.0006	0.0005	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0001	0.0007	0.0010	0.0013	0.0007	0.0022	0.0018	0.0021	0.0015	0.0013	0.0008	0.0006	0.0005	0.0004	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0004	0.0007	0.0017	0.0016	0.0038	0.0025	0.0023	0.0022	0.0016	0.0010	0.0012	0.0007	0.0004	0.0006	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0004	0.0010	0.0011	0.0033	0.0028	0.0028	0.0024	0.0018	0.0014	0.0014	0.0013	0.0004	0.0005	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0000	0.0002	0.0010	0.0028	0.0029	0.0024	0.0024	0.0019	0.0019	0.0011	0.0016	0.0008	0.0006	0.0006	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0002	0.0030	0.0034	0.0021	0.0018	0.0019	0.0016	0.0013	0.0012	0.0012	0.0007	0.0006	0.0004	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0018	0.0023	0.0023	0.0020	0.0019	0.0017	0.0014	0.0012	0.0009	0.0008	0.0006	0.0003	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

QUARTERS OF MATURITY

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Non-Claim Termination Rate - FRM15

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0004	0.0049	0.0181	0.0479	0.0406	0.0039	0.0049	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0005	0.0123	0.0545	0.0563	0.0044	0.0053	0.0021	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0026	0.0332	0.0461	0.0045	0.0062	0.0020	0.0043	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0035	0.0164	0.0023	0.0028	0.0027	0.0037	0.0040	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0002	0.0016	0.0031	0.0021	0.0031	0.0037	0.0009	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0034	0.0141	0.0055	0.0101	0.0075	0.0013	0.0012	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0004	0.0037	0.0113	0.0128	0.0017	0.0025	0.0033	0.0014	0.0000	0.0000	0.0001	0.0003	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0021	0.0167	0.0182	0.0026	0.0037	0.0066	0.0080	0.0018	0.0000	0.0000	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0022	0.0122	0.0022	0.0046	0.0097	0.0159	0.0062	0.0022	0.0006	0.0005	0.0008	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0006	0.0027	0.0059	0.0096	0.0185	0.0072	0.0030	0.0007	0.0004	0.0006	0.0007	0.0004	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0055	0.0444	0.0381	0.0279	0.0120	0.0063	0.0013	0.0004	0.0003	0.0001	0.0002	0.0001	0.0005	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0099	0.0665	0.0943	0.0241	0.0085	0.0026	0.0013	0.0019	0.0016	0.0012	0.0006	0.0004	0.0004	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0181	0.0719	0.0236	0.0088	0.0028	0.0018	0.0024	0.0024	0.0018	0.0011	0.0007	0.0004	0.0002	0.0002	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0097	0.0104	0.0061	0.0033	0.0018	0.0031	0.0037	0.0032	0.0019	0.0013	0.0012	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0029	0.0088	0.0056	0.0032	0.0040	0.0048	0.0046	0.0028	0.0023	0.0022	0.0013	0.0005	0.0005	0.0005	0.0004	0.0131	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0058	0.0147	0.0057	0.0077	0.0085	0.0068	0.0046	0.0033	0.0039	0.0018	0.0010	0.0010	0.0005	0.0005	0.0515	0.0177	0.0008	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0168	0.0271	0.0259	0.0289	0.0146	0.0067	0.0063	0.0085	0.0029	0.0011	0.0009	0.0013	0.0005	0.0358	0.0438	0.0113	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0207	0.0623	0.0691	0.0301	0.0139	0.0110	0.0146	0.0060	0.0031	0.0020	0.0024	0.0016	0.0249	0.0229	0.0356	0.0119	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0142	0.1053	0.0570	0.0320	0.0278	0.0315	0.0120	0.0057	0.0053	0.0028	0.0014	0.0282	0.0240	0.0228	0.0307	0.0151	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0270	0.0425	0.0527	0.0527	0.0446	0.0128	0.0066	0.0057	0.0034	0.0022	0.0351	0.0279	0.0272	0.0240	0.0331	0.0176	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0037	0.0363	0.0564	0.0400	0.0097	0.0069	0.0058	0.0041	0.0022	0.0444	0.0373	0.0327	0.0298	0.0277	0.0389	0.0148	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0036	0.0806	0.0444	0.0082	0.0070	0.0062	0.0048	0.0024	0.0437	0.0379	0.0349	0.0313	0.0284	0.0264	0.0363	0.0134	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0044	0.0259	0.0081	0.0078	0.0071	0.0053	0.0033	0.0550	0.0478	0.0449	0.0416	0.0381	0.0323	0.0314	0.0439	0.0184	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0012	0.0068	0.0100	0.0087	0.0075	0.0050	0.0635	0.0554	0.0537	0.0512	0.0446	0.0412	0.0365	0.0349	0.0485	0.0183	0.0004	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0077	0.0432	0.0270	0.0193	0.0113	0.0559	0.0468	0.0436	0.0410	0.0382	0.0358	0.0309	0.0287	0.0271	0.0365	0.0163	0.0005	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0063	0.0324	0.0304	0.0183	0.0645	0.0530	0.0505	0.0457	0.0419	0.0406	0.0375	0.0325	0.0292	0.0278	0.0407	0.0181	0.0006	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0056	0.0292	0.0259	0.0848	0.0662	0.0589	0.0552	0.0488	0.0457	0.0433	0.0386	0.0358	0.0304	0.0314	0.0429	0.0188	0.0005	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0031	0.0254	0.0895	0.0744	0.0694	0.0608	0.0586	0.0527	0.0468	0.0447	0.0410	0.0368	0.0320	0.0318	0.0429	0.0183	0.0009	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0042	0.0530	0.0807	0.0787	0.0731	0.0642	0.0569	0.0540	0.0490	0.0472	0.0446	0.0401	0.0349	0.0343	0.0483	0.0205	0.0015	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Loss Rate - FRM15

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0000	0.0017	0.0058	0.0096	0.0087	0.0102	0.0066	0.0036	0.0030	0.0015	0.0015	0.0005	0.0002	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0001	0.0013	0.0048	0.0067	0.0093	0.0061	0.0042	0.0032	0.0018	0.0011	0.0004	0.0002	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0003	0.0011	0.0013	0.0012	0.0009	0.0008	0.0006	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0003	0.0011	0.0012	0.0012	0.0008	0.0007	0.0005	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0001	0.0041	0.0107	0.0156	0.0153	0.0111	0.0079	0.0042	0.0026	0.0016	0.0010	0.0005	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0005	0.0017	0.0023	0.0019	0.0013	0.0009	0.0007	0.0006	0.0003	0.0001	0.0002	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0010	0.0031	0.0052	0.0043	0.0037	0.0024	0.0015	0.0013	0.0006	0.0005	0.0002	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0005	0.0016	0.0019	0.0018	0.0010	0.0006	0.0006	0.0005	0.0004	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0003	0.0013	0.0013	0.0018	0.0010	0.0008	0.0005	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0013	0.0047	0.0053	0.0076	0.0041	0.0028	0.0012	0.0012	0.0008	0.0008	0.0006	0.0004	0.0004	0.0005	0.0002	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0004	0.0019	0.0031	0.0024	0.0012	0.0010	0.0004	0.0003	0.0004	0.0003	0.0002	0.0000	0.0001	0.0001	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0007	0.0017	0.0019	0.0016	0.0010	0.0005	0.0003	0.0005	0.0003	0.0003	0.0001	0.0001	0.0002	0.0003	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0005	0.0015	0.0012	0.0009	0.0005	0.0005	0.0004	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0008	0.0017	0.0016	0.0010	0.0013	0.0013	0.0015	0.0013	0.0012	0.0014	0.0011	0.0006	0.0008	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0001	0.0017	0.0047	0.0053	0.0047	0.0049	0.0060	0.0054	0.0049	0.0043	0.0038	0.0027	0.0030	0.0009	0.0006	0.0001	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0002	0.0063	0.0121	0.0106	0.0112	0.0105	0.0074	0.0050	0.0076	0.0056	0.0044	0.0032	0.0021	0.0005	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0003	0.0123	0.0184	0.0197	0.0176	0.0110	0.0120	0.0111	0.0087	0.0068	0.0046	0.0035	0.0018	0.0005	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0000	0.0018	0.0048	0.0045	0.0029	0.0041	0.0048	0.0026	0.0017	0.0020	0.0012	0.0005	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0000	0.0012	0.0034	0.0033	0.0041	0.0060	0.0035	0.0025	0.0019	0.0014	0.0004	0.0003	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0000	0.0010	0.0016	0.0027	0.0051	0.0037	0.0031	0.0021	0.0011	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0003	0.0010	0.0024	0.0021	0.0020	0.0015	0.0008	0.0005	0.0006	0.0004	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0003	0.0008	0.0010	0.0011	0.0008	0.0005	0.0002	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0003	0.0009	0.0011	0.0011	0.0008	0.0003	0.0011	0.0011	0.0007	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0002	0.0009	0.0013	0.0014	0.0008	0.0029	0.0021	0.0022	0.0014	0.0009	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0002	0.0005	0.0012	0.0009	0.0015	0.0008	0.0007	0.0005	0.0004	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0002	0.0005	0.0005	0.0017	0.0012	0.0010	0.0006	0.0004	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0000	0.0001	0.0005	0.0016	0.0014	0.0011	0.0007	0.0008	0.0005	0.0003	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0002	0.0036	0.0033	0.0018	0.0014	0.0012	0.0008	0.0006	0.0004	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

QUARTERS OF MATURITY

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Claim Rate - ARM

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0005	0.0038	0.0142	0.0142	0.0192	0.0152	0.0173	0.0156	0.0107	0.0069	0.0050	0.0024	0.0017	0.0007	0.0007	0.0002	0.0005	0.0000	0.0000	0.0000	0.0005	0.0002	0.0000	0.0002	0.0002	0.0000	0.0002	0.0000	0.0002	0.0000
1991	0.0001	0.0038	0.0102	0.0144	0.0165	0.0181	0.0191	0.0158	0.0106	0.0074	0.0034	0.0017	0.0012	0.0011	0.0004	0.0002	0.0002	0.0001	0.0004	0.0003	0.0004	0.0003	0.0002	0.0002	0.0003	0.0003	0.0002	0.0001	0.0000	0.0000
1992	0.0001	0.0018	0.0066	0.0099	0.0128	0.0149	0.0123	0.0084	0.0055	0.0026	0.0016	0.0011	0.0005	0.0003	0.0002	0.0001	0.0002	0.0003	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
1993	0.0000	0.0021	0.0080	0.0132	0.0190	0.0155	0.0109	0.0070	0.0035	0.0020	0.0016	0.0007	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
1994	0.0001	0.0026	0.0108	0.0189	0.0197	0.0146	0.0086	0.0045	0.0029	0.0020	0.0010	0.0005	0.0003	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
1995	0.0000	0.0032	0.0152	0.0222	0.0186	0.0106	0.0060	0.0041	0.0034	0.0018	0.0010	0.0005	0.0003	0.0003	0.0004	0.0003	0.0003	0.0004	0.0002	0.0003	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
1996	0.0001	0.0044	0.0193	0.0250	0.0178	0.0101	0.0073	0.0056	0.0028	0.0014	0.0009	0.0006	0.0007	0.0005	0.0005	0.0005	0.0005	0.0004	0.0005	0.0005	0.0003	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0051	0.0178	0.0202	0.0143	0.0108	0.0080	0.0038	0.0021	0.0012	0.0009	0.0008	0.0008	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
1998	0.0001	0.0029	0.0073	0.0072	0.0057	0.0046	0.0026	0.0013	0.0008	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0002	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0001	0.0056	0.0131	0.0193	0.0182	0.0109	0.0052	0.0032	0.0026	0.0018	0.0024	0.0020	0.0019	0.0020	0.0017	0.0011	0.0013	0.0009	0.0005	0.0005	0.0004	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001
2000	0.0000	0.0034	0.0093	0.0132	0.0084	0.0056	0.0033	0.0027	0.0025	0.0021	0.0018	0.0015	0.0015	0.0016	0.0010	0.0008	0.0007	0.0007	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2001	0.0001	0.0037	0.0129	0.0136	0.0087	0.0067	0.0050	0.0044	0.0051	0.0041	0.0036	0.0026	0.0026	0.0018	0.0014	0.0011	0.0007	0.0006	0.0003	0.0002	0.0003	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0001
2002	0.0001	0.0038	0.0122	0.0115	0.0096	0.0077	0.0078	0.0068	0.0059	0.0046	0.0040	0.0039	0.0025	0.0020	0.0018	0.0009	0.0005	0.0005	0.0002	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0034	0.0087	0.0082	0.0074	0.0078	0.0063	0.0057	0.0040	0.0037	0.0034	0.0023	0.0013	0.0013	0.0008	0.0004	0.0005	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000
2004	0.0005	0.0061	0.0133	0.0153	0.0167	0.0144	0.0115	0.0078	0.0082	0.0077	0.0051	0.0036	0.0031	0.0018	0.0009	0.0007	0.0005	0.0004	0.0003	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002
2005	0.0006	0.0094	0.0203	0.0275	0.0269	0.0237	0.0162	0.0156	0.0152	0.0113	0.0090	0.0061	0.0037	0.0023	0.0015	0.0008	0.0006	0.0006	0.0004	0.0002	0.0001	0.0002	0.0003	0.0001	0.0001	0.0003	0.0002	0.0002	0.0003	0.0003
2006	0.0002	0.0111	0.0283	0.0426	0.0451	0.0319	0.0287	0.0210	0.0158	0.0128	0.0068	0.0033	0.0024	0.0015	0.0007	0.0011	0.0004	0.0004	0.0003	0.0004	0.0004	0.0002	0.0001	0.0003	0.0000	0.0001	0.0002	0.0001	0.0004	0.0002
2007	0.0000	0.0109	0.0415	0.0616	0.0415	0.0378	0.0314	0.0170	0.0140	0.0131	0.0087	0.0057	0.0020	0.0011	0.0013	0.0013	0.0007	0.0000	0.0004	0.0004	0.0004	0.0004	0.0007	0.0000	0.0002	0.0002	0.0002	0.0004	0.0002	0.0002
2008	0.0001	0.0073	0.0330	0.0412	0.0391	0.0418	0.0317	0.0164	0.0116	0.0075	0.0029	0.0017	0.0011	0.0006	0.0003	0.0007	0.0002	0.0005	0.0004	0.0000	0.0002	0.0000	0.0002	0.0001	0.0002	0.0001	0.0002	0.0001	0.0000	0.0001
2009	0.0008	0.0078	0.0223	0.0288	0.0395	0.0303	0.0179	0.0157	0.0100	0.0048	0.0026	0.0011	0.0010	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001	0.0002
2010	0.0004	0.0049	0.0122	0.0223	0.0228	0.0156	0.0122	0.0076	0.0050	0.0023	0.0013	0.0007	0.0005	0.0003	0.0003	0.0001	0.0002	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001
2011	0.0001	0.0037	0.0105	0.0115	0.0103	0.0075	0.0052	0.0033	0.0023	0.0014	0.0007	0.0004	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2012	0.0002	0.0045	0.0074	0.0062	0.0070	0.0045	0.0035	0.0023	0.0017	0.0006	0.0004	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
2013	0.0003	0.0018	0.0031	0.0053	0.0035	0.0034	0.0026	0.0018	0.0009	0.0005	0.0005	0.0000	0.0002	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0009	0.0026	0.0038	0.0023	0.0019	0.0013	0.0007	0.0004	0.0007	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0009	0.0027	0.0021	0.0023	0.0016	0.0009	0.0003	0.0007	0.0004	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
2016	0.0000	0.0002	0.0011	0.0026	0.0013	0.0004	0.0004	0.0000	0.0004	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0005	0.0050	0.0047	0.0021	0.0005	0.0011	0.0013	0.0005	0.0008	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0024	0.0056	0.0029	0.0019	0.0013	0.0011	0.0008	0.0008	0.0003	0.0005	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003

QUARTERS OF MATURITY

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Non-Claim Termination Rate - ARM

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0002	0.0071	0.0149	0.0265	0.0114	0.0033	0.0052	0.0021	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0007	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000
1991	0.0004	0.0059	0.0167	0.0130	0.0053	0.0110	0.0102	0.0052	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001	0.0002	0.0003	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0003	0.0080	0.0088	0.0043	0.0138	0.0077	0.0149	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0014	0.0014	0.0014
1993	0.0012	0.0076	0.0057	0.0213	0.0122	0.0217	0.0139	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0004	0.0002	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001	0.0005	0.0015	0.0013	0.0014	0.0011
1994	0.0021	0.0143	0.0317	0.0254	0.0374	0.0187	0.0039	0.0028	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0004	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0004	0.0019	0.0015	0.0014	0.0012	0.0010
1995	0.0093	0.0536	0.0783	0.0975	0.0307	0.0057	0.0088	0.0027	0.0000	0.0000	0.0000	0.0001	0.0003	0.0003	0.0002	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0012	0.0012	0.0010	0.0008	0.0007	0.0006
1996	0.0045	0.0698	0.1848	0.0896	0.0152	0.0178	0.0078	0.0018	0.0000	0.0000	0.0001	0.0004	0.0005	0.0003	0.0002	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0007	0.0013	0.0012	0.0010	0.0008	0.0009	0.0007	0.0006
1997	0.0095	0.1338	0.1672	0.0356	0.0403	0.0119	0.0052	0.0012	0.0000	0.0002	0.0005	0.0007	0.0004	0.0002	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001	0.0008	0.0013	0.0012	0.0010	0.0009	0.0006	0.0006
1998	0.0077	0.0555	0.0211	0.0246	0.0094	0.0040	0.0014	0.0002	0.0001	0.0004	0.0005	0.0004	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0010	0.0007	0.0006	0.0006	0.0005	0.0004	0.0004	0.0003	0.0003
1999	0.0026	0.0754	0.1241	0.0487	0.0177	0.0054	0.0025	0.0022	0.0023	0.0026	0.0013	0.0005	0.0002	0.0002	0.0004	0.0003	0.0001	0.0001	0.0002	0.0020	0.0036	0.0033	0.0025	0.0019	0.0016	0.0013	0.0014	0.0011	0.0009	0.0006
2000	0.0052	0.1181	0.0521	0.0184	0.0039	0.0022	0.0022	0.0021	0.0025	0.0010	0.0005	0.0001	0.0002	0.0003	0.0001	0.0001	0.0002	0.0002	0.0007	0.0029	0.0024	0.0015	0.0014	0.0012	0.0011	0.0007	0.0005	0.0006	0.0006	0.0005
2001	0.0285	0.1211	0.0555	0.0142	0.0085	0.0064	0.0061	0.0050	0.0021	0.0007	0.0004	0.0005	0.0003	0.0003	0.0003	0.0003	0.0028	0.0058	0.0042	0.0029	0.0022	0.0022	0.0013	0.0016	0.0009	0.0008	0.0008	0.0009	0.0009	0.0009
2002	0.0308	0.1422	0.0197	0.0132	0.0138	0.0110	0.0080	0.0030	0.0011	0.0004	0.0004	0.0006	0.0003	0.0004	0.0003	0.0005	0.0019	0.0064	0.0050	0.0042	0.0032	0.0023	0.0021	0.0014	0.0013	0.0010	0.0009	0.0009	0.0007	0.0006
2003	0.0283	0.0335	0.0189	0.0155	0.0134	0.0096	0.0029	0.0012	0.0004	0.0004	0.0008	0.0002	0.0002	0.0004	0.0004	0.0002	0.0063	0.0039	0.0037	0.0031	0.0024	0.0017	0.0013	0.0008	0.0008	0.0008	0.0008	0.0006	0.0006	0.0005
2004	0.0090	0.0470	0.0428	0.0347	0.0231	0.0074	0.0023	0.0009	0.0006	0.0016	0.0005	0.0005	0.0006	0.0007	0.0005	0.0132	0.0095	0.0067	0.0059	0.0044	0.0037	0.0026	0.0023	0.0017	0.0015	0.0013	0.0011	0.0009	0.0011	0.0007
2005	0.0137	0.0399	0.0465	0.0510	0.0143	0.0052	0.0012	0.0013	0.0036	0.0014	0.0008	0.0017	0.0015	0.0011	0.0195	0.0151	0.0126	0.0090	0.0076	0.0061	0.0048	0.0040	0.0027	0.0022	0.0022	0.0019	0.0014	0.0019	0.0014	0.0015
2006	0.0045	0.0416	0.0843	0.0691	0.0146	0.0043	0.0024	0.0081	0.0029	0.0018	0.0013	0.0019	0.0251	0.0195	0.0142	0.0121	0.0101	0.0069	0.0063	0.0061	0.0051	0.0032	0.0036	0.0015	0.0023	0.0016	0.0015	0.0013	0.0014	
2007	0.0063	0.0768	0.1321	0.0629	0.0144	0.0103	0.0177	0.0041	0.0017	0.0015	0.0031	0.0013	0.0297	0.0190	0.0166	0.0129	0.0129	0.0072	0.0048	0.0046	0.0055	0.0022	0.0031	0.0026	0.0026	0.0020	0.0009	0.0024	0.0013	0.0017
2008	0.0148	0.2046	0.1016	0.0499	0.0383	0.0431	0.0089	0.0039	0.0031	0.0026	0.0019	0.0308	0.0196	0.0130	0.0098	0.0077	0.0071	0.0039	0.0039	0.0033	0.0022	0.0010	0.0019	0.0016	0.0012	0.0009	0.0011	0.0008	0.0014	0.0008
2009	0.0684	0.1301	0.0797	0.0376	0.0420	0.0140	0.0068	0.0057	0.0059	0.0038	0.0539	0.0329	0.0247	0.0179	0.0108	0.0090	0.0058	0.0047	0.0026	0.0024	0.0017	0.0017	0.0012	0.0012	0.0016	0.0007	0.0007	0.0009	0.0005	0.0007
2010	0.0176	0.0542	0.0224	0.0264	0.0076	0.0134	0.0083	0.0066	0.0044	0.0807	0.0527	0.0337	0.0212	0.0140	0.0106	0.0086	0.0058	0.0042	0.0033	0.0026	0.0022	0.0017	0.0016	0.0014	0.0013	0.0010	0.0007	0.0007	0.0007	0.0007
2011	0.0020	0.0345	0.0360	0.0105	0.0198	0.0182	0.0081	0.0047	0.0751	0.0473	0.0316	0.0205	0.0128	0.0093	0.0062	0.0047	0.0040	0.0024	0.0027	0.0019	0.0017	0.0014	0.0009	0.0009	0.0008	0.0006	0.0006	0.0007	0.0007	0.0007
2012	0.0040	0.0311	0.0165	0.0232	0.0232	0.0137	0.0040	0.0732	0.0435	0.0285	0.0209	0.0125	0.0094	0.0062	0.0049	0.0037	0.0019	0.0022	0.0020	0.0018	0.0011	0.0005	0.0010	0.0010	0.0004	0.0005	0.0005	0.0006	0.0005	0.0004
2013	0.0034	0.0125	0.0293	0.0317	0.0203	0.0089	0.0951	0.0591	0.0352	0.0214	0.0167	0.0110	0.0082	0.0045	0.0040	0.0027	0.0017	0.0015	0.0011	0.0020	0.0009	0.0011	0.0006	0.0006	0.0006	0.0003	0.0008	0.0006	0.0006	0.0002
2014	0.0118	0.1380	0.0752	0.0284	0.0104	0.0777	0.0497	0.0324	0.0211	0.0167	0.0113	0.0073	0.0061	0.0035	0.0028	0.0027	0.0017	0.0018	0.0011	0.0006	0.0009	0.0009	0.0006	0.0003	0.0006	0.0004	0.0004	0.0006	0.0005	0.0003
2015	0.0404	0.0910	0.0463	0.0158	0.1447	0.0780	0.0472	0.0287	0.0171	0.0111	0.0058	0.0042	0.0024	0.0027	0.0021	0.0013	0.0013	0.0012	0.0009	0.0009	0.0007	0.0005	0.0004	0.0004	0.0002	0.0002	0.0002	0.0004	0.0002	0.0005
2016	0.0211	0.0551	0.0235	0.2425	0.1311	0.0637	0.0405	0.0263	0.0164	0.0140	0.0067	0.0075	0.0045	0.0028	0.0028	0.0024	0.0015	0.0013	0.0006	0.0009	0.0006	0.0009	0.0006	0.0006	0.0002	0.0011	0.0004	0.0006	0.0004	0.0002
2017	0.0024	0.0342	0.2797	0.2025	0.1296	0.0711	0.0382	0.0300	0.0190	0.0132	0.0116	0.0068	0.0076	0.0021	0.0021	0.0016	0.0003	0.0024	0.0013	0.0011	0.0003	0.0000	0.0003	0.0000	0.0000	0.0003	0.0008	0.0005	0.0000	0.0003
2018	0.0029	0.1733	0.2846	0.1685	0.1169	0.0673	0.0416	0.0270	0.0175	0.0122	0.0064	0.0069	0.0050	0.0034	0.0050	0.0037	0.0016	0.0005	0.0011	0.0011	0.0000	0.0008	0.0003	0.0005	0.0000	0.0005	0.0005	0.0003	0.0005	0.0003

QUARTERS OF MATURITY

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Loss Rate - ARM

Fiscal Year	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0008	0.0040	0.0147	0.0169	0.0231	0.0184	0.0192	0.0189	0.0137	0.0087	0.0062	0.0027	0.0015	0.0006	0.0008	0.0002	0.0006	0.0000	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000
1991	0.0001	0.0039	0.0110	0.0161	0.0192	0.0200	0.0229	0.0190	0.0122	0.0080	0.0038	0.0016	0.0011	0.0010	0.0005	0.0002	0.0001	0.0001	0.0003	0.0002	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
1992	0.0001	0.0018	0.0071	0.0108	0.0143	0.0171	0.0140	0.0093	0.0062	0.0027	0.0016	0.0011	0.0005	0.0003	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0022	0.0085	0.0143	0.0213	0.0177	0.0125	0.0076	0.0038	0.0020	0.0016	0.0007	0.0003	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1994	0.0001	0.0025	0.0110	0.0202	0.0214	0.0159	0.0094	0.0048	0.0029	0.0019	0.0009	0.0004	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0032	0.0159	0.0238	0.0203	0.0116	0.0063	0.0042	0.0032	0.0017	0.0009	0.0005	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0042	0.0204	0.0266	0.0190	0.0105	0.0074	0.0054	0.0025	0.0013	0.0008	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0004	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0053	0.0199	0.0218	0.0149	0.0112	0.0079	0.0036	0.0019	0.0011	0.0007	0.0007	0.0007	0.0006	0.0005	0.0005	0.0004	0.0004	0.0004	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0033	0.0083	0.0077	0.0057	0.0046	0.0025	0.0013	0.0007	0.0004	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0058	0.0133	0.0187	0.0180	0.0105	0.0047	0.0028	0.0022	0.0015	0.0021	0.0017	0.0016	0.0015	0.0015	0.0008	0.0009	0.0007	0.0004	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0033	0.0086	0.0123	0.0079	0.0050	0.0029	0.0023	0.0021	0.0018	0.0015	0.0012	0.0012	0.0013	0.0008	0.0005	0.0005	0.0004	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0034	0.0116	0.0128	0.0071	0.0059	0.0043	0.0039	0.0044	0.0036	0.0033	0.0021	0.0023	0.0016	0.0009	0.0006	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0029	0.0112	0.0104	0.0084	0.0069	0.0071	0.0062	0.0050	0.0039	0.0034	0.0031	0.0019	0.0015	0.0012	0.0005	0.0002	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0026	0.0076	0.0071	0.0065	0.0070	0.0057	0.0051	0.0034	0.0032	0.0028	0.0018	0.0010	0.0010	0.0005	0.0002	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0003	0.0051	0.0114	0.0137	0.0158	0.0135	0.0105	0.0072	0.0074	0.0069	0.0043	0.0028	0.0024	0.0011	0.0006	0.0004	0.0003	0.0002	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2005	0.0003	0.0073	0.0182	0.0265	0.0264	0.0233	0.0152	0.0149	0.0138	0.0100	0.0075	0.0050	0.0025	0.0011	0.0010	0.0005	0.0003	0.0002	0.0002	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2006	0.0001	0.0096	0.0264	0.0421	0.0446	0.0311	0.0270	0.0195	0.0155	0.0110	0.0109	0.0056	0.0039	0.0014	0.0007	0.0007	0.0009	0.0004	0.0000	0.0002	0.0001	0.0001	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2007	0.0000	0.0099	0.0399	0.0608	0.0435	0.0381	0.0298	0.0162	0.0121	0.0109	0.0056	0.0039	0.0014	0.0007	0.0007	0.0009	0.0004	0.0000	0.0002	0.0001	0.0001	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0000	0.0054	0.0279	0.0360	0.0315	0.0337	0.0277	0.0143	0.0085	0.0055	0.0015	0.0008	0.0005	0.0002	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0004	0.0052	0.0161	0.0211	0.0300	0.0230	0.0137	0.0109	0.0064	0.0028	0.0013	0.0005	0.0004	0.0001	0.0002	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0001	0.0027	0.0076	0.0151	0.0165	0.0109	0.0085	0.0045	0.0026	0.0011	0.0007	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0017	0.0057	0.0072	0.0067	0.0042	0.0025	0.0014	0.0011	0.0006	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0001	0.0019	0.0040	0.0033	0.0037	0.0023	0.0018	0.0011	0.0008	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0001	0.0008	0.0014	0.0021	0.0012	0.0010	0.0015	0.0010	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0004	0.0010	0.0021	0.0008	0.0008	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0002	0.0009	0.0008	0.0007	0.0004	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0000	0.0000	0.0003	0.0006	0.0004	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0000	0.0028	0.0017	0.0011	0.0002	0.0002	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0019	0.0028	0.0011	0.0004	0.0008	0.0004	0.0002	0.0002	0.0001	0.0001	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

QUARTERS OF MATURITY

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Claim Rate - All Products Combined

Fiscal Year	\ QUARTERS OF MATURITY																													
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0001	0.0035	0.0115	0.0149	0.0134	0.0098	0.0072	0.0061	0.0046	0.0033	0.0023	0.0015	0.0010	0.0008	0.0006	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
1991	0.0001	0.0028	0.0096	0.0117	0.0100	0.0080	0.0071	0.0055	0.0039	0.0028	0.0016	0.0011	0.0008	0.0007	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
1992	0.0001	0.0020	0.0067	0.0087	0.0087	0.0090	0.0076	0.0059	0.0038	0.0024	0.0016	0.0011	0.0008	0.0005	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
1993	0.0000	0.0019	0.0061	0.0089	0.0109	0.0097	0.0074	0.0050	0.0030	0.0021	0.0015	0.0010	0.0006	0.0004	0.0003	0.0002	0.0003	0.0003	0.0003	0.0002	0.0003	0.0002	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
1994	0.0000	0.0019	0.0061	0.0093	0.0101	0.0082	0.0056	0.0034	0.0024	0.0017	0.0011	0.0007	0.0004	0.0003	0.0002	0.0003	0.0003	0.0003	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
1995	0.0001	0.0029	0.0115	0.0170	0.0155	0.0107	0.0069	0.0049	0.0043	0.0027	0.0016	0.0011	0.0007	0.0006	0.0006	0.0007	0.0006	0.0005	0.0005	0.0004	0.0004	0.0005	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000
1996	0.0001	0.0036	0.0138	0.0181	0.0145	0.0097	0.0073	0.0060	0.0039	0.0023	0.0015	0.0010	0.0009	0.0008	0.0009	0.0008	0.0007	0.0007	0.0005	0.0007	0.0006	0.0004	0.0003	0.0004	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001
1997	0.0001	0.0041	0.0136	0.0157	0.0122	0.0101	0.0081	0.0051	0.0032	0.0020	0.0014	0.0012	0.0011	0.0010	0.0009	0.0009	0.0007	0.0008	0.0008	0.0005	0.0004	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1998	0.0001	0.0035	0.0099	0.0107	0.0102	0.0089	0.0060	0.0038	0.0024	0.0017	0.0014	0.0014	0.0014	0.0013	0.0012	0.0012	0.0009	0.0010	0.0009	0.0006	0.0004	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
1999	0.0001	0.0035	0.0094	0.0120	0.0125	0.0088	0.0054	0.0033	0.0023	0.0018	0.0017	0.0018	0.0017	0.0015	0.0015	0.0012	0.0011	0.0011	0.0007	0.0005	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
2000	0.0001	0.0051	0.0153	0.0189	0.0132	0.0077	0.0047	0.0032	0.0027	0.0022	0.0022	0.0018	0.0016	0.0015	0.0012	0.0012	0.0011	0.0008	0.0006	0.0006	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2001	0.0001	0.0051	0.0161	0.0167	0.0113	0.0071	0.0048	0.0039	0.0034	0.0036	0.0032	0.0027	0.0026	0.0020	0.0019	0.0017	0.0011	0.0008	0.0010	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
2002	0.0001	0.0045	0.0124	0.0116	0.0081	0.0058	0.0049	0.0044	0.0045	0.0039	0.0037	0.0035	0.0025	0.0024	0.0021	0.0013	0.0010	0.0012	0.0010	0.0007	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001
2003	0.0000	0.0037	0.0085	0.0077	0.0061	0.0057	0.0055	0.0064	0.0055	0.0054	0.0058	0.0042	0.0033	0.0029	0.0017	0.0009	0.0015	0.0014	0.0012	0.0009	0.0007	0.0006	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002
2004	0.0005	0.0063	0.0113	0.0122	0.0123	0.0118	0.0127	0.0107	0.0108	0.0114	0.0085	0.0069	0.0059	0.0037	0.0020	0.0030	0.0026	0.0021	0.0017	0.0014	0.0011	0.0010	0.0007	0.0007	0.0006	0.0005	0.0004	0.0003	0.0004	0.0003
2005	0.0004	0.0062	0.0154	0.0193	0.0209	0.0226	0.0189	0.0187	0.0199	0.0144	0.0118	0.0097	0.0062	0.0032	0.0046	0.0038	0.0033	0.0029	0.0026	0.0021	0.0016	0.0014	0.0011	0.0011	0.0010	0.0008	0.0007	0.0007	0.0006	0.0006
2006	0.0002	0.0066	0.0201	0.0283	0.0330	0.0263	0.0256	0.0275	0.0197	0.0155	0.0130	0.0084	0.0047	0.0051	0.0046	0.0036	0.0030	0.0025	0.0023	0.0021	0.0015	0.0014	0.0011	0.0011	0.0009	0.0007	0.0007	0.0007	0.0007	0.0006
2007	0.0002	0.0085	0.0278	0.0387	0.0294	0.0321	0.0402	0.0262	0.0194	0.0163	0.0109	0.0059	0.0060	0.0054	0.0043	0.0035	0.0030	0.0026	0.0023	0.0018	0.0017	0.0015	0.0011	0.0011	0.0009	0.0007	0.0007	0.0007	0.0007	0.0006
2008	0.0001	0.0073	0.0256	0.0259	0.0308	0.0417	0.0271	0.0192	0.0157	0.0101	0.0054	0.0060	0.0050	0.0041	0.0034	0.0029	0.0023	0.0021	0.0020	0.0016	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0005	0.0005	0.0005	0.0005
2009	0.0001	0.0047	0.0111	0.0169	0.0257	0.0198	0.0144	0.0118	0.0079	0.0044	0.0053	0.0046	0.0035	0.0028	0.0023	0.0019	0.0016	0.0014	0.0013	0.0011	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004	0.0004	0.0003	0.0003
2010	0.0001	0.0020	0.0065	0.0128	0.0125	0.0108	0.0089	0.0063	0.0038	0.0054	0.0048	0.0038	0.0031	0.0024	0.0020	0.0017	0.0015	0.0013	0.0011	0.0009	0.0008	0.0008	0.0006	0.0005	0.0005	0.0005	0.0003	0.0003	0.0003	0.0003
2011	0.0001	0.0018	0.0057	0.0069	0.0068	0.0062	0.0048	0.0029	0.0052	0.0047	0.0037	0.0030	0.0024	0.0018	0.0015	0.0012	0.0011	0.0010	0.0009	0.0008	0.0007	0.0006	0.0005	0.0005	0.0004	0.0003	0.0003	0.0002	0.0003	0.0002
2012	0.0001	0.0014	0.0032	0.0043	0.0050	0.0040	0.0026	0.0056	0.0053	0.0044	0.0037	0.0029	0.0023	0.0019	0.0015	0.0013	0.0011	0.0010	0.0010	0.0008	0.0007	0.0006	0.0005	0.0005	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002
2013	0.0001	0.0010	0.0028	0.0041	0.0042	0.0030	0.0063	0.0058	0.0050	0.0042	0.0034	0.0027	0.0021	0.0018	0.0015	0.0013	0.0012	0.0010	0.0009	0.0007	0.0006	0.0005	0.0005	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002
2014	0.0000	0.0010	0.0033	0.0049	0.0038	0.0076	0.0065	0.0053	0.0047	0.0039	0.0031	0.0026	0.0021	0.0016	0.0014	0.0012	0.0011	0.0009	0.0009	0.0007	0.0006	0.0005	0.0005	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002
2015	0.0000	0.0006	0.0027	0.0032	0.0086	0.0077	0.0065	0.0060	0.0053	0.0044	0.0037	0.0030	0.0024	0.0020	0.0017	0.0015	0.0013	0.0012	0.0011	0.0009	0.0007	0.0006	0.0005	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002
2016	0.0000	0.0007	0.0022	0.0087	0.0084	0.0075	0.0067	0.0061	0.0055	0.0046	0.0038	0.0031	0.0025	0.0021	0.0018	0.0015	0.0013	0.0012	0.0011	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002
2017	0.0000	0.0005	0.0083	0.0085	0.0073	0.0066	0.0058	0.0052	0.0047	0.0041	0.0033	0.0028	0.0023	0.0019	0.0016	0.0014	0.0012	0.0011	0.0010	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
2018	0.0000	0.0036	0.0060	0.0059	0.0059	0.0057	0.0051	0.0047	0.0042	0.0037	0.0033	0.0027	0.0023	0.0018	0.0016	0.0015	0.0013	0.0011	0.0010	0.0009	0.0007	0.0006	0.0006	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Incremental Non-Claim Termination Rate - All Products Combined

Fiscal Year	|	|	|	|	|	|	|	|	|	|	QUARTERS OF MATURITY	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0011	0.0107	0.0509	0.1286	0.0813	0.0070	0.0079	0.0014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0011	0.0271	0.1217	0.0971	0.0070	0.0092	0.0048	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0037	0.0452	0.0651	0.0062	0.0090	0.0048	0.0112	0.0067	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0025	0.0022	0.0021	
1993	0.0062	0.0255	0.0046	0.0062	0.0037	0.0094	0.0111	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0010	0.0029	0.0026	0.0025	0.0021
1994	0.0013	0.0072	0.0118	0.0084	0.0139	0.0111	0.0020	0.0009	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0003	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0000	0.0001	0.0004	0.0029	0.0022	0.0022	0.0021	0.0018
1995	0.0105	0.0458	0.0337	0.0551	0.0286	0.0038	0.0058	0.0033	0.0000	0.0000	0.0000	0.0003	0.0004	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0008	0.0026	0.0021	0.0020	0.0020	0.0021	0.0016
1996	0.0025	0.0277	0.0774	0.0496	0.0067	0.0091	0.0102	0.0047	0.0000	0.0001	0.0002	0.0004	0.0006	0.0006	0.0004	0.0002	0.0002	0.0004	0.0002	0.0001	0.0001	0.0001	0.0009	0.0029	0.0025	0.0025	0.0022	0.0022	0.0020	0.0019
1997	0.0074	0.0778	0.0887	0.0149	0.0182	0.0146	0.0147	0.0039	0.0001	0.0002	0.0005	0.0008	0.0006	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0011	0.0030	0.0026	0.0024	0.0023	0.0021	0.0020	0.0019	0.0017
1998	0.0079	0.0368	0.0081	0.0122	0.0176	0.0239	0.0102	0.0024	0.0003	0.0006	0.0011	0.0013	0.0007	0.0005	0.0006	0.0008	0.0004	0.0003	0.0003	0.0002	0.0012	0.0035	0.0030	0.0029	0.0029	0.0025	0.0022	0.0022	0.0021	0.0018
1999	0.0011	0.0150	0.0272	0.0283	0.0353	0.0138	0.0054	0.0013	0.0008	0.0012	0.0015	0.0010	0.0006	0.0006	0.0011	0.0006	0.0004	0.0003	0.0002	0.0008	0.0027	0.0026	0.0026	0.0024	0.0021	0.0021	0.0019	0.0017		
2000	0.0252	0.1551	0.0993	0.0478	0.0165	0.0066	0.0021	0.0011	0.0013	0.0012	0.0006	0.0004	0.0004	0.0006	0.0004	0.0003	0.0003	0.0002	0.0008	0.0027	0.0020	0.0018	0.0018	0.0018	0.0016	0.0015	0.0013	0.0012	0.0012	0.0011
2001	0.0291	0.1218	0.1321	0.0329	0.0106	0.0028	0.0014	0.0023	0.0030	0.0016	0.0012	0.0016	0.0021	0.0010	0.0006	0.0005	0.0004	0.0015	0.0041	0.0034	0.0029	0.0026	0.0025	0.0022	0.0022	0.0021	0.0017	0.0018	0.0017	0.0017
2002	0.0367	0.1518	0.0479	0.0134	0.0044	0.0024	0.0035	0.0044	0.0027	0.0020	0.0029	0.0037	0.0017	0.0009	0.0007	0.0006	0.0019	0.0051	0.0042	0.0039	0.0033	0.0028	0.0027	0.0024	0.0023	0.0020	0.0019	0.0019	0.0019	
2003	0.0290	0.0311	0.0141	0.0046	0.0028	0.0036	0.0063	0.0042	0.0035	0.0052	0.0114	0.0036	0.0019	0.0015	0.0013	0.0007	0.0083	0.0061	0.0056	0.0052	0.0044	0.0035	0.0033	0.0031	0.0030	0.0027	0.0025	0.0024	0.0024	0.0024
2004	0.0124	0.0345	0.0135	0.0077	0.0075	0.0112	0.0076	0.0058	0.0086	0.0186	0.0089	0.0041	0.0028	0.0022	0.0014	0.0141	0.0098	0.0085	0.0079	0.0071	0.0058	0.0051	0.0047	0.0043	0.0041	0.0038	0.0036	0.0036	0.0037	
2005	0.0115	0.0157	0.0122	0.0133	0.0171	0.0108	0.0085	0.0151	0.0327	0.0118	0.0067	0.0045	0.0036	0.0017	0.0159	0.0120	0.0101	0.0088	0.0079	0.0072	0.0059	0.0052	0.0047	0.0046	0.0048	0.0045	0.0040	0.0042	0.0042	0.0043
2006	0.0030	0.0232	0.0344	0.0546	0.0250	0.0174	0.0244	0.0430	0.0182	0.0102	0.0066	0.0047	0.0022	0.0125	0.0102	0.0087	0.0075	0.0069	0.0062	0.0055	0.0048	0.0044	0.0040	0.0039	0.0039	0.0037	0.0039	0.0039	0.0041	
2007	0.0081	0.0709	0.0939	0.0376	0.0215	0.0274	0.0456	0.0206	0.0115	0.0078	0.0065	0.0028	0.0113	0.0087	0.0081	0.0071	0.0064	0.0052	0.0048	0.0047	0.0040	0.0033	0.0033	0.0033	0.0034	0.0035	0.0033	0.0033	0.0034	0.0034
2008	0.0207	0.1593	0.0676	0.0349	0.0457	0.0656	0.0257	0.0132	0.0094	0.0073	0.0031	0.0117	0.0090	0.0078	0.0070	0.0062	0.0051	0.0043	0.0040	0.0036	0.0032	0.0029	0.0028	0.0027	0.0029	0.0029	0.0028	0.0029	0.0029	0.0030
2009	0.0444	0.0626	0.0423	0.0709	0.0845	0.0200	0.0169	0.0159	0.0104	0.0039	0.0235	0.0170	0.0148	0.0123	0.0109	0.0092	0.0072	0.0060	0.0053	0.0047	0.0040	0.0037	0.0035	0.0035	0.0036	0.0036	0.0033	0.0035	0.0035	0.0035
2010	0.0097	0.0265	0.0448	0.0484	0.0064	0.0152	0.0163	0.0110	0.0044	0.0415	0.0298	0.0244	0.0204	0.0167	0.0147	0.0115	0.0090	0.0075	0.0065	0.0059	0.0050	0.0045	0.0045	0.0044	0.0044	0.0043	0.0040	0.0041	0.0042	0.0043
2011	0.0013	0.0403	0.0439	0.0056	0.0139	0.0133	0.0091	0.0040	0.0515	0.0362	0.0302	0.0248	0.0203	0.0161	0.0146	0.0113	0.0086	0.0069	0.0061	0.0056	0.0048	0.0043	0.0042	0.0042	0.0043	0.0042	0.0039	0.0041	0.0042	0.0041
2012	0.0030	0.0279	0.0056	0.0144	0.0124	0.0081	0.0039	0.0659	0.0468	0.0385	0.0323	0.0266	0.0211	0.0171	0.0157	0.0119	0.0084	0.0072	0.0064	0.0060	0.0054	0.0046	0.0045	0.0045	0.0045	0.0045	0.0041	0.0044	0.0045	0.0045
2013	0.0006	0.0050	0.0222	0.0136	0.0092	0.0046	0.0807	0.0614	0.0507	0.0419	0.0344	0.0274	0.0218	0.0174	0.0155	0.0118	0.0092	0.0079	0.0073	0.0069	0.0059	0.0051	0.0050	0.0049	0.0051	0.0049	0.0046	0.0042	0.0045	0.0050
2014	0.0057	0.1430	0.0552	0.0237	0.0075	0.0520	0.0423	0.0392	0.0331	0.0280	0.0226	0.0183	0.0151	0.0121	0.0105	0.0089	0.0071	0.0064	0.0057	0.0055	0.0046	0.0043	0.0042	0.0042	0.0043	0.0041	0.0038	0.0042	0.0045	0.0043
2015	0.0197	0.0749	0.0383	0.0118	0.0782	0.0602	0.0546	0.0501	0.0411	0.0319	0.0257	0.0206	0.0165	0.0131	0.0114	0.0100	0.0082	0.0071	0.0065	0.0062	0.0055	0.0047	0.0045	0.0046	0.0047	0.0048	0.0043	0.0047	0.0048	0.0049
2016	0.0150	0.0416	0.0162	0.1025	0.0804	0.0698	0.0655	0.0583	0.0449	0.0348	0.0279	0.0222	0.0175	0.0141	0.0126	0.0109	0.0090	0.0080	0.0071	0.0068	0.0057	0.0052	0.0051	0.0050	0.0051	0.0051	0.0048	0.0050	0.0053	0.0052
2017	0.0057	0.0280	0.1078	0.0913	0.0822	0.0738	0.0675	0.0580	0.0449	0.0353	0.0283	0.0220	0.0180	0.0148	0.0134	0.0116	0.0097	0.0084	0.0077	0.0072	0.0062	0.0056	0.0054	0.0055	0.0056	0.0055	0.0051	0.0053	0.0056	0.0055
2018	0.0034	0.0643	0.1025	0.0977	0.0911	0.0789	0.0695	0.0592	0.0461	0.0361	0.0279	0.0228	0.0187	0.0156	0.0138	0.0121	0.0102	0.0088	0.0080	0.0075	0.0063	0.0057	0.0056	0.0055	0.0056	0.0056	0.0053	0.0054	0.0056	0.0058

Mutual Mortgage Insurance Fund Forward Analysis
Data as of September 30, 2018
Loss Rate - All Products Combined

Fiscal Year	\															QUARTERS OF MATURITY														
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
1990	0.0001	0.0034	0.0122	0.0170	0.0157	0.0116	0.0082	0.0069	0.0051	0.0036	0.0023	0.0014	0.0009	0.0007	0.0005	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
1991	0.0001	0.0028	0.0106	0.0135	0.0119	0.0094	0.0085	0.0064	0.0044	0.0030	0.0017	0.0011	0.0008	0.0006	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1992	0.0001	0.0020	0.0072	0.0098	0.0100	0.0109	0.0092	0.0069	0.0044	0.0026	0.0017	0.0011	0.0007	0.0004	0.0003	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0020	0.0068	0.0103	0.0132	0.0117	0.0087	0.0058	0.0032	0.0022	0.0014	0.0009	0.0005	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0020	0.0067	0.0107	0.0120	0.0096	0.0064	0.0037	0.0025	0.0016	0.0010	0.0006	0.0004	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0028	0.0122	0.0186	0.0173	0.0118	0.0074	0.0049	0.0041	0.0024	0.0013	0.0009	0.0006	0.0005	0.0005	0.0005	0.0005	0.0003	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
1996	0.0000	0.0035	0.0145	0.0195	0.0158	0.0102	0.0073	0.0057	0.0034	0.0019	0.0012	0.0008	0.0007	0.0006	0.0007	0.0006	0.0006	0.0005	0.0004	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0001	0.0042	0.0149	0.0169	0.0126	0.0102	0.0079	0.0046	0.0028	0.0016	0.0011	0.0010	0.0009	0.0008	0.0007	0.0007	0.0006	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0001	0.0035	0.0103	0.0109	0.0099	0.0085	0.0055	0.0033	0.0021	0.0014	0.0012	0.0011	0.0012	0.0010	0.0009	0.0009	0.0007	0.0007	0.0006	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0001	0.0035	0.0094	0.0119	0.0123	0.0083	0.0049	0.0029	0.0020	0.0016	0.0015	0.0016	0.0015	0.0013	0.0012	0.0009	0.0008	0.0008	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0001	0.0047	0.0144	0.0182	0.0123	0.0070	0.0042	0.0028	0.0023	0.0020	0.0019	0.0016	0.0014	0.0013	0.0010	0.0010	0.0008	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0001	0.0044	0.0147	0.0153	0.0103	0.0063	0.0043	0.0035	0.0031	0.0032	0.0028	0.0023	0.0021	0.0015	0.0014	0.0012	0.0007	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0001	0.0039	0.0112	0.0105	0.0073	0.0052	0.0044	0.0040	0.0040	0.0035	0.0031	0.0029	0.0019	0.0018	0.0015	0.0008	0.0006	0.0006	0.0005	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0032	0.0077	0.0068	0.0056	0.0053	0.0051	0.0059	0.0050	0.0048	0.0050	0.0034	0.0026	0.0022	0.0011	0.0005	0.0009	0.0007	0.0006	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0004	0.0058	0.0101	0.0112	0.0120	0.0114	0.0121	0.0101	0.0099	0.0101	0.0075	0.0058	0.0047	0.0025	0.0012	0.0018	0.0015	0.0011	0.0008	0.0006	0.0005	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000
2005	0.0003	0.0053	0.0142	0.0191	0.0212	0.0228	0.0190	0.0181	0.0190	0.0135	0.0106	0.0082	0.0043	0.0020	0.0028	0.0022	0.0017	0.0015	0.0012	0.0009	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000
2006	0.0001	0.0055	0.0190	0.0282	0.0338	0.0264	0.0253	0.0271	0.0190	0.0143	0.0115	0.0064	0.0034	0.0033	0.0027	0.0020	0.0016	0.0013	0.0011	0.0009	0.0006	0.0005	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000
2007	0.0001	0.0075	0.0269	0.0390	0.0289	0.0318	0.0410	0.0260	0.0183	0.0147	0.0087	0.0043	0.0042	0.0035	0.0026	0.0020	0.0016	0.0013	0.0011	0.0008	0.0007	0.0006	0.0004	0.0004	0.0003	0.0002	0.0002	0.0001	0.0000	0.0000
2008	0.0001	0.0061	0.0235	0.0233	0.0276	0.0385	0.0248	0.0166	0.0131	0.0074	0.0035	0.0030	0.0023	0.0017	0.0013	0.0011	0.0009	0.0008	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000
2009	0.0001	0.0037	0.0091	0.0135	0.0214	0.0165	0.0115	0.0091	0.0052	0.0026	0.0027	0.0021	0.0015	0.0011	0.0009	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
2010	0.0001	0.0014	0.0046	0.0095	0.0095	0.0079	0.0059	0.0036	0.0019	0.0028	0.0022	0.0016	0.0012	0.0008	0.0007	0.0005	0.0005	0.0004	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2011	0.0000	0.0011	0.0038	0.0050	0.0048	0.0039	0.0026	0.0013	0.0027	0.0022	0.0016	0.0012	0.0009	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0007	0.0021	0.0028	0.0030	0.0022	0.0012	0.0032	0.0027	0.0021	0.0016	0.0011	0.0008	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0006	0.0018	0.0025	0.0023	0.0015	0.0039	0.0033	0.0027	0.0021	0.0015	0.0012	0.0008	0.0006	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0005	0.0018	0.0027	0.0019	0.0032	0.0024	0.0017	0.0014	0.0011	0.0008	0.0006	0.0005	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0003	0.0012	0.0014	0.0039	0.0031	0.0023	0.0019	0.0015	0.0012	0.0009	0.0007	0.0005	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0000	0.0002	0.0008	0.0045	0.0039	0.0030	0.0023	0.0019	0.0016	0.0012	0.0010	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0002	0.0046	0.0044	0.0033	0.0026	0.0020	0.0016	0.0013	0.0011	0.0008	0.0007	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0018	0.0034	0.0030	0.0027	0.0022	0.0017	0.0014	0.0012	0.0010	0.0008	0.0006	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000