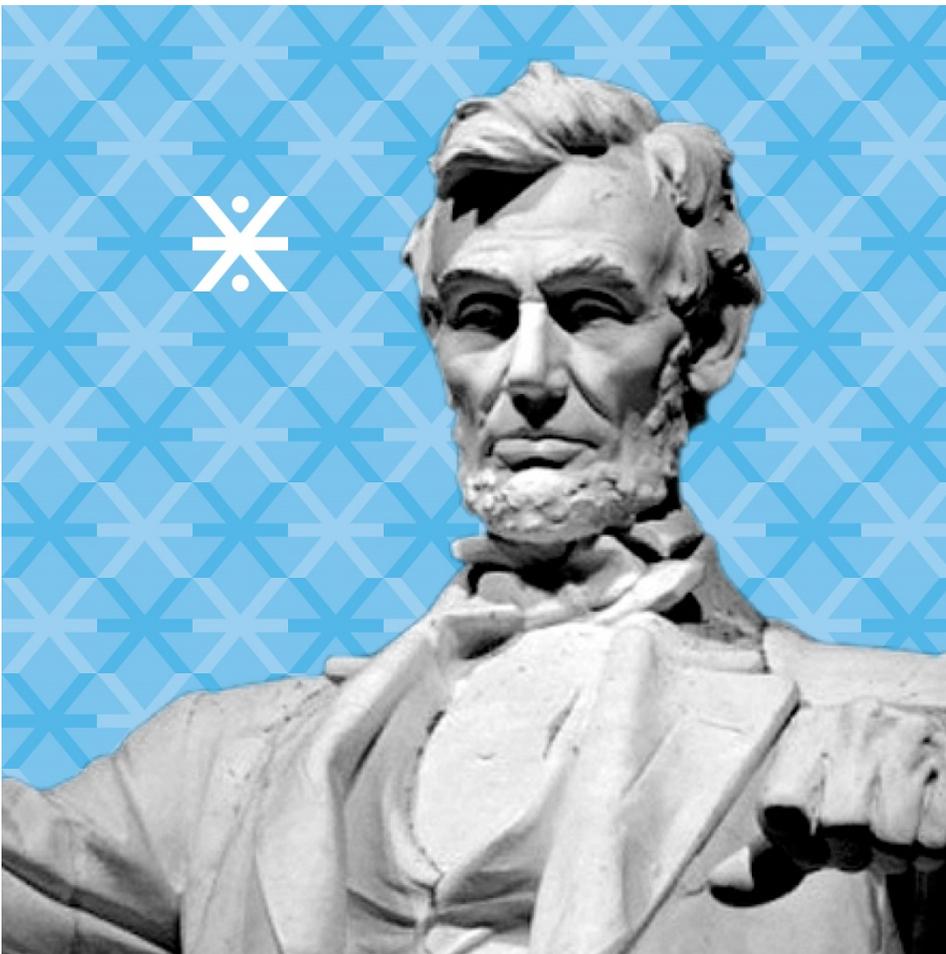


**U.S. Department of Housing and Urban  
Development (HUD) Federal Housing  
Administration (FHA)**

Actuarial Review of FHA's Mutual Mortgage  
Insurance Fund for Forward Loans (Excluding  
HECM)

December 11, 2013



**SUBMITTED BY:**

Summit Consulting, LLC  
718 7th Street NW  
Suite 314  
Washington, DC 20001  
[www.summitllc.us](http://www.summitllc.us)

Milliman, Inc.  
15800 W. Bluemound Road  
Suite 100  
Brookfield, WI 53005  
[www.milliman.com](http://www.milliman.com)



December 11, 2013

The Honorable Carol J. Galante  
Assistant Secretary for Housing – Federal Housing Commissioner  
U.S. Department of Housing and Urban Development  
451 Seventh Street, SW, Room 9100  
Washington, DC 20410

Dear Commissioner Galante:

We are pleased to submit the attached report documenting our actuarial review of the forward mortgages in FHA's Mutual Mortgage Insurance Fund (MMI Fund) as of the end of fiscal year (FY) 2013. This report excludes our evaluation of the Home Equity Conversion Mortgage portion of the MMI Fund.

We estimate that the economic value of the forward portion of the MMI Fund was negative \$10.6 billion as of the end of FY 2013, and will be negative \$0.1 billion at the end of FY 2014. Insurance in force as of the end of FY 2013 is estimated to be \$1.166 trillion on an unamortized basis and \$1.089 trillion on an amortized basis.

We forecast that the economic value of the forward portion of the MMI Fund will increase in each successive year as a result of forecasted improving economic conditions, higher premium rates compared to historical endorsements, and improved borrower characteristics, such as higher credit scores and lower loan-to-value ratios compared to historical endorsements.

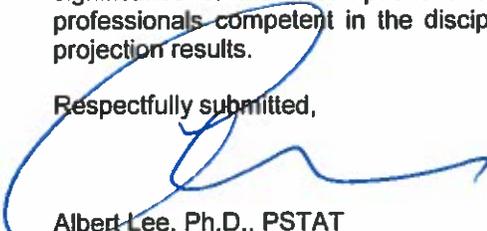
Summit Consulting, LLC & Milliman, Inc. note that these estimates are subject to significant variability due to the nature of mortgage insurance as described in our report.

To estimate the impact of this variability, the economic value of the forward portion of the MMI Fund was also estimated as of the end of FY 2013 under six alternative economic scenarios. All of the economic scenarios were developed by Moody's Analytics and were used without adjustment by Summit Consulting, LLC & Milliman, Inc. Further details on the economic scenarios and variability of results are detailed in the report.

The authors and peer reviewers of this analysis are Members of the American Academy of Actuaries, Fellows of the Society of Actuaries, Accredited Professional Statistician of the American Statistical Association and/or have significant expertise in the evaluation of mortgage insurance or similar exposures.

Any reader of this analysis must possess a certain level of expertise in relevant areas to accurately interpret the significance of the assumptions and their impacts. The reader should be advised by actuaries or other professionals competent in the discipline of actuarial projections of this type, so as to properly interpret the projection results.

Respectfully submitted,



Albert Lee, Ph.D., PSTAT  
Principal and Economist  
Summit Consulting, LLC



Jonathan B. Glowacki, CERA, FSA, MAAA  
Consulting Actuary  
Milliman, Inc.



Kenneth A. Bjurstrom  
Principal and Financial Consultant  
Milliman, Inc.

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## Executive Summary

An agency within the U.S. Department of Housing and Urban Development (HUD), the Federal Housing Administration (FHA), through its Mutual Mortgage Insurance (MMI) Fund, provides mortgage insurance on loans made by FHA-approved lenders throughout the United States and its territories. The 1990 Cranston-Gonzalez National Affordable Housing Act (NAHA) requires an independent actuarial analysis of the economic net worth of FHA's MMI Fund. FHA has retained Summit Consulting, LLC and Milliman, Inc. (jointly "Summit & Milliman") to perform an independent actuarial review of FHA's MMI Fund.

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 FHA's reverse mortgage program, Home Equity Conversion Mortgages (HECMs), into the MMI Fund. HECMs are analyzed separately and are excluded from this actuarial report. In the remainder of this report, the term "MMI Fund" refers to the MMI Fund excluding HECMs. The primary purpose of this actuarial review is to forecast:

- the economic value of the MMI Fund (defined as the sum of existing capital resources, total assets less total liabilities of the MMI Fund, and the net present value (NPV) of the current endorsements, excluding HECMs); and
- the insurance-in-force (IIF) of the MMI Fund, excluding HECMs.

This report presents the results of the Summit & Milliman analysis for fiscal year (FY) 2013. **The economic value forecast of the MMI Fund, as of the end of FY 2013, is negative \$10.6 billion.**

For this analysis, a single deterministic path of home prices and interest rates was used to forecast the economic value of the MMI Fund. The economic value of the MMI Fund under additional alternative economic scenarios is presented to provide sensitivity testing of the MMI Fund to economic conditions.

NAHA requires the MMI Fund to have a capital ratio of at least two percent, so the MMI Fund could withstand a moderate economic downturn. The capital ratio is defined as the ratio of the MMI Fund's economic value to unamortized IIF. Because the HECM business is excluded from this analysis, the capital ratio of the MMI Fund is not included in this report.

### Status of the MMI Fund

Table 1 reports the forecast of the MMI Fund's current and future economic value, and Table 2 summarizes the forecasted IIF. Both tables summarize the forecasts under the baseline economic scenario.

**Table 1: MMI Fund Value Forecast for Fiscal Years 2013 to 2020 (\$ Millions)**

Fiscal Year	Total Fund Economic Value	NPV of Future Cash Flows <sup>a</sup>	NPV of Current Book of Business <sup>a</sup>	NPV of New Book of Business <sup>a</sup>	Capital Resources	Return on Investment <sup>b</sup>
	A = B + E	B = C + D	C	D	E = E(prior) + F	F
2013	-10,634	-31,195	-37,075	5,880	20,561	-
2014	-146	-20,788	-32,666	11,879	20,642	81
2015	9,052	-11,777	-22,306	10,529	20,829	187
2016	17,767	-3,626	-13,304	9,679	21,393	564
2017	27,378	5,173	-4,978	10,151	22,205	812
2018	38,207	15,149	4,207	10,942	23,058	854
2019	50,216	26,290	14,709	11,581	23,927	869
2020	63,523	38,679	26,292	12,387	24,844	917

Source: Summit & Milliman forecasts

<sup>a</sup>Present values are discounted to the end of the respective fiscal year using single effective rates as discussed in Appendix D.

Current book defined as surviving loans, net of those acquired during the fiscal year.

New book defined as loans acquired during the fiscal year.

<sup>b</sup>Return on investment is calculated using the single effective rate as discussed in Appendix D.

The MMI Fund's economic value is calculated as the sum of the NPV of future cash flows, current endorsements, new endorsements, and capital resources.

**The economic value of the MMI Fund is forecast to be negative \$10.6 billion, as of the end of FY 2013, and forecast to be negative \$0.1 billion at the end of FY 2014.** The economic value of the MMI Fund is forecast to increase in each successive year as a result of a forecast for improved economic conditions compared to recent years, higher premium rates compared to historical endorsements, and improved borrower characteristics, such as higher credit scores and lower loan-to-value ratios compared to historical endorsements.

The capital resources of the MMI Fund at the end of FY 2013 are \$20.6 billion. Capital resources over the next seven years are forecast as the prior year capital resources plus return on investment of those capital resources. Investment return rates are calculated as averages of the monthly 1 year Constant Maturity Treasury (CMT) rates over the projected fiscal year.

**Table 2: Insurance in Force Forecast for Fiscal Years 2013 to 2020 (\$ Millions)**

Fiscal Year	Unamortized IIF	Amortized IIF	New Endorsement Volume
2013 <sup>a</sup>	1,166,299	1,089,551	234,793
2014	1,143,994	1,055,557	117,952
2015	1,129,426	1,028,666	106,931
2016	1,116,446	1,005,438	103,147
2017	1,112,370	991,708	106,796
2018	1,121,462	991,540	115,790
2019	1,141,669	1,001,241	123,381
2020	1,170,917	1,019,154	132,859

Source: Summit & Milliman forecasts

<sup>a</sup>FY 2013 endorsement volume includes volume forecast adjustment.

For the next seven forecast years as insurance terminations are replaced with new endorsement volume, unamortized IIF is forecast to remain around \$1.1 trillion and amortized IIF is forecast to remain around \$1.0 trillion. New endorsements for FHA-insured mortgages are forecast to drop in subsequent endorsement years.<sup>1</sup> The drop in new endorsement volume results from lower estimated refinance activity and lower market share for FHA-insured mortgages as a result of improvements in the housing market (as measured by changes in home prices) and less competitive pricing for FHA-insured mortgages compared to privately-insured mortgages.

### **Economic Value of the MMI Fund under Alternative Economic Scenarios**

The NPV of future cash flows under six alternative economic scenarios is presented in the table below. The economic scenarios were developed by Moody's Analytics and were used without adjustments by Summit & Milliman.<sup>2</sup>

The most severe scenario to the economic value of the MMI Fund is the S4 scenario, which forecasts a protracted economic slump. This scenario produces an economic value of the fund estimate of negative \$43.9 billion. The optimistic scenario, S1, produces an economic value of the fund estimate of negative \$10.6 billion. Further details on the scenario assumptions and results are discussed in Section III.

<sup>1</sup> Endorsement years refer to insurance written during the corresponding fiscal year. For example, endorsement year 2013 refers to insurance contracts endorsed during fiscal year 2013, which is defined as October 1, 2012 through September 30, 2013.

<sup>2</sup> For further information regarding Moody's Analytics alternative scenarios please view the following document: <http://www.economy.com/home/products/samples/Moodys-Analytics-US-Alternative-Scenarios.pdf>

**Table 3: Fund Value Forecast under Alternative Scenarios as of FY 2013 (\$ Millions)**

Scenario	Description	Economic Value	Difference from Baseline
	Baseline	-10,634	-
S1	Stronger near-term rebound	-10,647	-13
S2	Slower near-term recovery	-12,166	-1,532
S3	Second recession	-23,457	-12,823
S4	Protracted slump	-43,876	-33,242
S5	Below-trend long-term growth	-16,023	-5,389
S6	Oil price increase, dollar inflation	-17,338	-6,704

Source: Summit & Milliman forecasts

### Impact of Economic Forecasts

As demonstrated above, the economic value of the MMI Fund and its pattern of capital accumulation through FY 2020 depend on many factors. One of the most influential factors is the prevailing economic conditions through 2050, and most critically, during the first ten years of that time period. Summit & Milliman captured the most significant factors in the U.S. economy affecting the performance of FHA-insured mortgages through the use of the following model variables:

- 30 year home mortgage commitment rates
- One year CMT rate
- 10 year CMT rate
- 30 year CMT rate
- Change in local home prices
- Interest rates for cash flow discounting

The performance of FHA’s endorsements, measured by their economic value, is affected by changes in these economic variables. The results of this report are based on Moody’s Analytics quarterly forecasts for interest rates and metropolitan statistical area (MSA) average home price appreciation rates.<sup>3</sup> Moody’s Analytics forecasted these economic variables simultaneously along with other macroeconomic and regional variables as of July 2013.

### Risks, Assumptions, and Data Reliance

The forecasts presented in this review reflect projections of events more than 30 years into the future. These projections are dependent upon a number of assumptions, including economic forecasts by Moody’s Analytics and the assumption that FHA’s policies regarding refunds, premiums, distributive shares, underwriting or servicing rules, and administrative expenses remain stable. To the extent that these and/or other assumptions are subject to change, the actual results may vary, perhaps significantly, from current projections.

<sup>3</sup> State-level home price appreciation rates were used if MSA-level forecasts were not available.

Estimation of the variables in the models used for predicting prepayments and claims depends on large amounts of loan-level data, requiring extensive data processing. For this review, Summit & Milliman used the actual historical loan-level data as of June 30, 2013 provided by FHA. Summit & Milliman received additional program changes and information from FHA subsequent to June 30, 2013 and incorporated these into the analysis where appropriate.

In performing this evaluation, Summit & Milliman has assumed that FHA (a) used its best efforts to supply accurate and complete data and (b) did not knowingly provide any inaccurate data. Summit & Milliman performed a limited review of the data used directly in Summit & Milliman's analysis for reasonableness and consistency and have not found material defects in the data. If there are material defects in the data, it is possible that they would be uncovered by a detailed, systematic review and comparison of the data to search for values that are questionable or relationships that are materially inconsistent. Such a review was beyond the scope of Summit & Milliman's assignment.

## Introduction and Background

The Federal Housing Administration (FHA) is a government agency providing mortgage insurance coverage to single-family homebuyers through the Mutual Mortgage Insurance (MMI) Fund, financed through the insurance premiums FHA collects on its insured loans.

Effective in 1990, the Cranston-Gonzalez National Affordable Housing Act (NAHA) required, among other things, that the MMI Fund be actuarially sound by maintaining a minimum capital ratio of two percent to sufficiently withstand a moderate economic downturn. As defined by NAHA, this required capital ratio is the ratio of the MMI Fund's economic value to its unamortized insurance-in-force (IIF). To ensure adherence to the necessary minimum capital ratio requirement, NAHA requires an annual independent actuarial review.

### Scope

FHA has retained Summit & Milliman to perform a calculation of the economic value of FHA's MMI Fund forward mortgage portfolio as of September 30, 2013. This report documents the results of the analysis for the forward mortgage component of the MMI Fund. A separate report documents the results of the analysis for the Home Equity Conversion Mortgage (HECM) component of the MMI Fund.

The calculation described in this report entails 30 year projection for the existing insurance portfolio and seven future endorsement years for the following items on forward mortgage endorsements:

- Upfront and Annual Premium
- Estimated Claim Payments
- Premium Refunds
- Loan Modification Payments

### Management Discussion

Throughout the course of this analysis Summit & Milliman had discussions with FHA management concerning certain assumptions used in this analysis. Specifically, Summit & Milliman had discussions with FHA management concerning:

- Historical program changes and the potential impacts or considerations on the models developed for this analysis;
- Loan-level data collected by FHA and how to use these data;
- Recent changes to FHA loss mitigation programs including mortgage modifications and pre-Real Estate Owned (REO) claim alternatives;
- Assumptions about future volume forecasts; and
- Capital resources for the FHA as of the end of fiscal year (FY) 2013.

The design of the forecast models, including the selection of explanatory variables in the models, was developed independently from FHA. Summit & Milliman provided information regarding model updates to report progress in model development to FHA. However, Summit &

Milliman's decisions regarding model form, variables considered for the model specifications, or adjustments to the models were not influenced by FHA.

## Report Outline

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

### **Section I: Program Information**

This section provides an overview of FHA insurance. It includes a brief summary of mortgage insurance, a discussion on policy changes that influence the economic value of the MMI Fund, and a summary of premium changes from FY 1990 through FY 2013.

### **Section II: Summary of Findings**

This section provides a summary of the findings from this actuarial review. It presents the analysis results in terms of the current and forecast economic value of the MMI Fund. The section also reports the net present value (NPV) of future cash flows for endorsement years 1983 through 2013, decomposing forecasts into granular segments.

### **Section III: Sensitivity Analysis**

Forecasts of the economic value of the MMI Fund are sensitive to economic forecasts such as future home prices, interest rate paths, third party sale (TPS) volumes and other factors. This section provides forecasts of the economic value of MMI Fund under six alternative economic scenarios generated by Moody's Analytics and 15 TPS severity scenarios generated by Summit & Milliman.

### **Section IV: Discussion of Portfolio Characteristics**

Mortgage insurance results are influenced by the types of loans endorsed by the FHA. This section provides summary tables and discussions of trends in the characteristics on mortgages endorsed by FHA. The section discusses trends in endorsement volume, loan-to-value (LTV) ratios, credit scores, and others.

### **Section V: Summary of Methodology**

The economic value of the MMI Fund is forecast using models to forecast the performance of FHA-insured mortgages. This section of the report provides an overview of the models used to forecast the performance of FHA-insured mortgages.

### **Section VI: Qualifications and Disclosures**

Any actuarial report is subject to a discussion of the qualifications and disclosures of the actuarial review. This section of the report provides a discussion of the qualifications and disclosures applicable to this actuarial review.

## List of Appendices

### **Appendix A: Discussion of Anticipated Portfolio Trends**

The models developed to forecast performance of FHA-insured mortgages are complex. This appendix segments the forecasts into various components providing the reader with support for the forecasts and documenting trends observed in the data.

### **Appendix B: Technical Details of the Forward Model**

This appendix provides a technical description of the model used to forecast the performance of FHA-insured mortgages. The appendix describes the process used to develop the model and provides the coefficients used in the model.

### **Appendix C: Technical Details of Loss Severity Model**

This appendix provides a technical description of the model used to forecast the severity rate on FHA-insured mortgages. The appendix describes the process used to develop the model and provides the coefficients used in the model.

### **Appendix D: Technical Details of the Cash Flow Model**

This appendix provides a technical description of the model used to forecast cash flows which are then used to develop the economic value of the MMI Fund.

### **Appendix E: Technical Details of the Volume Demand Model**

A requirement of this actuarial review is to forecast the future volume for FHA-endorsements for the next seven fiscal years. This appendix provides a technical description of the model used to forecast future endorsements.

### **Appendix F: Historical and Forecast Results**

This appendix provides claim rates, non-claim termination rates, claim type rates, and loss severity rates for historical and forecasted endorsements.

## Section I: Program Information

This section of the review provides a brief discussion of mortgage insurance, a discussion of trends in FHA's market share of the high-LTV market, and a discussion of relevant FHA policy changes.

### Mortgage Insurance Summary

Mortgage insurance allows for the purchase of a home using a smaller down payment than would otherwise be required by a lender, typically 20% or more. Banks and mortgage lenders generally require borrowers to obtain mortgage insurance from third-party mortgage insurers on loans with low down payments. Through mortgage insurance, a portion of the credit default risk on high LTV loans is transferred from lenders and investors to a third party.

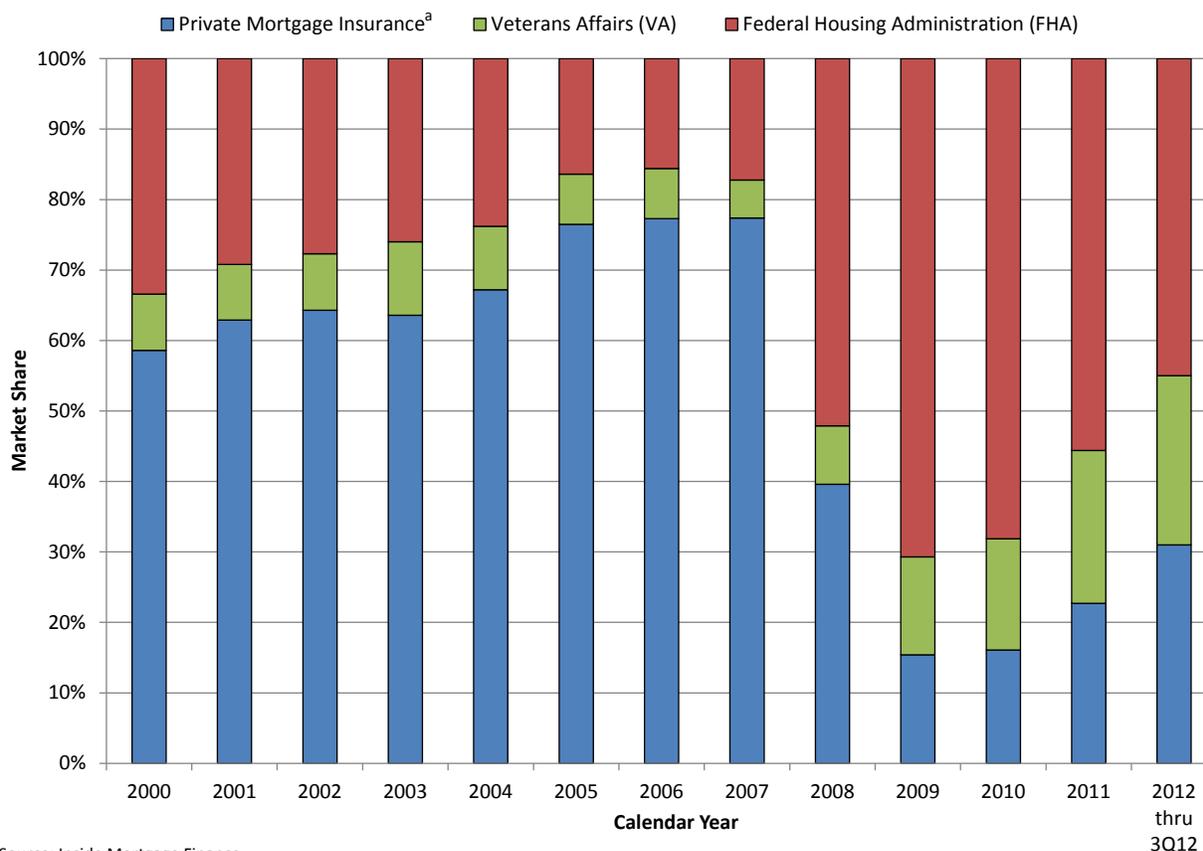
For loans with low down payments, borrowers have a choice between private or government-provided mortgage insurance. Mortgage insurance is funded through premiums paid by the borrower or lender. Premiums are typically paid during the life of the loan but can also be paid up front at closing. For FHA-insured mortgages, borrowers typically pay both an upfront premium and an annual premium.

Mortgage insurers, both private and FHA, disperse mortgage default risk by diverting accumulated premium revenues derived from relatively strong mortgage markets to cover claim losses in relatively weak mortgage markets.

### FHA Market Share

Historically, FHA has played a countercyclical role in the mortgage market. As such, it insures *more* mortgages when lenders and private mortgage insurers are tightening their underwriting standards and raising premium rates and insures *fewer* mortgages when lenders and private mortgage insurers are easing their underwriting standards and lowering premium rates. During periods of growth in the mortgage market, loan execution with private mortgage insurance is generally less expensive than loan execution with public mortgage insurance; the opposite is true during stress periods in the mortgage market. This countercyclical relationship is demonstrated in the following figure.

Figure 1: U.S. Primary Mortgage Insurance Market Share



Source: Inside Mortgage Finance

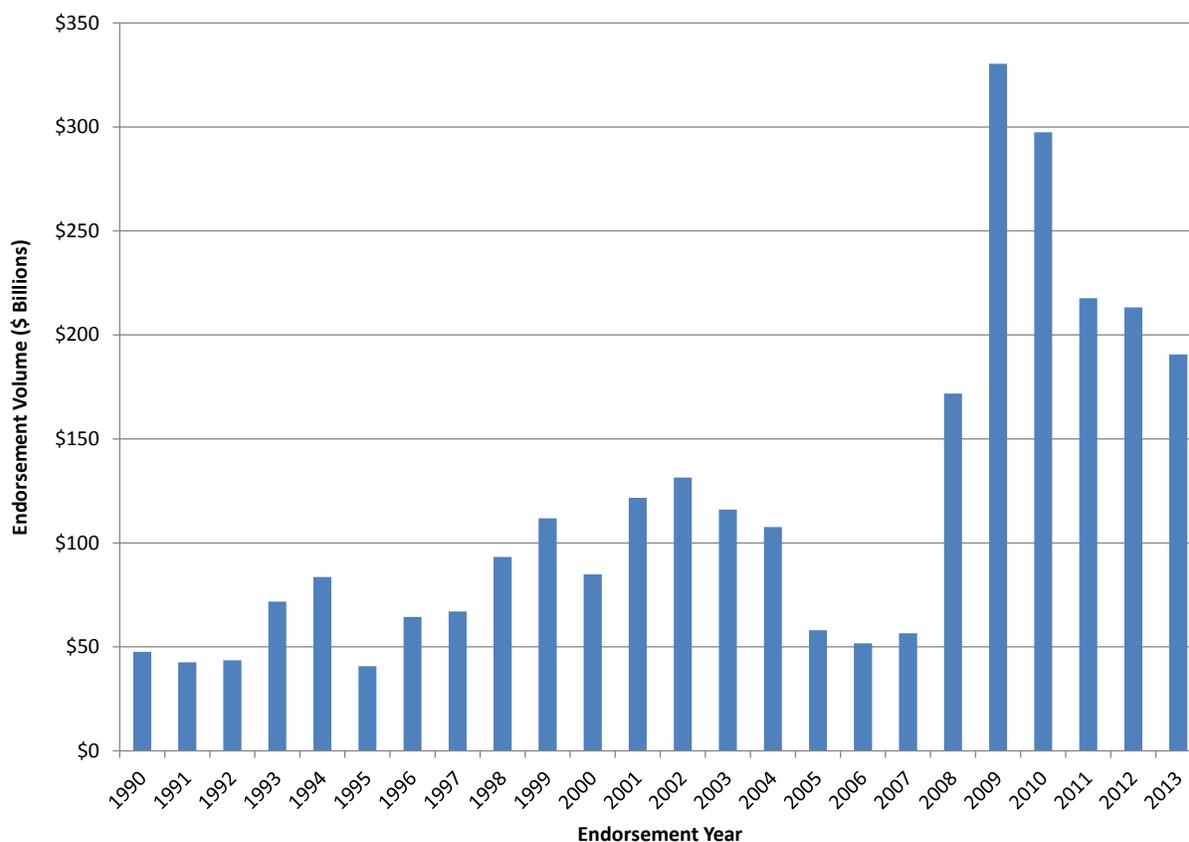
<sup>a</sup>Private mortgage insurance includes flow, bulk and Home Affordable Refinance Program (HARP) originations

The figure above shows the market share of the private market compared to Veterans Administration (VA) and FHA-insured mortgages for loans with mortgage insurance from 2000 through 2012. The blue bars on the figure represent the share of the market for private-insured mortgages by calendar year, the green bars represent the share of the market for VA-insured mortgages, and the red bars represent the share of the market for FHA-insured mortgage originations by calendar year. The sum of the red, green, and blue bars equal 100% for the entire amount of all mortgage originations with mortgage insurance. Market share is defined as the dollar amount of originations for each mortgage insurer (i.e., FHA, VA, or private) divided by the total dollar amount of originations with mortgage insurance for each calendar year.

FHA’s share of the mortgage market for loans with mortgage insurance steadily decreased from approximately 35% to less than 20% from 2000 to 2007. This period corresponds to a period in the mortgage market where underwriting standards were broadly loosening. Subsequently, FHA’s market share increased from less than 20% in 2006 and 2007 to over 70% in 2009 and 2010, following the financial crisis when private lenders restricted credit. From 2009 through 2012, FHA’s market share of the high-LTV market has declined to less than 50%.

The following figure provides a visualization of the volume of FHA-insured originations by calendar year.

**Figure 2: Endorsement Volume by Endorsement Year<sup>a</sup> (\$ Billions)**



Source: FHA internal database  
<sup>a</sup>FY 2013 data through June 30, 2013

The volume of FHA endorsements is heavily skewed toward recent originations during the post-financial crisis period. Specifically, FHA endorsement volume increased significantly starting in 2008 and continuing through 2013. For these five endorsement years (FY 2008 through FY 2013), FHA endorsed approximately \$1.42 trillion of mortgages; this compares to total endorsements of approximately \$1.39 trillion for the prior 17 endorsement years (FY 1990 through FY 2007).

### Policy Changes

FHA has implemented several policy changes during recent years, which affected loans endorsed by FHA, including changes to minimum down payments, premium rates for FHA insurance, and other criteria. This section identifies significant policy changes enacted by FHA.

#### Down Payment Requirements

The size of a borrower’s down payment is an important underwriting assessment used to manage credit risk in the mortgage industry. Generally, smaller down payments are associated with higher levels of default risk. FHA has changed minimum down payment requirements three times since 1998 to manage their credit risk. The following table lists these changes:

**Table 4: Minimum Down Payment Policy Changes**

Mortgagee Letter	Effective Year	Minimum Down Payment
1998-29	1998	Ranging between 1.25% and 2.85% (according to closing costs in individual states and appraised values)
2008-23	2008	3.5% (maximum loan-to-value ratio of 96.5%; not to exceed 100%, including upfront mortgage insurance premium)
2010-29	2010	Minimum credit score 500 3.5% (for new borrowers with credit scores $\geq$ 580) 10% (for new borrowers with credit scores between 500 and 580)

Source: FHA

In 2008, FHA required minimum down payments of 3.5%. This minimum included any financing of the upfront mortgage insurance premium. In 2010, FHA enhanced this requirement to differentiate the down payment required by borrower credit score. Borrowers with lower credit scores have a higher minimum down payment, and the minimum down payment for borrowers with a credit score above 580 was left unchanged at 3.5%.

### Down Payment Assistance

Under most FHA programs, the borrower is required to make a minimum down payment of at least 3.5% of the lesser of the appraised property value or the purchase price. Past FHA guidelines allowed borrowers to use seller-funded gifts as down payment assistance. However, the passage of the Housing and Economic Reform Act (HERA) on July 30, 2008 officially terminated seller-funded down payment assistance for FHA endorsements—though it still does permit such assistance from family members. In 2012, FHA clarified that this rule does not apply to funds provided by Housing Finance Agencies.

### Loan Limits

Starting in 2009, as the housing market entered a national downturn, FHA increased loan limits eligible for FHA mortgage insurance. FHA began a series of gradual increases to the maximum eligible loan amount, allowing borrowers with higher loan amounts purchasing properties in higher cost areas to benefit from FHA mortgage insurance. Historically, FHA-insured loans were not eligible for higher loan amounts or properties in higher cost areas. The higher loan limits introduced in 2009 are still in effect. Currently, the national loan limit for a one-unit, single-family residence is set at \$729,750, with a modestly higher ceiling allowed for properties located in Hawaii, Alaska, Guam, and the U.S. Virgin Islands.

### Premiums

FHA has made significant changes to upfront and annual premiums since 1990. Generally, FHA lowered the upfront premium rate from FY 1990 through FY 2008 over a series of reductions. After FY 2008, FHA increased the annual premium rate an average rate of 50 basis points per endorsement to an average of over 100 basis points per endorsement. The figure below provides a visual of the average upfront and annual premium rate by endorsement year for FY 1990 through FY 2013 endorsements.

Figure 3: Average Upfront and Annual Premium Rate by Endorsement Year (% of UPB)



Source: FHA internal database  
\*2013 endorsement year data through June 30, 2013

## Section II: Summary of Findings

This section of the review summarizes the results of the analysis. The section provides a forecast of the economic value of the MMI Fund as of FY 2013, provides a forecast of the economic value of the MMI Fund from FY 2013 through FY 2020, and summarizes the NPV of cash flows for each endorsement year as of FY 2013.

### Current Fund Status

**The economic net worth of the MMI Fund in FY 2013 is forecast to be negative \$10.6 billion,** as shown in the table below. The economic net worth of the MMI Fund is equal to the sum of capital resources at the end of the year (\$20.6 billion) plus the NPV of future cash flows on outstanding insurance (negative \$31.2 billion).

During FY 2013, the capital resources for the forward portfolio of the MMI Fund decreased from \$29.1 billion to \$20.6 billion. The decrease was largely driven by two items: net insurance income of negative \$6.4 billion and a transfer of \$4.3 billion to the financing account for HECM.

**Table 5: Fund Economic Value (\$ Millions)**

	FY 2013 <sup>a</sup>
<b>Beginning-of-Year Positions</b>	
Cash	33,348
Investments	2,770
Properties and Mortgages	2,065
Other Assets and Receivables	14
Total Assets	38,197
Liabilities	-9,098
<b>Capital Resources at Beginning of Year</b>	<b>29,099</b>
<b>Activity During Fiscal Year</b>	
Net Gain From Investment	939
Net Insurance Income	-6,368
Net Change in Value of Property Inventory	670
Net Change in Accounts Payable	485
Mandatory Appropriation	-
Transfer to HECM Financing Account	-4,263
<b>Capital Resources at End of Year</b>	<b>20,561</b>
<b>Actuarial Calculation</b>	
Present Value of Future Cash Flows on Outstanding Insurance	-31,195
<b>Economic Value</b>	<b>-10,634</b>

Source: FHA and Summit & Milliman forecasts

<sup>a</sup>Present values are discounted to the end of FY 2013

### Economic Value Forecast

The economic value of the MMI Fund is forecast to increase each year over the next eight years. The MMI Fund's economic value is calculated as the sum of the NPV of future cash flows, current endorsements, new endorsements, and capital resources.

**Table 6: MMI Fund Value Forecast for Fiscal Years 2013 to 2020 (\$ Millions)**

Fiscal Year	Total Fund Economic Value	NPV of Future Cash Flows <sup>a</sup>	NPV of Current Book of Business <sup>a</sup>	NPV of New Book of Business <sup>a</sup>	Capital Resources	Return on Investment <sup>b</sup>
	A = B + E	B = C + D	C	D	E = E(prior) + F	F
2013	-10,634	-31,195	-37,075	5,880	20,561	-
2014	-146	-20,788	-32,666	11,879	20,642	81
2015	9,052	-11,777	-22,306	10,529	20,829	187
2016	17,767	-3,626	-13,304	9,679	21,393	564
2017	27,378	5,173	-4,978	10,151	22,205	812
2018	38,207	15,149	4,207	10,942	23,058	854
2019	50,216	26,290	14,709	11,581	23,927	869
2020	63,523	38,679	26,292	12,387	24,844	917

Source: Summit & Milliman forecasts

<sup>a</sup>Present values are discounted to the end of the respective fiscal year using single effective rates as discussed in Appendix D.

Current book defined as surviving loans, net of those acquired during the fiscal year.

New book defined as loans acquired during the fiscal year.

<sup>b</sup>Return on investment is calculated using the single effective rate as discussed in Appendix D.

The economic value of the MMI Fund is forecast to be negative \$10.6 billion, as of the end of FY 2013 and forecast to be negative \$0.1 billion at the end of FY 2014 after including the forecast of the economic value of FY 2014 endorsements. The economic value of the MMI Fund is forecast to increase in each successive year as a result of improved economic forecasts compared to recent years, higher annual premium rates compared to historical rates, and improved borrower characteristics, such as higher credit scores and lower LTV ratios from recent endorsement years.

### Present Value

The total NPV of current and new endorsements as of the end of FY 2013 is expected to be negative \$31.2 billion, including \$5.9 billion of positive economic value from FY 2013 endorsements. The negative forecast of the NPV of future cash flows is driven by large negative cash flow forecasts from endorsement years 2008 through 2010.

The table below shows the NPV of future cash flow forecasts by endorsement year. The column on the far right expresses the NPV of future cash flow forecasts as a percent of amortized IIF for each endorsement year.

**Table 7: Present Value of Future Cash Flows by Endorsement Year – Current Endorsements<sup>a</sup> (\$ Millions)**

Endorsement Year	Amortized IIF	NPV of Future Cash Flows	NPV of Future Cash Flows as a Percent of Amortized IIF
1984	1	0	-1.2%
1985	14	0	-2.2%
1986	253	-7	-2.6%
1987	516	-13	-2.6%
1988	251	-7	-2.6%
1989	143	-4	-2.8%
1990	188	-5	-2.6%
1991	294	-10	-3.3%
1992	528	-20	-3.9%
1993	1,167	-28	-2.4%
1994	1,745	-40	-2.3%
1995	806	-33	-4.0%
1996	1,493	-65	-4.4%
1997	1,697	-82	-4.9%
1998	3,350	-164	-4.9%
1999	4,740	-255	-5.4%
2000	2,546	-191	-7.5%
2001	5,645	-503	-8.9%
2002	9,638	-901	-9.4%
2003	17,614	-1,676	-9.5%
2004	22,344	-2,757	-12.3%
2005	17,752	-3,006	-16.9%
2006	16,804	-3,072	-18.3%
2007	19,057	-3,987	-20.9%
2008	56,957	-9,777	-17.2%
2009	147,167	-9,886	-6.7%
2010	187,881	-5,386	-2.9%
2011	155,099	777	0.5%
2012	182,057	4,021	2.2%
2013	231,803	5,880	2.5%
<b>Total</b>	<b>1,089,551</b>	<b>-31,195</b>	<b>-2.9%</b>

Source: Summit & Milliman forecasts

<sup>a</sup>FY 2013 includes volume forecast adjustment

The NPV of future cash flows is forecast to be negative \$31.2 billion for all endorsement years through 2013. The NPV of future cash flows for endorsement years 2008 through 2010 accounts for negative \$25.0 billion of the economic value of the MMI Fund. When expressed as a percent of amortized IIF, endorsement years 2009 and 2010 are associated with less negative ratios of the NPV of future cash flows compared to endorsement years 2001 through 2008. The

ratios of NPV of future cash flows to IIF for endorsement years 2004 through 2007 are all less than negative 11% with 2007 having the lowest rate of negative 20.9%. However, the volume of these endorsement years is small relative to 2008 and subsequent endorsement years. Therefore, although the performance of the 2008 through 2010 endorsement years is better compared to prior endorsement years (i.e. less negative ratios of the NPV of future cash flows relative to IIF), the volume of these endorsement years results in a higher dollar value of negative NPV of future cash flows as of September 30, 2013.

For 2011 endorsements, a turnaround in this trend is noted, as the NPV of future cash flow forecast of the FY 2011 and subsequent endorsement years becomes positive. FY 2014 through FY 2020 are forecast to continue this positive NPV trend.

The turnaround in NPV of future cash flows stems from improved economic forecasts, higher annual premium rates, and improved credit characteristics of the insured population. The table below provides a summary of the unamortized IIF forecast, NPV of future cash flows, and the ratio of the NPV of future cash flows compared to unamortized IIF.

**Table 8: Present Value of Future Cash Flows by Endorsement Year – Future Endorsements (\$ Millions)**

Endorsement Year	Unamortized IIF	NPV of Future Cash Flows	NPV of Future Cash Flows as a Percent of Unamortized IIF
2014	117,952	11,879	10.1%
2015	106,931	10,529	9.8%
2016	103,147	9,679	9.4%
2017	106,796	10,151	9.5%
2018	115,790	10,942	9.5%
2019	123,381	11,581	9.4%
2020	132,859	12,387	9.3%

Source: Summit & Milliman forecasts

## Section III: Sensitivity Analysis

Summit & Milliman forecast the NPV of future cash flows under alternative economic forecasts of home price index (HPI) and interest rates to assess the sensitivity to these forecasts given different macroeconomic expectations as well as an estimate of the potential impact for a higher utilization rate of TPS. This section summarizes the results of the sensitivity analysis.

### Economic Forecasts

Summit & Milliman relied on six alternative economic forecasts produced by Moody's Analytics to assess the sensitivity of the FY 2013 MMI Fund to changes in macroeconomic conditions, namely interest and home price appreciation rates.<sup>4</sup> The scenarios are provided to Summit & Milliman and are used without adjustment. Each alternative scenario is designed by Moody's so that there is a certain probability that the economy will, broadly speaking, perform better than the scenario. The six alternative economic scenarios are each assigned a probability of occurrence and described by Moody's Analytics as:

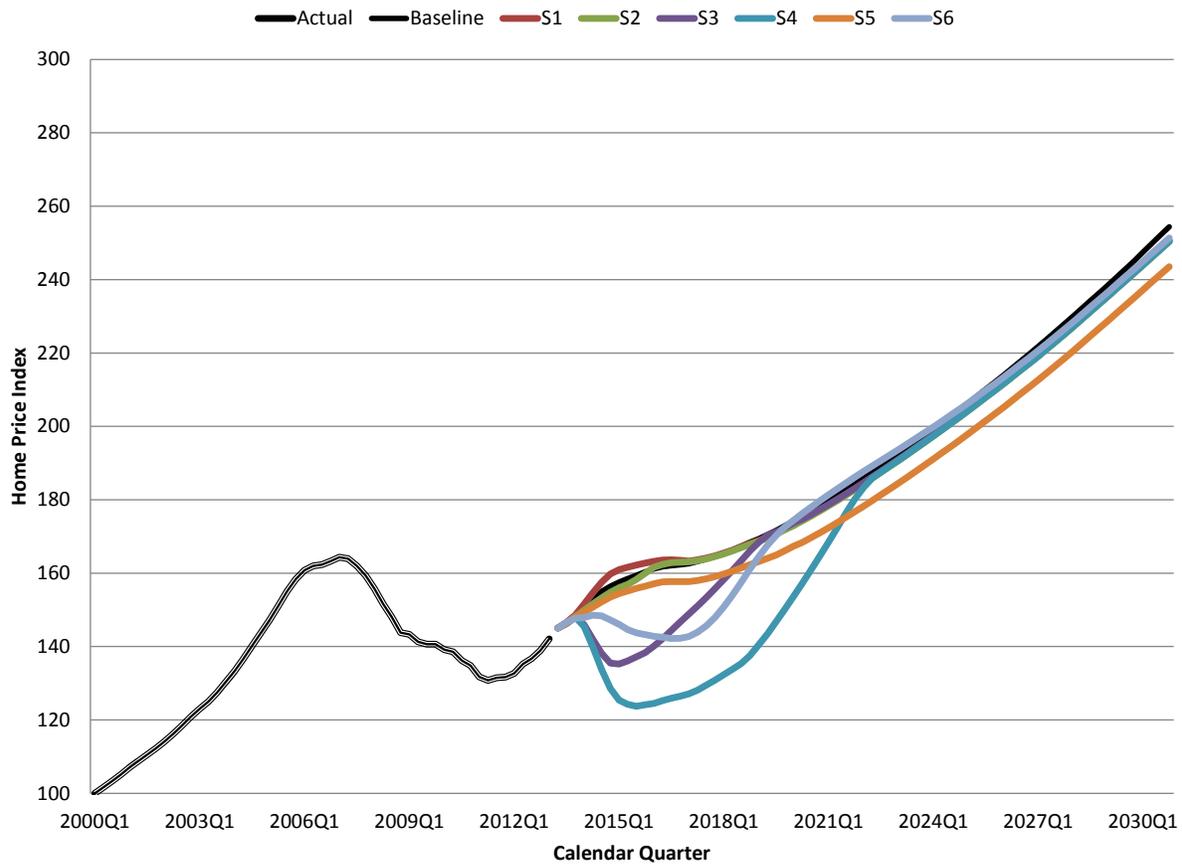
1. **S1: Stronger Near-Term Rebound**
  - a. 10% probability the economy will perform better than this forecast
2. **S2: Slower Near-Term Recovery**
  - a. 75% probability the economy will perform better than this forecast
3. **S3: Second Recession**
  - a. 90% probability the economy will perform better than this forecast
4. **S4: Protracted Slump**
  - a. 96% probability the economy will perform better than this forecast
5. **S5: Below-Trend Long-Term Growth**
  - a. 96% probability the economy will perform better than this forecast
6. **S6: Oil Price Increase, Dollar Crash Inflation**
  - a. 90% probability the economy will perform better than this forecast

The figure below provides a visual of the HPI forecast for the United States under the baseline economic forecast and the alternative six scenarios used in this analysis.

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<sup>4</sup> The alternative HPI forecasts represent September 30, 2013 forecasts as opposed to July 30, 2013 forecasts as used in the baseline estimate of this report due to data availability for MSA-level forecasts. The alternative purchase-only HPI forecasts as of July 30, 2013 contained limited MSA-level forecasts.

Figure 4: Moody's Analytics Purchase-Only Home Price Index

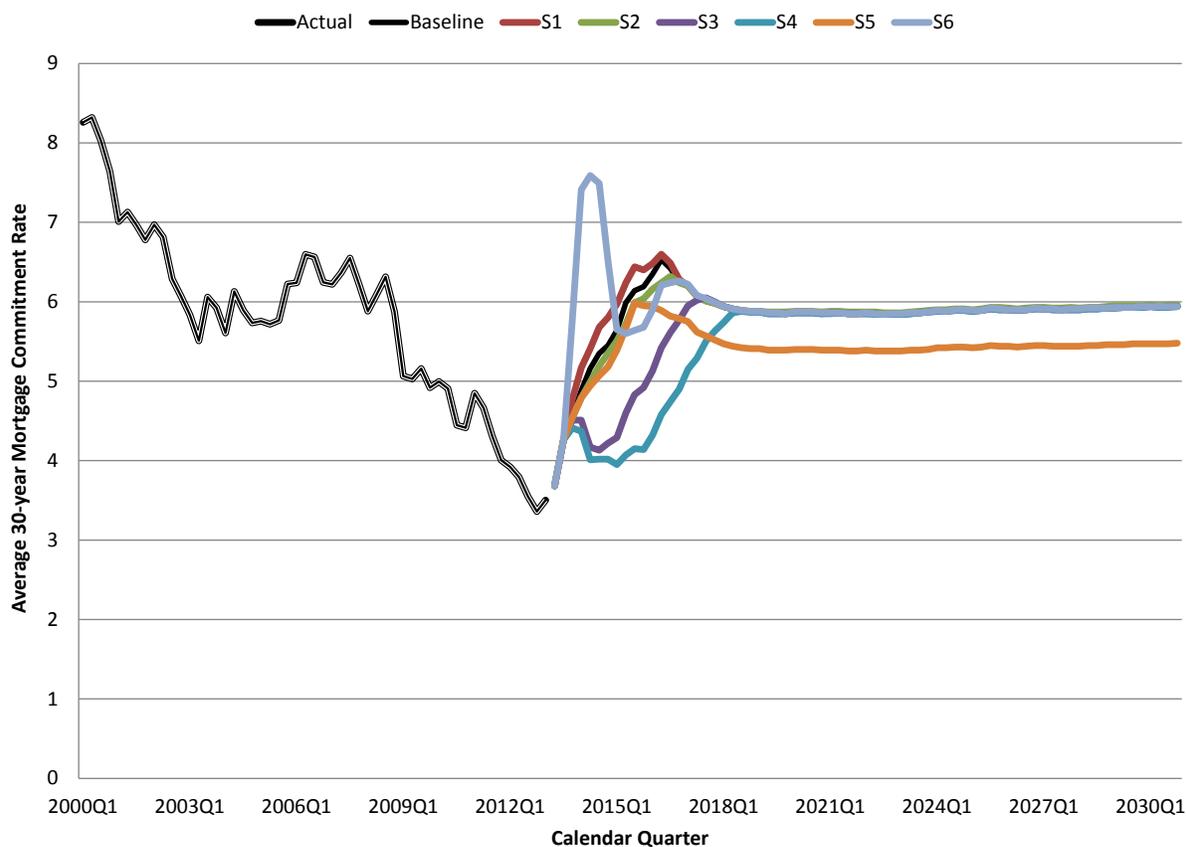


Source: Moody's Analytics

The most severe scenarios for adverse movements in home prices are scenarios 3, 4, and 6. These scenarios forecast additional declines in home prices which would adversely affect the performance of FHA-insured mortgages.

The forecast models used in this review use two economic variables to estimate the performance on FHA-insured mortgages: HPI and mortgage interest rates. The figure below provides a visual of the average 30 year mortgage commitment rate forecast under the baseline economic forecast and the alternative six scenarios used in this analysis.

Figure 5: Moody’s Analytics Average 30 year Mortgage Commitment Rate



Source: Moody’s Analytics

### Alternative Scenario Economic Value Estimates

The following table provides Summit & Milliman’s economic value estimates under scenarios S1 to S6 and the differences from baseline.

Table 9: Forecast Fund Economic Value under Baseline and Alternative Scenarios as of FY 2013 (\$ Millions)

Scenario	Description	Economic Value	Difference from Baseline
	Baseline	-10,634	-
S1	Stronger near-term rebound	-10,647	-13
S2	Slower near-term recovery	-12,166	-1,532
S3	Second recession	-23,457	-12,823
S4	Protracted slump	-43,876	-33,242
S5	Below-trend long-term growth	-16,023	-5,389
S6	Oil price increase, dollar inflation	-17,338	-6,704

Source: Summit & Milliman forecasts

The most pessimistic scenario for the economic value of the MMI Fund is Moody’s Analytics S4 scenario, the protracted slump, which results in an estimated economic value of negative \$43.9

billion. This scenario forecasts significant declines in home prices from current levels and a drop in interest rates. Additional declines in home prices increases the forecast of the number of claims for FHA endorsements.

The second most severe scenario for the economic value of the MMI Fund is scenario S3, a second recession. This scenario is similar to S4 but less severe. The forecast of home price declines for this scenario also results in elevated claims which drive the lower economic value estimate.

The economic value of the fund estimate for scenarios S1 and S2 forecast slightly similar economic values to the baseline scenario. The S1 scenario corresponds to a stronger near-term rebound in the economy before settling back to the baseline trend estimate. The higher home price forecast for this scenario results in lower claim estimates compared to the baseline. This scenario also corresponds to lower premium revenue for FHA as loans prepay more quickly as compared to the baseline. The combination of lower claims and lower premium revenue results in a slight decrease in the economic value of the fund.

Scenario S2 corresponds to a slower near-term recovery. Home price forecasts for this scenario are more pessimistic compared to the baseline, which increases the forecast of the number of claims and reduces the economic value estimate of the fund.

Scenarios S5 and S6 estimate an economic value of the fund that is more pessimistic than scenarios S1 and S2, but less severe than scenarios S3 and S4. For scenario S5, below trend long-term growth, the forecast results in roughly the same amount of premium as in the baseline scenario. This forecast results in a higher number of claims as a result of less-optimistic home price appreciation.

For scenario S6, a spike in interest rates and subsequent decline in home price, the forecast results in more premium revenue. As interest rates spike upward, fewer mortgages end in a non-claim termination; however, this greater premium revenue is more than offset by additional claims estimated as a result of declines in home prices.

### **Forecasts for Alternative Third Party Sale Scenario**

In FY 2013 FHA expanded a pilot program in which properties secured by non-performing FHA-insured loans are offered for sale by the lender who has completed the foreclosure process. This pilot program, Claim without Conveyance of Title (CWCOT), allows sale through a competitive bid process to private investors.

In addition, in June 2012, as part its Distressed Asset Stabilization Program and in an effort to address its seriously delinquent loan portfolio, FHA announced that, over the next several years, it would significantly increase the number of loans it makes available for purchase as well as add new neighborhood stabilization pools to encourage investment in communities hardest hit by the foreclosure crisis. The “Neighborhood Stabilization Outcome” (NSO) pools, as an additional safeguard in distressed communities, require that no more than 50% of the loans within a purchased pool be marketed as real-estate owned (REO) properties and – if the servicer and borrower are unable to avoid taking the loan through foreclosure – that the

servicer achieve some other neighborhood stabilizing outcome, which may include holding the property for rental for at least three years.<sup>5</sup>

Summit & Milliman evaluated recent data on third party sales severity to measure actual versus modeled results. TPS sales historically have made-up a small portion of all property dispositions (less than 10%). However, going forward FHA has made TPS a required policy for lenders to execute with the expectation there will be cost savings over REO dispositions. Summit & Milliman’s analysis found that on average, TPS actual severity rates are lower than Summit & Milliman Loss Severity Model estimates. However, by endorsement year, these estimates are similar to FHA actual results. At this time Summit & Milliman does not have sufficient data to evaluate the impact on cost savings of TPS versus REO. Additionally, Summit & Milliman’s analysis indicates a large standard deviation in TPS, and therefore it is difficult to say with confidence the results are statistically significant.

To illustrate the potential future impact on the Fund for a higher utilization of TPS, Summit & Milliman performed a sensitivity analysis to evaluate the impact of future volumes of TPS reaching up to 50% of REO dispositions. There are two TPS adjustments used in the analysis, the first adjustment is the probability of TPS instead of REO claim. This adjustment is the percent of expected to go to conveyance claim, but instead go to TPS. The second adjustment, TPS severity, is a percentage point reduction to the REO loss severity rate. The tables below summarize these results.

**Table 10: Forecast Fund Value Given TPS Adjustment as of FY 2013 (\$ Millions)**

Probability of TPS (Rather Than REO)	TPS Severity Reduction		
	8%	10%	12%
10%	-9,765	-9,547	-9,330
20%	-8,895	-8,461	-8,026
30%	-8,026	-7,374	-6,722
40%	-7,157	-6,287	-5,418
50%	-6,287	-5,201	-4,114

Source: Summit & Milliman forecasts

In the first cell of the table above, the probability of TPS in lieu of REO is 10%, and the TPS severity reduction is 8%. This cell indicates that 10% of all claims that would have been disposed through REO are assumed to be disposed of through TPS *and* the average reduction in the loss severity rate for TPS is 8% (e.g. if the REO severity rate were estimated to be 40%, the TPS severity rate would equal 32%). Under this scenario, the economic value of the fund is estimated to be negative \$9.7 billion, which is \$0.9 billion higher than the baseline economic value. Under a 50% utilization rate of TPS and an average reduction in severity rate of 12%, the

<sup>5</sup> Source: HUD website

economic value of the fund would be negative \$4.1 billion, which is \$6.5 billion higher than the baseline economic value.

The following table summarizes the difference in forecasted economic value between each scenario in Table 10 and the baseline economic value. For example, given a 10% probability of TPS in lieu of REO and an 8% severity reduction would increase the fund value by \$0.9 billion.

**Table 11: Forecast Fund Value Difference from Baseline Given TPS Adjustment as of FY 2013 (\$ Millions)**

Probability of TPS (Rather Than REO)	TPS Severity Reduction		
	8%	10%	12%
10%	869	1,087	1,304
20%	1,739	2,173	2,608
30%	2,608	3,260	3,912
40%	3,477	4,347	5,216
50%	4,347	5,433	6,520

Source: Summit & Milliman forecasts

## Section IV: Discussion of Portfolio Characteristics

Mortgage performance (i.e. claim and non-claim termination rates) varies according to the underwriting characteristics in insured mortgages. For example, borrowers with higher credit scores are associated with lower claim rates, all else equal. This section provides a summary of the select portfolio characteristics on insured mortgages as of June 30, 2013. Where weighted-averages or percent distributions are shown, all figures are calculated using the amortized IIF as of June 30, 2013.

### Insurance-in-Force

The table below provides a summary of IIF by endorsement year. The table provides a column for the number of active endorsements, unamortized IIF, and amortized IIF. Unamortized IIF is the sum of the original mortgage amount for all active endorsements. Amortized IIF is the sum of the scheduled unpaid principal balance as of the reported fiscal year.

**Table 12: Number of Endorsements and Insurance in Force as of FY 2013<sup>a</sup> (\$ Millions)**

Endorsement Year	Number of Active Loans	Unamortized IIF	Amortized IIF
Pre-2000	526,299	34,394	20,284
2000	45,731	3,519	2,790
2001	85,137	7,429	5,902
2002	135,638	12,705	10,075
2003	218,785	23,147	18,371
2004	267,545	28,512	23,275
2005	194,662	21,747	18,513
2006	166,358	19,701	17,438
2007	170,117	21,724	19,789
2008	436,947	63,935	59,177
2009	1,017,016	164,883	153,732
2010	1,255,368	207,487	195,877
2011	986,996	170,106	162,642
2012	1,107,058	194,786	189,767
2013	1,038,561	186,755	185,083
<b>Total</b>	<b>7,652,218</b>	<b>1,160,829</b>	<b>1,082,715</b>

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013. Table 7 includes FY 2013 volume forecast adjustment and thus reports greater IIF.

Origination volume through June of the 2013 endorsement year accounts for about 14% of all active endorsements by count. As a percentage of unamortized IIF, this endorsement year accounts for about 16% of active endorsements. Endorsement years 2008 through 2013 account for about 85% of unamortized IIF.

## Geography

Of all 50 states, D.C., and U.S. protectorates, over half of FHA’s IIF is concentrated in just 10 states. Within the top 10, the distribution of shares has skewed toward California for recent endorsement years.

**Table 13: Geographic Distribution by Endorsement Year<sup>a</sup> – Percent of IIF (%)**

State	Endorsement Year						All Years
	2008	2009	2010	2011	2012	2013 <sup>a</sup>	
CA	4.9	9.7	12.2	15.3	17.4	17.7	12.6
TX	10.0	7.1	7.0	6.6	6.9	6.6	8.2
FL	7.0	5.1	5.0	4.7	4.3	4.7	5.0
NY	5.4	4.8	4.7	5.1	4.4	3.8	4.6
NJ	4.4	4.7	3.9	3.9	3.8	3.6	3.9
GA	5.5	4.2	3.5	3.0	2.9	3.1	3.9
VA	3.5	4.0	3.9	3.9	3.9	3.8	3.7
PA	3.9	3.9	4.1	3.8	3.5	3.2	3.6
MD	3.8	4.0	3.6	3.6	3.5	3.6	3.5
IL	3.5	3.8	3.4	3.3	3.2	3.4	3.5
Other	48.1	48.7	48.6	47.0	46.1	46.5	47.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013

Prior to 2007, California was a relatively small component of FHA business because a lot of the California housing market was ineligible for FHA insurance. FHA loan limits were generally less than the average cost of a home in California. In 2009, FHA loan limits were increased to levels that made a large portion of the California market eligible for FHA insurance. Subsequently, FHA’s share of the California market increased, as is evident in the above table.

## Product Type

Fixed rate 30 year term (FRM30) mortgages compose the majority of FHA’s business. From 1992 through 1997, FHA endorsed a large portion of adjustable rate mortgages (ARMs); however, since 1997 ARMs have been a smaller portion of FHA business. In recent years, FHA’s volume has shifted heavily towards streamline refinance loans as borrowers from older endorsement years are taking advantage of lower interest rates.

The table below provides the distribution of mortgage endorsements for the following product types:

- Fixed rate 30 year term – FRM30
- Fixed rate 30 year term streamline refinance – FRM30 SR
- Fixed rate 15 year term – FRM15
- Fixed rate 15 year term streamline refinance – FRM15 SR
- Adjustable rate mortgage - ARM

- Adjustable rate mortgage streamline refinance – ARM SR

**Table 14: Product Distribution by Endorsement Year<sup>a</sup> – Percent of IIF (%)**

Endorsement Year	FRM30	FRM30 SR	FRM15	FRM15 SR	ARM	ARM SR	Total
1983	93.5	0.1	6.4	0.0	-	-	100.0
1984	94.0	0.0	5.5	-	0.5	-	100.0
1985	89.4	0.0	7.7	-	2.9	-	100.0
1986	87.8	2.4	7.7	0.4	1.8	-	100.0
1987	80.1	10.2	4.9	1.7	3.1	0.1	100.0
1988	86.3	4.6	3.3	0.5	5.2	0.0	100.0
1989	92.8	2.7	2.4	0.2	2.0	-	100.0
1990	92.3	2.9	2.4	0.2	2.2	-	100.0
1991	85.9	3.9	2.8	0.6	6.8	0.1	100.0
1992	63.6	12.5	2.5	2.7	17.1	1.5	100.0
1993	46.9	28.4	2.4	7.2	13.0	2.1	100.0
1994	43.1	26.4	1.8	7.9	18.2	2.7	100.0
1995	63.9	4.2	1.4	1.1	28.6	0.9	100.0
1996	60.9	7.8	1.3	1.6	26.7	1.8	100.0
1997	57.5	4.1	1.1	0.7	34.1	2.5	100.0
1998	65.7	20.6	1.1	1.5	9.2	1.9	100.0
1999	75.7	14.9	1.1	1.6	5.7	1.1	100.0
2000	86.8	2.4	0.7	0.2	9.5	0.4	100.0
2001	71.9	23.3	1.0	0.8	2.2	0.9	100.0
2002	65.9	21.9	1.2	1.8	6.0	3.2	100.0
2003	50.8	37.6	1.3	3.1	3.8	3.3	100.0
2004	62.2	21.5	1.4	2.6	8.1	4.3	100.0
2005	69.1	16.2	1.3	1.4	9.1	3.0	100.0
2006	88.1	7.0	1.4	0.5	2.9	0.3	100.0
2007	92.1	5.1	1.2	0.1	1.3	0.1	100.0
2008	90.8	5.9	1.6	0.1	1.4	0.2	100.0
2009	77.1	19.3	2.2	0.4	0.8	0.3	100.0
2010	79.0	13.2	3.6	0.4	2.8	1.0	100.0
2011	72.3	15.5	5.6	0.6	4.2	1.8	100.0
2012	65.4	24.5	6.4	1.2	1.5	1.0	100.0
2013	54.1	41.0	3.1	1.0	0.5	0.4	100.0

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013

### Origination Loan to Value

FHA facilitates mortgage lending to the underserved market; this market includes borrowers with limited resources for down payments. Therefore, FHA’s business tends to result in a high concentration of high LTV ratios, as shown in the table below. The table below also provides the percent of mortgages that were streamline refinance mortgages in the column farthest to the right. The table highlights that the percent of streamline originations has fluctuated throughout history, and recent originations have a heavy concentration in streamline refinance mortgages.

**Table 15: Original LTV Distribution by Endorsement Year<sup>a</sup> – Percent of IIF (%)**

Endorsement Year	<=80	80<-90	90<-95	95<-97	>97	Total	Streamline Refinance
1983	24.0	29.5	26.6	18.2	1.7	100.0	0.1
1984	17.4	26.7	25.7	23.2	7.1	100.0	0.0
1985	17.6	31.0	26.6	22.8	2.0	100.0	0.0
1986	19.9	30.1	26.3	22.1	1.6	100.0	2.7
1987	18.1	27.7	28.0	23.9	2.3	100.0	11.7
1988	10.0	19.9	33.3	32.6	4.2	100.0	5.1
1989	8.9	18.1	34.4	34.5	4.1	100.0	3.0
1990	8.0	17.6	34.5	35.7	4.2	100.0	3.4
1991	6.9	15.6	27.7	30.8	19.0	100.0	4.8
1992	5.9	15.2	26.9	36.8	15.2	100.0	17.2
1993	6.4	15.7	24.7	29.9	23.4	100.0	38.7
1994	6.5	14.4	23.2	29.8	26.0	100.0	40.0
1995	3.9	10.9	23.5	33.2	28.4	100.0	6.7
1996	4.2	12.0	24.7	33.1	26.0	100.0	11.6
1997	4.5	12.3	25.3	33.3	24.6	100.0	7.0
1998	5.7	14.8	26.2	31.6	21.7	100.0	22.5
1999	5.2	11.1	12.3	28.4	43.1	100.0	18.0
2000	3.2	6.7	6.6	33.5	50.0	100.0	3.1
2001	4.8	10.4	9.5	34.1	41.3	100.0	23.4
2002	5.5	11.1	9.8	34.5	39.1	100.0	26.9
2003	7.1	13.1	12.0	32.0	35.7	100.0	44.9
2004	7.4	12.0	10.5	34.4	35.7	100.0	30.7
2005	6.9	10.8	9.1	36.8	36.4	100.0	22.4
2006	7.3	10.3	13.2	35.6	33.7	100.0	8.6
2007	7.7	11.0	19.5	33.0	28.7	100.0	5.2
2008	6.9	11.7	22.5	35.6	23.4	100.0	6.2
2009	5.8	13.1	17.6	46.6	16.9	100.0	18.0
2010	5.7	14.3	11.1	60.7	8.3	100.0	12.8
2011	5.8	14.4	12.4	61.7	5.7	100.0	15.1
2012	6.3	13.4	17.7	58.8	3.8	100.0	23.1
2013	6.3	17.0	27.9	46.2	2.6	100.0	42.2

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013

### Origination Credit Score

FHA data contain credit scores (i.e. FICO credit scores) for loans endorsed on or after May 2004, when FHA started to require credit score reporting if a credit score were part of the servicer’s

underwriting process. Prior to 2004, most FHA endorsements do not include credit score data because there was no requirement that lenders provide this information to FHA.<sup>6</sup>

In addition, origination credit scores are not reported in the FHA internal database for streamline refinance loans. Thus, Summit & Milliman retained the prior (or original) mortgage credit score for streamline refinance mortgages. The table below provides the percent of mortgages that were streamline refinance mortgages in the column farthest to the right. The table highlights that the percent of streamline originations has fluctuated throughout history, and recent originations have a heavy concentration in streamline refinance mortgages.

**Table 16: Original Credit Score Distribution by Endorsement Year<sup>a</sup> – Percent of IIF (%)**

Endorsement Year	300 -< 550	550 -< 600	600 -< 650	650 -< 700	700 -< 750	750 -< 800	800 - 850	Total	Streamline Refinance
2004	5.9	20.1	32.1	23.2	12.6	5.9	0.3	100.0	30.7
2005	8.0	20.6	32.1	22.2	11.2	5.6	0.4	100.0	22.4
2006	7.4	20.0	32.0	22.5	11.5	6.1	0.6	100.0	8.6
2007	10.2	23.6	32.0	19.7	9.1	4.8	0.5	100.0	5.2
2008	6.3	17.6	31.9	23.9	12.5	7.2	0.7	100.0	6.2
2009	1.0	6.2	26.1	30.2	20.8	14.2	1.5	100.0	18.0
2010	0.2	1.2	21.2	32.4	24.5	18.4	2.2	100.0	12.8
2011	0.1	0.7	17.3	34.5	25.2	19.6	2.6	100.0	15.1
2012	0.1	0.7	18.3	37.1	24.3	17.2	2.4	100.0	23.1
2013	0.1	0.5	16.9	40.7	24.6	15.3	1.9	100.0	42.2

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013

Since the recent financial crisis, general market trends have been moving toward credit tightening, resulting in endorsements for FHA-insured mortgages with higher credit scores. The above table shows that concentrations of greater than 700 FICO credit scores began increasing in 2009.

### Origination Note Rate

Since the recent recession, interest rates have been historically low. As such, weighted average note rates across product types have declined for FHA’s business and are at historically low levels.

<sup>6</sup> Appendix B describes the process used by Summit & Milliman to estimate FICO credit scores for endorsement prior to 2004 for modeling purposes.

**Table 17: Dollar Weighted Average Origination Note Rate by Endorsement Year<sup>a</sup> (%)**

Endorsement Year	Total	FRM30		FRM15		ARM	ARM SR
		FRM30	SR	FRM15	SR		
1983	12.10	12.17	12.13	11.04	11.10	12.00	11.00
1984	12.77	12.81	13.03	11.95	11.75	13.29	-
1985	12.00	12.04	12.14	11.48	11.27	12.00	-
1986	10.02	10.05	9.71	9.85	9.37	10.01	8.62
1987	9.35	9.40	9.41	9.14	8.97	8.55	7.76
1988	10.02	10.05	10.71	9.71	9.81	9.05	8.90
1989	10.00	9.99	11.05	9.83	10.19	9.32	9.11
1990	9.77	9.76	10.69	9.55	9.92	9.14	8.83
1991	9.27	9.38	9.99	9.05	9.23	7.64	7.64
1992	8.13	8.49	8.82	8.21	8.20	6.43	6.46
1993	7.53	7.73	8.10	7.37	7.52	5.85	6.23
1994	7.40	7.72	7.79	7.20	7.43	6.24	6.13
1995	7.92	8.29	8.33	7.95	8.14	7.06	7.02
1996	7.51	7.88	7.98	7.53	7.65	6.55	6.79
1997	7.39	7.90	8.17	7.63	7.91	6.47	6.75
1998	7.20	7.30	7.46	7.06	7.07	6.12	6.47
1999	7.29	7.42	7.22	7.04	6.95	6.22	6.02
2000	8.19	8.33	8.17	8.03	7.85	7.00	6.39
2001	7.33	7.40	7.30	6.90	6.72	6.01	5.91
2002	6.74	6.95	6.80	6.40	6.27	5.26	5.25
2003	5.89	6.07	5.97	5.48	5.44	4.40	4.41
2004	5.80	6.08	5.89	5.48	5.41	4.40	4.31
2005	5.76	5.93	5.82	5.60	5.60	4.77	4.63
2006	6.24	6.29	6.08	6.11	5.99	5.36	5.06
2007	6.47	6.49	6.36	6.36	6.18	5.62	5.61
2008	6.27	6.30	6.06	5.87	5.54	5.40	5.32
2009	5.49	5.58	5.25	5.07	4.78	5.07	4.53
2010	5.04	5.11	5.10	4.59	4.62	3.98	4.27
2011	4.52	4.62	4.59	4.13	4.12	3.51	3.66
2012	3.90	3.96	3.94	3.43	3.48	3.14	3.34
2013 <sup>a</sup>	3.51	3.47	3.62	3.06	3.24	2.67	2.82

Source: FHA internal database

<sup>a</sup>FY 2013 data through June 30, 2013

The weighted average note rate (by original mortgage amount) has declined from a peak of 12.77% in FY 1984 to 3.51% in FY 2013. This decline is unlikely to persist as market rates in late FY 2013 have started to increase and are forecast (by Moody's Analytics) to move towards 6% over the next few years.

## Section V: Summary of Methodology

A key exercise in estimating the economic value of the MMI Fund is to forecast the number and amount of claim payments and the amount of premiums collected from the insurance portfolio. Summit & Milliman developed a statistical model to forecast the performance of insured forward mortgages (Forward Model), which was used in this actuarial review to forecast the number, amounts, and timing of claims, as well as the persistency (or duration) of the mortgages to estimate future premium. This section provides a high level summary of the methodology used in each individual piece of the Forward Model.

Technical details about each piece of the model can be found in the Appendices. Specifically,

- **Appendix A provides a discussion of anticipated portfolio trends;**
- **Appendix B provides the technical details of development of the Forward Model;**
- **Appendix C provides the technical details of development of the Loss Severity Model;**
- **Appendix D provides the technical details of the Cash Flow Model;**
- **Appendix E provides the technical details of the Volume Demand Model;**
- **Appendix F provides historical performance and model forecast results.**

### Model Input Data

#### Loan-Level Data

Summit & Milliman obtained loan-level data from FHA containing 28.9 million loans endorsed from 1975 until June of 2013. The data include two types of datasets: a static dataset and a delinquency episode dataset.

The static dataset includes underwriting information, origination dates, and the status of the insured loans as of June 30, 2013. It also includes information on any claim events experienced by the individual loans.

The delinquency dataset includes information about individual delinquency episodes, with data beginning in calendar year 1990. Calendar years 1990 through 2013 contain records detailing the starting and ending dates of 90 day delinquency episodes. A given endorsement may be associated with zero or multiple delinquency episodes.

The delinquency episode data contain a record with expanded information for delinquency episodes, beginning with 60 day delinquencies for calendar years 2006 through 2013. (Note that in this context, 60 day and 90 day delinquency episodes refer to loans missing two and three mortgage payments, respectively). The expanded information includes starting and ending dates of foreclosure activity and fields that indicate the ultimate resolution of each delinquency episode through forbearance, loan modification, self-cure, or other means.

Using both the static and delinquency episode datasets, Summit & Milliman developed quarterly transactional data detailing the performance history of FHA-endorsed mortgages. The transaction database constructed with static data as of February 28, 2013 was used to calibrate the loan transition model and the Loss Severity Model discussed in this report. Historical and predicted values for loan transitions, loss severity, and loan amortization schedules were constructed using the transactional database with updated data as of June 30, 2013.

FHA also provided Summit & Milliman with a dataset identifying all delinquent loans, the severity of delinquency, and any loss mitigation activity as of June 30, 2013.

### **Economic Data**

Summit & Milliman obtained historical and forecast economic data from Moody's Analytics, via FHA. The economic data include Metropolitan Statistical Area (MSA) and state-level HPI, 1 year and 10 year constant maturity interest rates, and average 30 year fixed rate mortgage commitment rates published by Freddie Mac.

FHA provided HPIs constructed using purchase-only transactions. The purchase-only HPI, provided to Summit & Milliman as of July 30, 2013, includes indices from 1991 Q1 through 2043 Q4 for 75 MSAs.

Mortgage and interest rate data, provided to Summit & Milliman as of July 30, 2013, include historical data from 1953 Q2 through 2013 Q1, with forecast data through 2043 Q4.

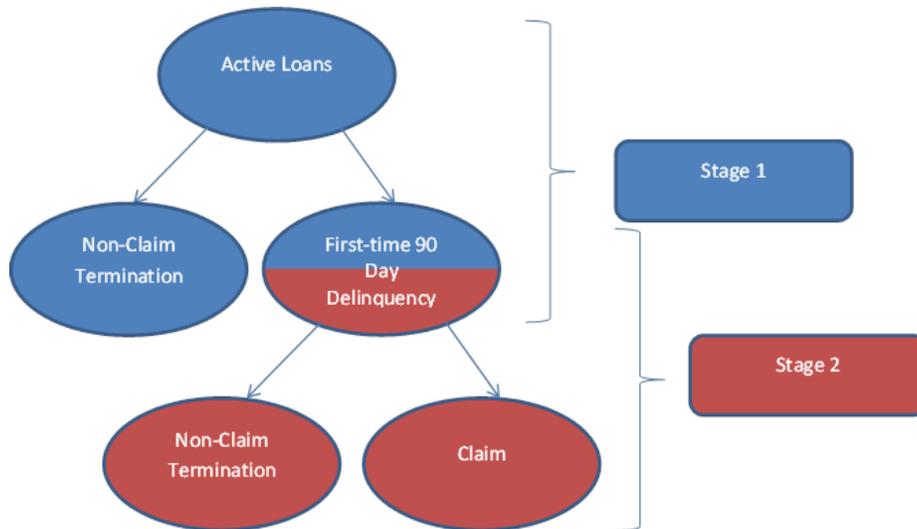
### **Forward Model Methodology**

The Forward Model forecasts the performance of mortgages in a two-stage framework. Stage 1 forecasts the probability of a mortgage transitioning from performing to either a non-claim termination or serious delinquency (90 days or more delinquent) at each quarter of development. A non-claim termination is a termination of insurance coverage where FHA is no longer liable for the performance of the mortgage, such as through early repayment of the mortgage note.

Once a mortgage becomes seriously delinquent, the mortgage is no longer considered performing and permanently transitions from Stage 1 to Stage 2 of the Forward Model.

Stage 2 of the Forward Model forecasts the ultimate performance of mortgages after becoming seriously delinquent. Note that the Stage 2 model does not assume all delinquent mortgages terminate prior to expiry. Rather, it forecasts the probability of termination conditional upon loan age, underwriting characteristics, and economic conditions. It is possible for mortgages that enter the Stage 2 model to remain insured for the remaining life of the mortgage without a claim or early non-claim termination. Also note that once a mortgage enters the Stage 2 model, it cannot revert to the Stage 1 model. The following figure provides a visualization of the model stages for the Forward Model.

Figure 6: Forward Model Diagram – State 1 and Stage 2 Framework



Stage 1 of the Forward Model is a model for performing mortgages, while Stage 2 is a model for non-performing mortgages. Since different factors affect mortgage performance in the pre-90 day delinquency and post-90 day delinquency period in different ways, separating the model estimation into two stages allows the behavior of mortgages to be modeled in a more precise manner. In addition, the Stage 2 model facilitates the analysis and adjustments for specific loss mitigation efforts, such as loan modifications, to cure non-performing loans.

### Incorporating the Non-Performing Inventory

FHA provides insurance on an inventory of 1,169,253 mortgages that were delinquent by two or more payments as of June 30, 2013 and for an additional 474,526 mortgages that were ever three or more payments delinquent. The 1,643,779 mortgage “non-performing inventory” contains mortgages that range in delinquency statuses from mortgages starting the foreclosure process to mortgages that have missed only one payment. Data on the delinquency of a mortgage provide additional information that is useful for estimating the probability of a claim. For example, mortgages in the foreclosure process have almost a 100% probability of resulting in a claim, while mortgages that have missed only one payment have a significantly lower probability of claim due to the potential ability to cure. To capture this information, the Summit & Milliman classified delinquencies into one of five types of delinquency:

1. Foreclosures and Probable Claims
  - Defined as mortgages that are in some stage of the foreclosure process or otherwise have a high probability of resulting in a claim
2. Persistent Delinquencies
  - Defined as mortgages that have been delinquent for more than nine months, missed at least three payments, and are not repaying their mortgage
3. Ever-90 Days Delinquent

- Defined as mortgages that were ever 90 days delinquent and are not included in the prior categories
- 4. First-Time 90 Days Delinquent or Worse
  - Defined as mortgages that are 90 days delinquent or worse as of June 30, 2013 and are not included in the prior categories
- 5. 60 Days Delinquent
  - Defined as mortgages that are 60 days delinquent as of June 30, 2013 and are not included in one of the prior categories

For each delinquency category, Summit & Milliman modified the Stage 1 and Stage 2 framework to take advantage of the additional information provided by the delinquency status of the mortgage.

The table below segments the delinquency inventory as of June 2013 into each of the above delinquency statuses and shows the ultimate number of claims forecast for each status. The ultimate number of claims is calculated as the sum of all future claims from June 30, 2013 through the entire forecast period for each mortgage.

The 1,169,253 loans delinquent as of June 30, 2013 were extracted from a loan-level file provided by FHA that included a unique identifier and the delinquency level for these loans. The 231,125 additional mortgages that were ever delinquent were extracted from the delinquency episode datasets described above as of June 30, 2013. (The two segments equal the Total from Delinquency Inventory of 1,400,378 in the table below).

The following table includes the same data for mortgages that were not delinquent as of June 30, 2013 and have not been delinquent by 90 days or more. If a mortgage was delinquent by 90 days or more as of June 30, 2013 and the mortgage was previously 90 days or more delinquent from a prior delinquency episode, the table below classifies the mortgage as an “Ever-90 Days Delinquent” mortgage for consistency with the Stage 2 model.

**Table 18: Claim Rate Forecast by Delinquency Status as of June 30, 2013**

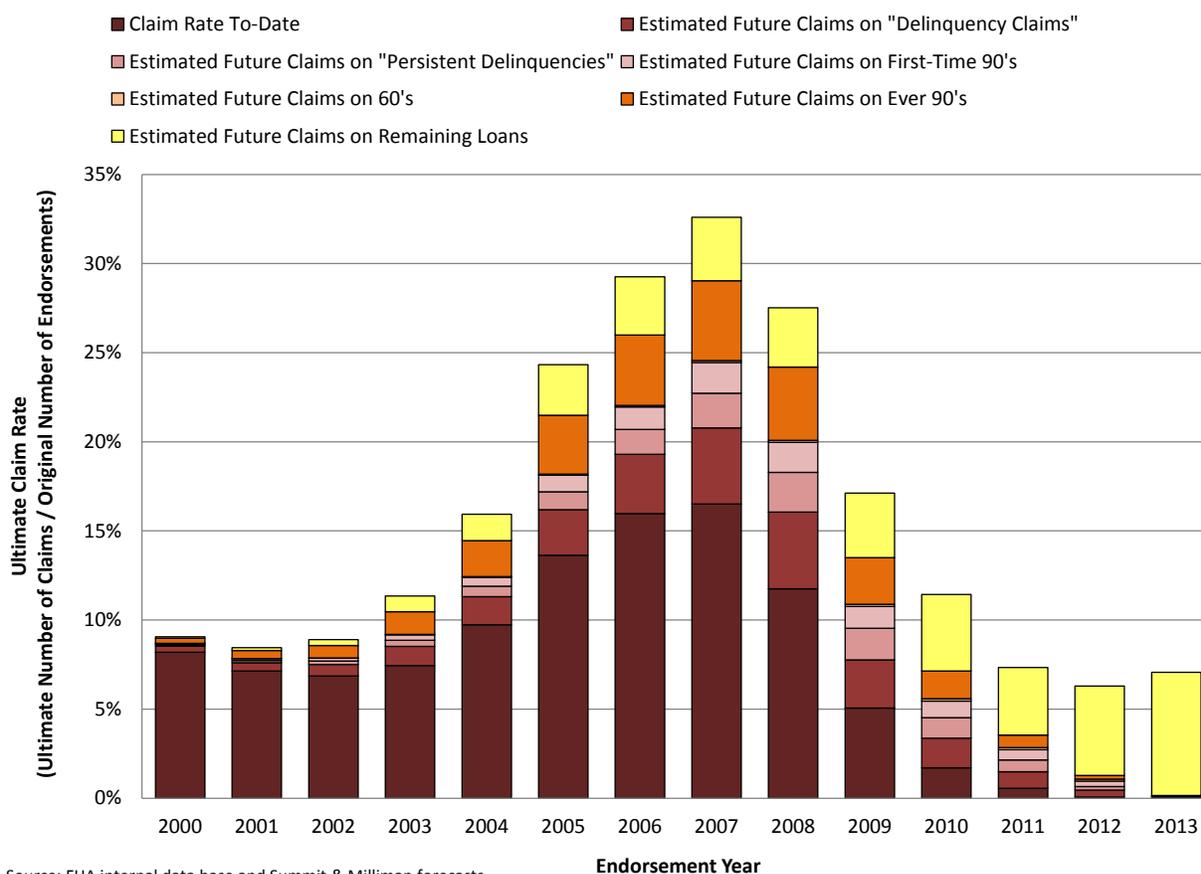
Delinquency Status	Number of Mortgages as of June 30, 2013	Ultimate Number of Claims	Ultimate Claim Rate
Foreclosures and Probable Claims	234,322	234,322	100%
Persistent Delinquencies	139,001	117,980	85%
Ever-90 Days Delinquent	745,588	231,093	31%
First-Time 90 Days Delinquent	247,151	95,410	39%
60 Days Delinquent	34,316	10,375	30%
<b>Total from Delinquency Inventory</b>	<b>1,400,378</b>	<b>689,180</b>	<b>49%</b>
<b>Mortgages that were not delinquent as of June 30, 2013 and have never been 90 days delinquent or worse</b>	<b>6,092,593</b>	<b>421,315</b>	<b>7%</b>
<b>All Mortgages</b>	<b>7,493,971</b>	<b>1,110,495</b>	<b>15%</b>

Source: Summit & Milliman forecasts

Of the 1.1 million future claims, 689,180 (62%) arise from mortgages that are non-performing or have been delinquent by three payments or more in the past. The remaining 38% of claims are forecast to arise from the residual population of mortgages.

Ultimate claim rates vary over time due to business deliveries, loan status, economic forecasts and book persistency. As such, the Forward Model’s forecast normalizes these effects over time. The following figure provides a depiction of the ultimate claim rate forecasts by delinquency status and endorsement year for endorsement years 2000 through 2013. The dark red bars on the graph show the paid claim rates to-date, the lighter red bars show the claim rate forecast on delinquencies, with darker red columns corresponding to more serious delinquencies. The orange bars on the chart show the claim rate forecast for mortgages that were ever 90 days delinquent, and the light yellow bars show the claim forecasts on the remaining exposure.

Figure 7: Ultimate Claim Composition by Endorsement Year and Delinquency Status



Source: FHA internal data base and Summit & Milliman forecasts

### Incorporating Loan Modifications

FHA’s commitment to increased levels of support for borrowers who are delinquent on their mortgages is evident in the creation of loan modification programs. Loss mitigation programs, and specifically loan modifications, were discussed with FHA. As a result, Summit & Milliman’s loan modification assumptions were developed in consideration of Mortgagee Letter 2011-28<sup>7</sup>. Summit & Milliman explicitly adjusted the claim rate forecasts from the models discussed above to account for modifications, as a haircut adjustment to the forecasts.<sup>8</sup>

Discussions with FHA indicated to Summit & Milliman that future loan modifications must be applied equally to all delinquent mortgages. Therefore, Summit & Milliman incorporated modifications into this analysis by applying a specific haircut adjustment to the claim rates

<sup>7</sup> On November 16, 2012, HUD subsequently issued ML 2012-22, which, among other changes, clarified surplus income and permitted mortgagors who were initially unsuccessful in completing trial payment plans to re-apply for standard loan modifications or HAMP if their financial circumstances had changed since their initial application for assistance.

<sup>8</sup> The modification adjustment also applies to mortgages that were or have ever been 90 days delinquent as of June 30, 2013, as well as mortgages that were 60 days delinquent. The modification adjustment is not applied to foreclosures and probable claims or persistent delinquencies.

developed from the forecast models for all mortgages. This adjustment is equal to the product of two factors:

1. The probability of modification after the borrower's first 90 day delinquency;
  - a. Equal to 35% for all mortgages, with the exception of foreclosures, probable claims, and persistent delinquencies
2. A multiplicative modification factor applied to the claim rate forecast of the mortgage, conditional on default (i.e. the Stage 2 claim rate);
  - a. Equal to 40% for all mortgages

Both of these factors were developed using traditional actuarial methods, namely the development factor method and the Bornhuetter-Ferguson (B-F) method. These common actuarial methods rely on experience to-date and historical patterns of incidence to forecast the ultimate rate for a given outcome.

Summit & Milliman chose to rely on actuarial techniques to adjust for loan modifications because they allow for the development of ultimate forecasts of an event based on limited experience and historical development patterns. The depth of assistance, frequency of use, and effectiveness of government loan modification programs all changed significantly in recent years, so the data may not have enough experience to develop an econometric model that accurately forecasts the benefit of loan modifications. The development of these factors is discussed in more detail in Appendix B of this report.

### *Estimating Loss Severity*

For loans resulting in a claim, FHA incurs a net loss equal to the difference between the amount owed to a servicer or investor and the amount recovered from disposing a property that collateralized a defaulted mortgage. This loss amount divided by the original mortgage amount is known as the *loss severity rate*.<sup>9</sup> This section describes the design of the Loss Severity Model used in the Forward Model.

The Loss Severity Model is used to forecast the loss severity rate, given a claim for loans in the MMI Fund. This model uses three estimations to assign a loss severity rate to an insured mortgage:

1. The probability of conveyance versus pre-foreclosure sale;
2. The severity rate of conveyance;
3. The severity rate of pre-foreclosure sale.

Formulaically, the severity rate forecast is equal to<sup>10</sup>:

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<sup>9</sup> Loss severity rates may be expressed as either a percent of original mortgage amount or unpaid principal balance. Summit & Milliman selected original mortgage amount for two reasons: first, severity rates are generally more stable using original mortgage amount compared to using unpaid principal balance; second, the data available to Summit & Milliman does not contain the current unpaid principal balance for outstanding mortgages. Using unpaid principal balance requires forecasting the unpaid principal balance for delinquent loans, introducing additional uncertainty into the model.

<sup>10</sup> The sum of the probability of conveyance and the probability of pre-foreclosure sale is equal to 100%.

Severity Rate = Probability of Conveyance \* Severity Rate of Conveyance + Probability of Pre-Foreclosure Sale \* Severity Rate of Pre-Foreclosure Sale

The results of this model, along with the outputs from the Stage 1 and Stage 2 components of the Forward Model, are used to calculate the expected claim and the recovery components required to forecast the economic value of the MMI Fund.

### Predicting Loss Severity Rates

There are multiple possible claim types for FHA-insured loans. The most common claim type is conveyance, or REO, where FHA takes possession of the deed upon foreclosure and disposes of the property. In recent years, FHA has initiated several programs to encourage servicers to attempt pre-REO claim types, namely pre-foreclosure sales, which are historically associated with lower severity rates. In a pre-foreclosure sale (PFS), the defaulting borrower sells the mortgaged property for less than the outstanding balance of the mortgage, satisfying some of the loan and avoiding foreclosure. FHA makes a claim payment to the servicer equal to the shortfall in the outstanding loan balance after proceeds from the sale of the property are applied against the mortgage. In a pre-foreclosure sale, FHA does not have to pay for property maintenance between foreclosure and disposition, legal expenses, and other expenses associated with an REO.

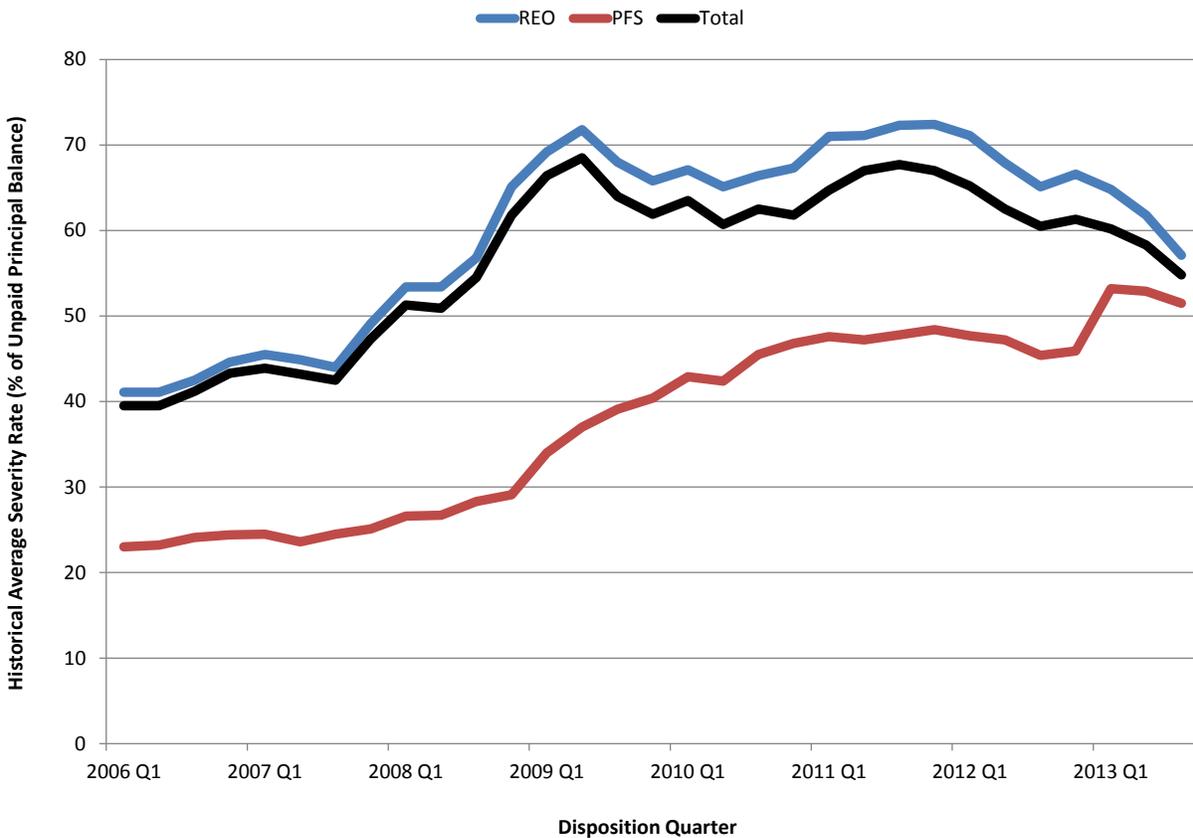
All else equal, FHA incurs more costs during an REO claim type compared to PFS claim type. In an REO claim type, FHA makes an initial (claim) payment to acquire the property. FHA is responsible for disposing of the property and incurs additional costs during this process. FHA receives a recovery payment once the property is disposed. In a PFS claim type, the servicer and borrower sell the property and incur any costs related to this transaction. FHA makes a claim payment equal to the shortfall between the sales price of the property and the outstanding balance on the mortgage plus additional expenses, such as accrued interest.

The figure below charts historical severity rates as a percent of unpaid principal balance for REO claim types (blue line), PFS claim types (red line), and total severity (black line) from fiscal quarters 2006 Q1 through 2013 Q3.<sup>11</sup> Total severity represents the weighted average severity rate for dispositions including both REO and PFS claim types. Average severity rates increased from FY 2006 through FY 2009 as home prices declined nationally and resulted in lower recoveries for disposed properties. From FY 2009 through FY 2011, severity rates averaged approximately 65% before declining to under 60% for FY 2013. The average severity rate declined as a result of a larger share of PFS dispositions. A trend noted in the data is the average severity rate on PFS has been increasing from approximately 25% in FY 2006 to over 50% in FY 2013. Factors driving this trend include declines in home prices for properties sold under the PFS program; these figures include alternative pre-REO disposition programs.

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<sup>11</sup> PFS includes other disposition types such as bulk sales and claims without conveyance of title. These disposition types were used in FY 2012 and FY 2013.

Figure 8: Historical Average Severity Rate by Claim Type and Disposition Quarter (% of UPB)

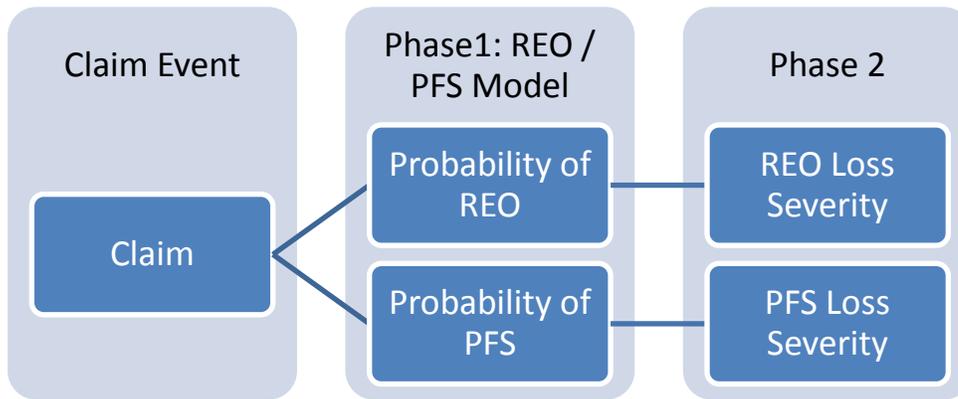


Source: FHA 2013 Q3 Quarterly Report to Congress

Phase 1 of the Loss Severity Model forecasts the probability of REO versus PFS using a binary logistic model for each future loan-quarter observation in the transactional database (assuming the loan has already gone to claim). The Phase 2 model predicts the REO and PFS loss severities for each loan-quarter observation using Ordinary Least Squares (OLS) regression. The Phase 2 model calculates the loss rate using two loss rate equations, one for REO, and the other for PFS. The calculated probability of each type of claim is multiplied by the corresponding predicted loss severity rates and added together to create a predicted loss rate for each loan given claim. The two-stage claim severity estimation methodology is illustrated in the following figure:



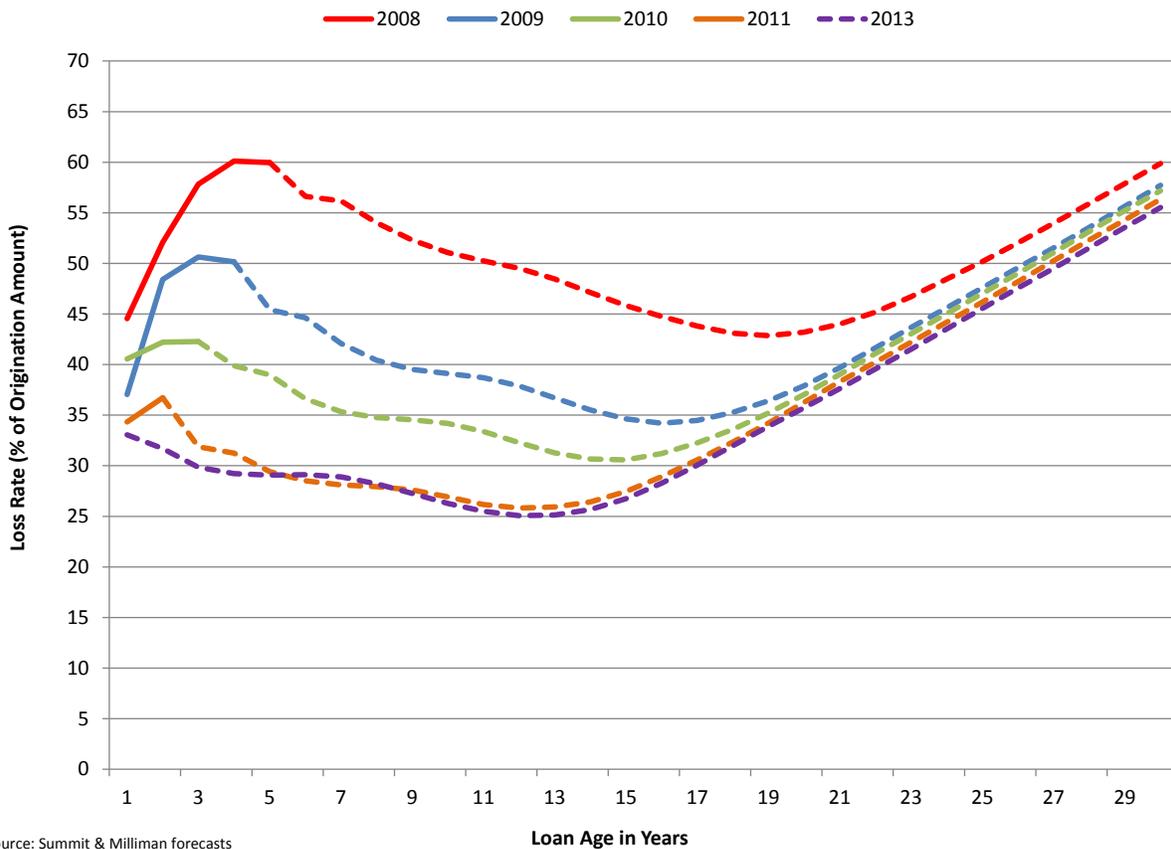
Figure 9: Claim Severity Process



The figure below depicts historical and forecast total loss severity rates (i.e. the expected severity rate with consideration of both REO and PFS) for endorsement years 2008 through 2013. Summit & Milliman’s forecast anticipates severity rates to decline in subsequent calendar quarters largely as a result of improvement in the housing market. Home prices are forecast to appreciate from 2013 through the evaluation period, and Summit & Milliman expects similar improvement in loss severity rates on claims.

For older forecast periods the loss severity rate is estimated to rise. This trend is consistent with historical data where loans that result in a claim 20 years or more after origination generally do not appreciate with the market and often result in a relatively large severity rate as a percent of the original mortgage amount.

Figure 10: Loss Severity Rate Forecasts by Endorsement Year (% of Original Mortgage Amount)



### Loss Severity Reduction Programs

Starting in 2009, FHA began to increase the use of alternative property disposition programs. In past years, pre-foreclosure sales were the majority of FHA’s pre-REO alternatives. In the past two years, FHA has introduced two additional programs aimed at reducing claim expenses and/or decreasing the time from claim to disposition:

- Distressed Asset Stabilization Program (DASP), wherein pools of non-performing loans are sold to purchasers prior to foreclosure, and;
- Claim Without Conveyance of Title (CWCOT) or TPS, whereby foreclosed properties are sold to third party purchasers prior to the properties being conveyed to FHA.

Summit & Milliman did not explicitly model these programs due to a lack of data availability and limited success for recent transactions.<sup>12</sup> However, DASP is implicitly accounted for in the actuarial model. This claim type is treated as a conveyance claim in the Loss Severity Model and thus is included in the model development data. TPS claims are excluded from the Loss Severity Model, however various scenarios have been included in Section III of this report to estimate the potential impact of TPS dispositions.

<sup>12</sup> See Section III for discussion on CWCOT TPS versus REO analysis.

### Cash Flow Modeling

The economic value of the forward mortgage portfolio is calculated as the NPV of all future cash flows for all surviving forward loans in the portfolio, plus the capital resources of the fund as of September 30, 2013. This calculation requires a forecast of nominal expected future cash flows and appropriate discount rates. The model calculates a quarterly forecast of each cash flow component outlined in the following table.

**Table 19: Preliminary Cash Flow Components**

Output Variable	Flow <sup>a</sup>	Definition
<b>Upfront Premiums</b>	+	The expected sum of upfront premiums for the given period
<b>Annual Premiums</b>	+	The expected sum of annual premiums for the given period
<b>Claim-PFS</b>	-	The expected claim from a pre-foreclosure sale for a given period
<b>Net Claim-REO</b>	-	The expected net loss from REO claim for a given period
<b>Loss Mitigation Payments</b>	-	Any expected outflows associated with loss mitigation payments
<b>Premium Refunds</b>	-	The expected sum of premium refunds for the given period

<sup>a</sup>Plus signs indicate an inflow to FHA, and minus signs indicates an outflow from FHA, or a missing inflow

The economic value of the fund is calculated by discounting the cash flow components described above to an NPV, which is added to the current capital resources of the fund. To calculate the NPV, each cash flow component is discounted at the cohort level using a set of PV factors. These PV factors are derived from the same weighted average discount rates, known as Single Effective Rates (SERs), used to budget FHA’s borrowing costs with respect to the U.S. Department of the Treasury. These rates are only available since 1992, and Summit & Milliman used an OLS regression model to forecast historical SERs.

### Forward Volume Demand

Summit & Milliman developed a Volume Demand Model to forecast market mortgage originations and FHA insurance activity for the next seven years. Using industry, economic, and FHA data, the model is used to forecast dollar volumes of future FHA market share as a proportion of future market mortgage originations for purchase and refinance loans. These future dollar volumes of FHA endorsements are used in the economic valuation of the MMI Fund.

## Section VI: Qualifications and Disclosures

Summit & Milliman members contributing to this analysis are Members of the American Academy of Actuaries, Fellows of the Casualty Actuarial Society, and/or have significant expertise in the evaluation of mortgage insurance and reinsurance.

In performing this analysis, Summit & Milliman has relied on data evaluated as of June 30, 2013 and other information concerning the data evaluated as of June 30, 2013, provided to Summit & Milliman by or on behalf of FHA through the date of this report. Summit & Milliman has not audited or verified these data and information. If the underlying data or information were inaccurate or incomplete, the results of Summit & Milliman's analysis may likewise be inaccurate or incomplete. Except where noted specifically within this report, Summit & Milliman is not aware of any relevant events or changes to the data subsequent to Summit & Milliman's analysis that would materially impact the result of the analysis.

In performing this evaluation, Summit & Milliman has assumed that FHA (a) used its best efforts to supply accurate and complete data and (b) did not knowingly provide any inaccurate data. Summit & Milliman performed a limited review of the data used directly in the analysis for reasonableness and consistency and have not found material defects in the data. If there are material defects in the data, it is possible that they would be uncovered by a detailed, systematic review and comparison of the data to search for data values that are questionable or relationships that are materially inconsistent. Such a review was beyond the scope of Summit & Milliman's assignment.

The analysis and any conclusions provided in Summit & Milliman's deliverables are based on data provided to Summit & Milliman by third-party sources. Summit & Milliman does not warrant the accuracy or completeness of any third-party data, and Summit & Milliman disclaims any and all liability in connection with such third-party data. Any errors in the data provided may affect the results of Summit & Milliman's analysis. Summit & Milliman is not liable for the results of its analysis to the extent errors are contained in third-party data sources.

Any analysis of unpaid claims or study of future operating results involves forecasts of future contingencies. While Summit & Milliman's analysis represents the best professional judgment, arrived at after careful analysis of the available information, it is important to note that a significant degree of variation from Summit & Milliman's projections is not only possible but is, in fact, probable. Summit & Milliman has attempted to reflect this variability by providing a range of forecast outcomes under various scenarios. However, there is no assurance that the actual ultimate outcomes will fall within the range provided. The sources of this variation are numerous: future national or regional economic conditions, mortgage prepayment speeds, and legislative changes affecting FHA's business are examples.

The uncertainty associated with Summit & Milliman's forecasts is also magnified by the nature of mortgage insurance. Mortgage insurance results are sensitive to economic factors such as housing market conditions, interest rate levels, and so on. Past experience may not be indicative of future conditions. A loan underwritten in a given year is generally insured over

several calendar years. Therefore, adverse economic conditions in a given calendar year could affect results not only for the current underwriting year but also for prior underwriting years.

Future economic developments that give rise to additional delinquencies and losses will impact ultimate losses, and unprecedented changes and stresses in the market add to uncertainty. Forecasts become significantly more uncertain given economic deterioration, elevated default rates, adverse home price trends, and loss mitigation programs administered by mortgage servicers. Some of these variables have been at unprecedented levels and historical trends may not be indicative of future outcomes. The overall results are potentially sensitive to any of these variables and reasonable deviations from the embedded assumptions could materially change the results.

Any reader of this report must possess a certain level of expertise in areas relevant to this analysis to appreciate the significance of the assumptions and the impact of these assumptions on the illustrated results. The reader should be advised by, among other experts, actuaries or other professionals competent in the area of actuarial projections of the type in this report, so as to properly interpret the projection results.

## Disclosures

Actuarial Standards require Summit & Milliman to disclose the following:

### Purpose

The purpose of this analysis is to independently forecast FHA's future losses and premium associated with FHA's existing business under a run-off scenario, as well as under a scenario assuming the addition of seven new fiscal years of endorsements.

Except where noted specifically to the contrary, data used in Summit & Milliman's analyses were evaluated as of June 30, 2013. The Moody's Analytics scenarios were supplied to Summit & Milliman as of July 30, 2013 and reflect actual Federal Housing Finance Agency (FHFA) data as of March 31, 2013.

### Constraints

Summit & Milliman's ability to complete this review is constrained by the following:

- abbreviated contract duration to perform this actuarial review;
- delayed availability of FY 2013 Q4 data due to federal government shutdown;
- limited availability of historically collected credit scores.

### Scope

Summit & Milliman's forecasts are discounted and undiscounted with respect to the time value of money. For the discount rate, Summit & Milliman used SERs, which define FHA's borrowing costs from the U.S. Department of the Treasury.

FHA requested Summit & Milliman use SER when constructing this discounting assumption. As such, Summit & Milliman expresses no opinion on the appropriateness of the selected discount rates.

FHA does not enter into reinsurance agreements with third parties. Therefore, Summit & Milliman's forecasts are presented on both a gross basis (direct plus assumed) and a net basis (gross less ceded) with respect to reinsurance recoverables. Summit & Milliman has not made any provisions for uncollectible reinsurance as this assumption is not applicable to this review.

## Appendix A: Discussion of Anticipated Portfolio Trends

Mortgage insurance valuation results are sensitive to many factors, such as the non-performing inventory of mortgages, housing market conditions such as home prices and interest rate levels, expectations for prepayments, and more.

The performance of the forward mortgage portfolio is currently transitioning from a period of higher expected defaults, claims and loss severities to a period of anticipated declining losses and potentially higher net premium revenue. Stabilizing and improving house prices should slow the rate of new defaults and lower loss severities on those borrowers who ultimately claim as a result of the foreclosure or third party sale process.

In addition, a period of historically unprecedented improvement in borrower credit underwriting, down payments and higher premium rates should also serve to lower the risk of credit losses from more recent endorsement years. Due to recent program and premium changes, Summit & Milliman expect premium revenues to continue to improve as the impact of substantially higher premium rates are realized for endorsements in the latter half of 2013 and going forward.

Overall portfolio persistency should improve due to a borrower's negative propensity to refinance or prepay their loan when faced with an expected rising interest rate environment along with historically low interest rates on their existing mortgage. However, this negative propensity may be marginalized as the FHA portfolio atypically now consists of borrowers that may find cheaper and still cancelable mortgage insurance options as an improving economy increases the equity in their homes and the mobility of their employment opportunities.

This appendix identifies current factors influencing the valuation of the MMI Fund and provides a discussion of the relationship between these factors and the forecasts.

### Non-Performing Inventory

The section discusses the influential variables associated with expectations on future claims within the non-performing inventory. The discussion includes the impacts of borrower equity and house price appreciation.

For FHA to pay on a claim of an insured mortgage, generally the insured mortgage must have previously transitioned through various stages of delinquency. To forecast or gauge the expected number of claims over the next few years, it is important to review the inventory of delinquent mortgages. As of June 30, 2013, there were over 1 million FHA-insured mortgages that were 90 days delinquent or worse.

One significant factor that influences the probability of a mortgage transitioning from delinquency to claim is the equity position of the delinquent borrowers. Delinquent borrowers in a negative equity position have a higher probability of claim, based on historical data, compared to borrowers in a positive equity position. The next table provides a distribution of the delinquency inventory by endorsement year and home price appreciation (HPA) cohort. Of the 1 million delinquent mortgages, nearly 75% of the delinquent risk by outstanding loan balance have experienced home price depreciation since origination and are potentially in a



negative equity position. Of these delinquent borrowers, over 30% of the properties have depreciated by 10% or more since origination.

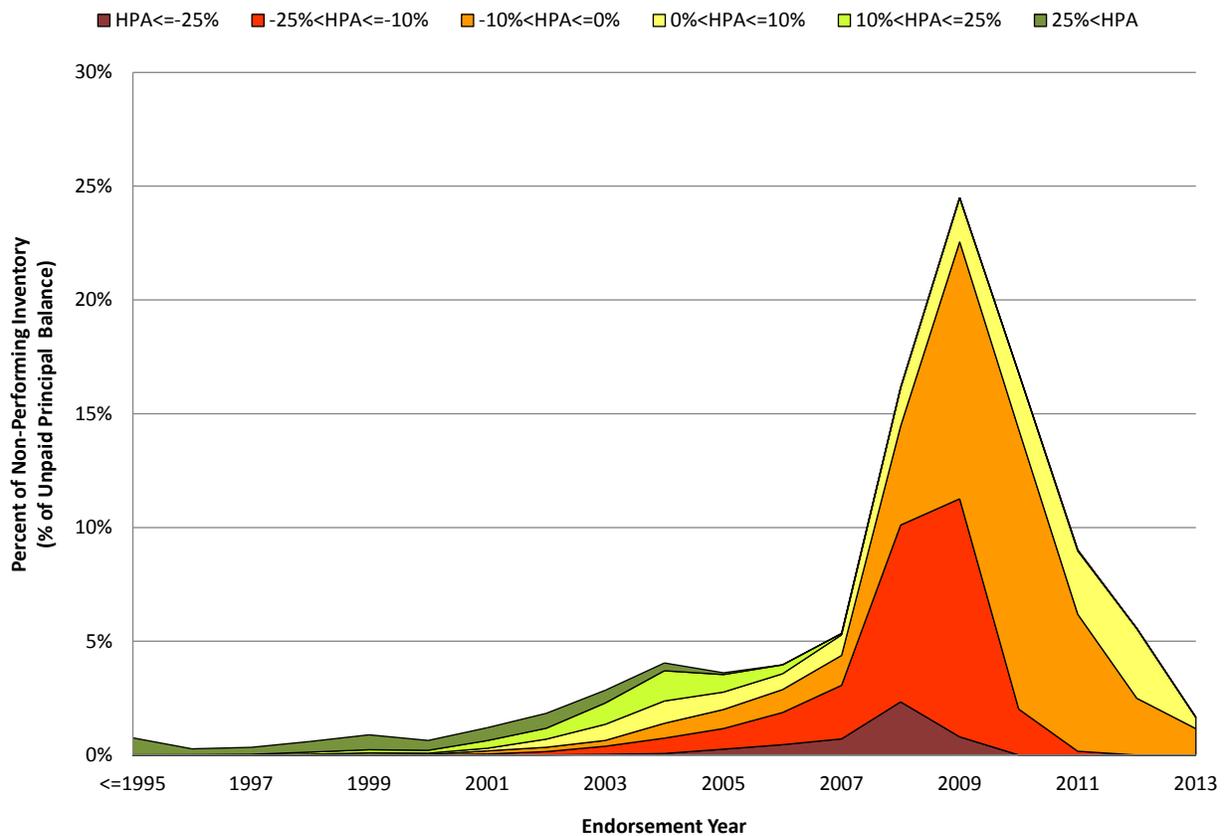
**Table 20: Distribution of Delinquent Loans by Endorsement Year and HPA Cohort (% of UPB)**

Credit Subsidy Cohort	Home Price Appreciation Since Origination						Total
	HPA<=-25%	-25%<HPA<=-10%	-10%<HPA<=0%	0%<HPA<=10%	10%<HPA<=25%	25%<HPA	
<=1995	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.8%
1996	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%
1997	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%
1998	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%	0.6%
1999	0.0%	0.0%	0.0%	0.1%	0.1%	0.7%	0.9%
2000	0.0%	0.0%	0.0%	0.1%	0.1%	0.4%	0.6%
2001	0.0%	0.0%	0.1%	0.1%	0.3%	0.6%	1.2%
2002	0.0%	0.1%	0.2%	0.4%	0.5%	0.7%	1.8%
2003	0.0%	0.4%	0.3%	0.7%	0.9%	0.6%	2.8%
2004	0.1%	0.7%	0.7%	1.0%	1.3%	0.3%	4.0%
2005	0.3%	0.9%	0.8%	0.8%	0.8%	0.1%	3.6%
2006	0.5%	1.4%	1.0%	0.7%	0.4%	0.0%	4.0%
2007	0.7%	2.4%	1.3%	0.9%	0.1%	0.0%	5.3%
2008	2.3%	7.8%	4.3%	1.7%	0.0%	0.0%	16.1%
2009	0.8%	10.5%	11.3%	1.9%	0.0%	0.0%	24.5%
2010	0.0%	2.0%	12.3%	2.5%	0.0%	0.0%	16.8%
2011	0.0%	0.2%	6.0%	2.8%	0.0%	0.0%	9.0%
2012	0.0%	0.0%	2.5%	3.1%	0.0%	0.0%	5.6%
2013	0.0%	0.0%	1.2%	0.5%	0.0%	0.0%	1.7%
Total	4.7%	26.3%	42.1%	17.1%	4.8%	5.1%	100.0%

Source: FHA internal database and Moody's Analytics

The table above also highlights that the majority of the non-performing inventory is concentrated in origination years 2008 through 2010. Average home prices in the United States generally declined from 2007 through 2012, so the majority of these borrowers purchased their homes as prices were declining (and continued to decline subsequent to their purchase). The chart below provides a visual of the non-performing inventory by endorsement year and HPA cohort.

**Figure 11: Visualization of Non-Performing Inventory by Endorsement Year and HPA Cohort**



Source: FHA internal database and Moody's Analytics  
 \*2013 endorsement year data through June 30, 2013

This graph segments the non-performing population by HPA cohort and highlights that non-performing inventory is concentrated in endorsement years 2008 through 2010. The red areas of the graph correspond to the worst HPA environments (at least less than 10%), the orange area corresponds to an HPA environment of between -10% and 0%, and the yellow and green areas correspond to positive HPA. The non-performing inventory is concentrated mostly in HPA environments of 0 to negative HPA. Historically, non-performing mortgages in this type of HPA environment have a higher probability of claim relative to mortgages in a positive HPA environment.

The table below (repeated from the main body of this document) shows Summit & Milliman's forecast of the number of non-performing mortgages and the number of claims for the non-performing inventory.

**Table 21: Claim Rate Forecast by Delinquency Status as of June 30, 2013**

Delinquency Status	Number of Mortgages as of June 30, 2013	Ultimate Number of Claims	Ultimate Claim Rate
Foreclosures and Probable Claims	234,322	234,322	100%
Persistent Delinquencies	139,001	117,980	85%
Ever-90 Days Delinquent	745,588	231,093	31%
First-Time 90 Days Delinquent	247,151	95,410	39%
60 Days Delinquent	34,316	10,375	30%
<b>Total from Delinquency Inventory</b>	<b>1,400,378</b>	<b>689,180</b>	<b>49%</b>

Source: FHA internal database and Summit & Milliman forecasts

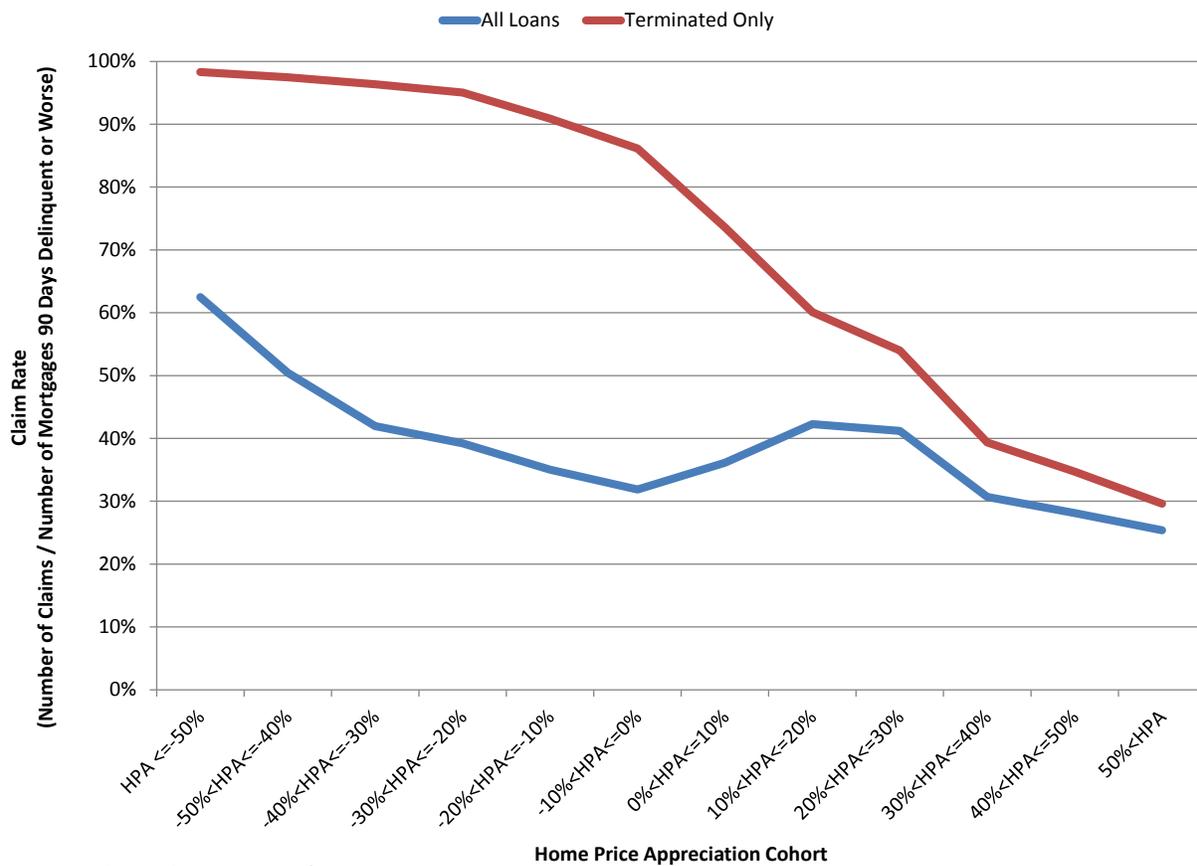
Summit & Milliman forecasts approximately 49% of the non-performing inventory will terminate in a claim. This share equates to 689,180 claims and is consistent with historical observations.

The following figure shows historical ultimate claim rates for all non-performing FHA-insured mortgages from endorsement years 1975 through 2013 with experience through June 30, 2013. Ultimate claim rates are calculated as the total number of claims as of June 30, 2013 divided by the total number of mortgages that were ever non-performing for each cohort. In this chart, home price appreciation is measured from origination through five years for each mortgage.

The figure shows the ultimate claim rate for two populations of mortgages. The blue line includes all mortgages in the denominator, and the red line includes only mortgages that terminated (either through claim or non-claim termination as of June 30, 2013) in the denominator.

Regarding the blue line, historical data indicate an ultimate claim rate of approximately 35% for HPA cohorts similar to the non-performing inventory. For the red line, historical data indicate an ultimate claim rate closer to 90% for similar HPA cohorts. The blue line is likely skewed lower because it includes a large inventory of unresolved non-performing loans and will likely trend up, and the red line is likely skewed higher because it includes only loans that have terminated and excludes cures from the denominator. The actual claim rate for this population will likely be in between the blue and red lines on this chart, which is consistent with Summit & Milliman's forecast of 49%.

Figure 12: Historical Claim Rates on Non-Performing Mortgages by HPA Cohort



Source: FHA internal database and Moody's Analytics

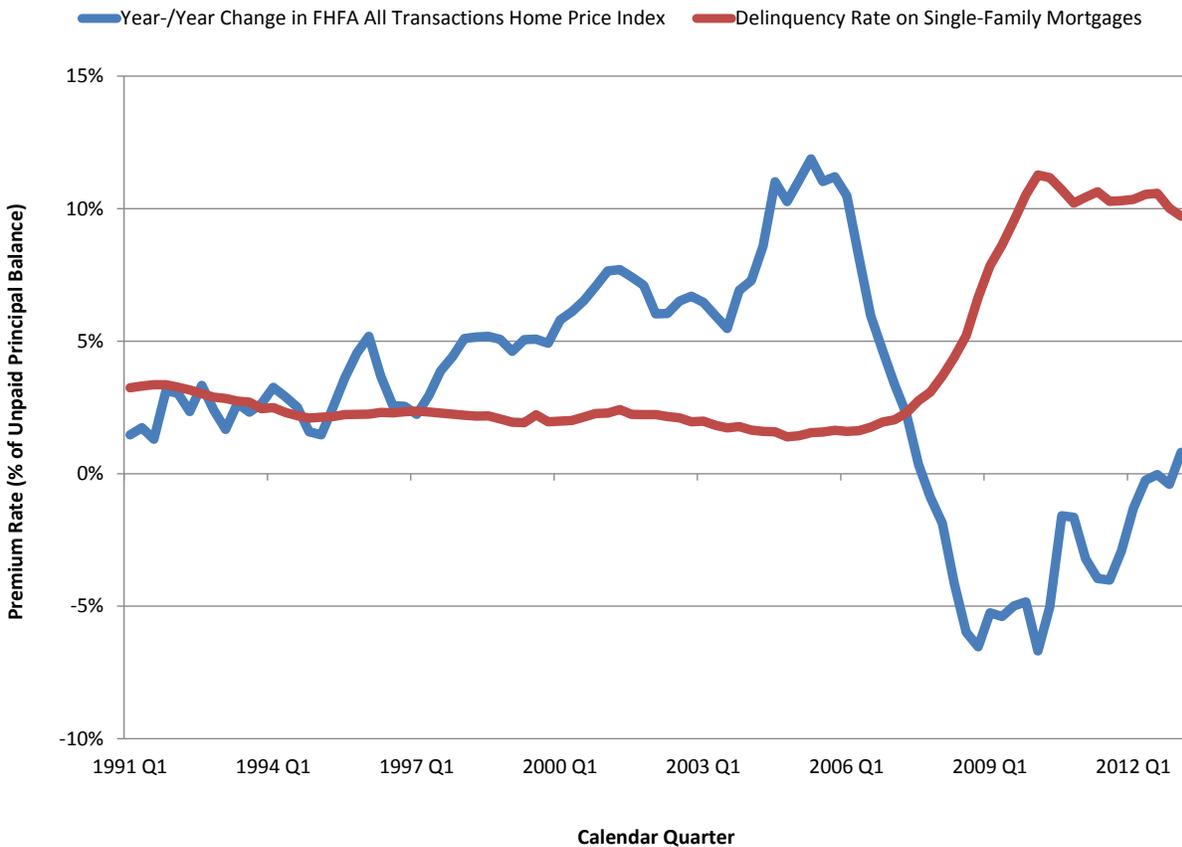
### Claim Rates Relationship to Home Prices

Mortgage default rates are sensitive to economic factors, particularly housing market conditions. FHA insures the performance of mortgages over the lifetime of the loan; therefore, adverse economic conditions in a given year can affect results for that underwriting year, as well as loans underwritten in previous years.

The relationship between home prices and single-family mortgage delinquency rates is shown in the next figure. The blue line on the chart represents the year-over-year change in the FHFA All Transactions House Price Index, and the red line represents the 30 day or more delinquency rate for single-family home mortgages, as reported by the Board of Governors of the Federal Reserve System.<sup>13</sup>

<sup>13</sup> Summit & Milliman also received a purchase-only house price index, but the figures use the all transactions house price index because it is more representative of the population of “all mortgages.”

Figure 13: House Price Index Value and Delinquency Rates by Calendar Quarter



Source: Federal Reserve Board and Moody's Analytics

This chart demonstrates that following a long period of consistent, positive appreciation beginning in the latter half of 2007, annual changes in home prices were negative. This decrease in home prices was correlated with a large spike in delinquencies in the mortgage market. As home prices continued to decline through 2012, the 30 day or more delinquency rate increased from an average of approximately 2.5% to more than 10%.

The volume of endorsements increased significantly starting in 2008 and continuing through 2013. Endorsement years 2008 through 2012 correspond to periods of declining home prices and therefore increased risk to the MMI Fund.

Counteracting the effect of home price declines is a trend over the most recent endorsement years of improved underwriting quality of FHA's business in terms of higher credit score borrowers, larger down payments, higher premium rates, and other offsetting factors. Additionally, home price declines are expected to have bottomed out sometime during 2013, and the economic forecasts relied upon in this Review forecast home price appreciation for the remainder of the forecast period.

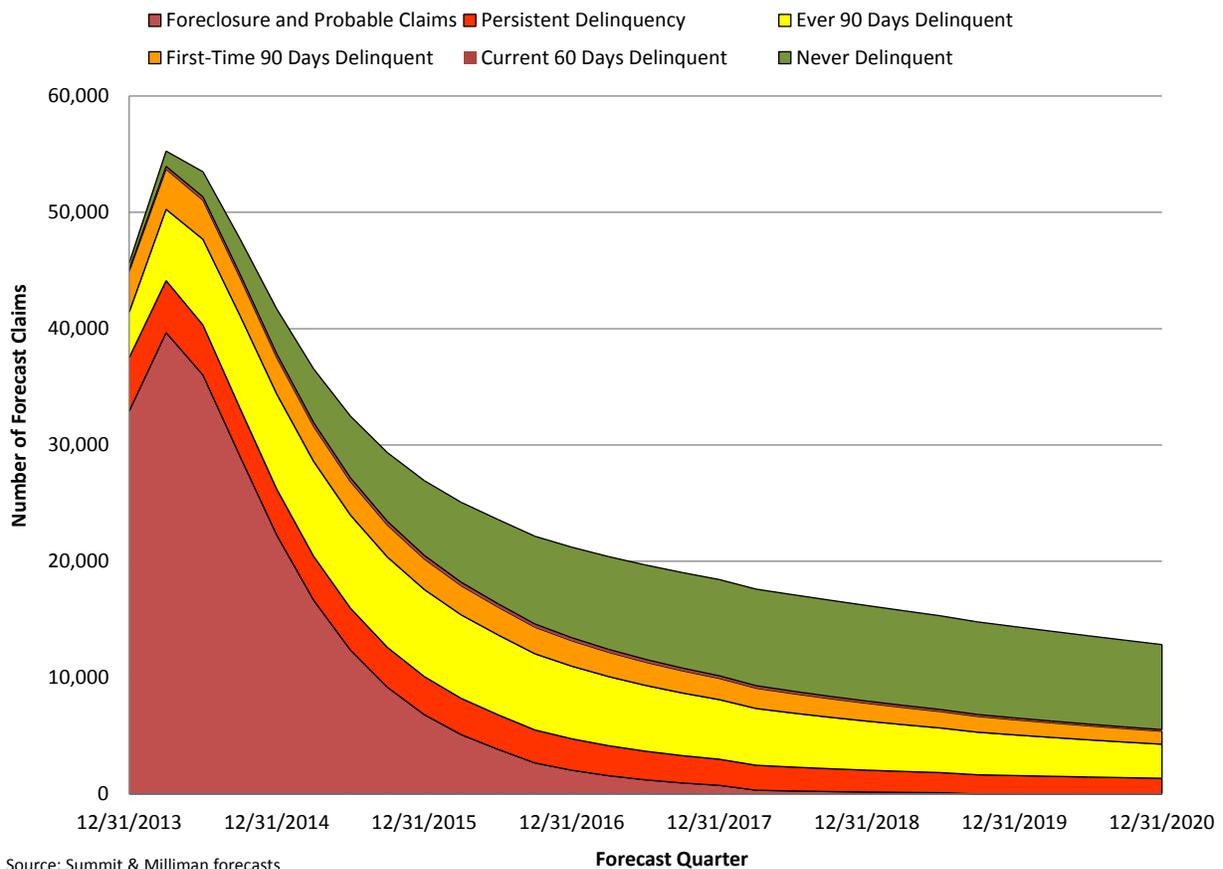
Summit & Milliman forecast ultimate claim rates will peak for endorsement year 2007 around 32.5% as these mortgages were endorsed at the height of the mortgage boom and then claim rates will return to more average claim rates for subsequent endorsement years. However, FHA's volume for 2007 was relatively small compared to endorsement years 2008 through

2013, so the dollar impact of the high claim rates for this endorsement year is muted. Mortgages endorsed in FY 2008 through FY 2011 are forecast to have lower claim rates compared to FY 2007; however, the dollar impact of these endorsement years on the economic value of the MMI Fund is forecast to be greater due to the magnitude of endorsements.

### Claim Terminations

The figure below provides a visual of expected future claim payments by delinquency status for all endorsement years up to and including 2013.<sup>14</sup>

**Figure 14: Claim Count Forecast by Delinquency Status**



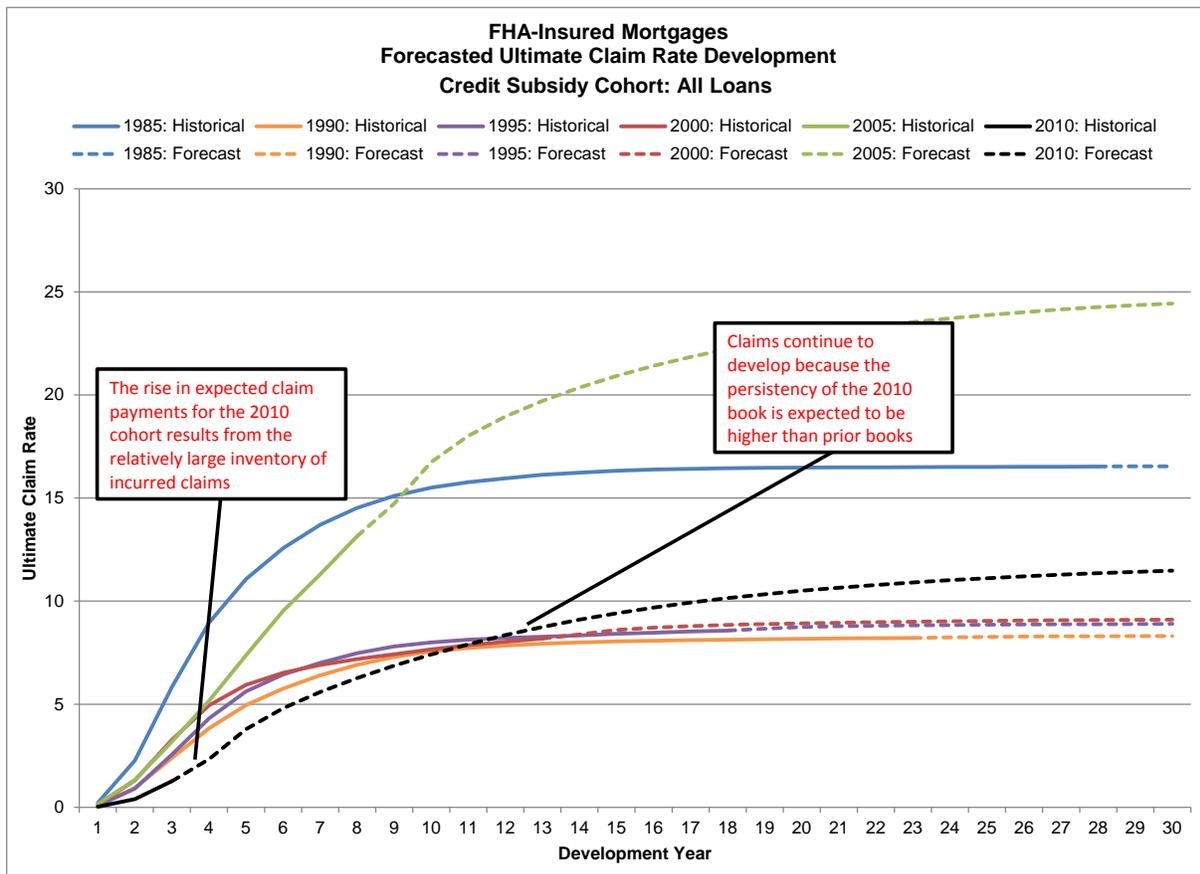
Source: Summit & Milliman forecasts

This chart implies a larger number of claim payments from delinquencies over the next few calendar years as the inventory of non-performing mortgages resolves. As a result of paying out the non-performing inventory, a jump in conditional claims rates is forecast over the next two years before returning to more historical trends.

<sup>14</sup> The “Summary of Methodology” section of this report expands on the definition of each delinquency status shown in this chart.

A second factor that influences Summit & Milliman’s claim rate forecasts is the expected persistency of the more recent endorsement years. Higher levels of expected persistency mean the insured portfolio is at risk for a longer duration to experience a life event such as divorce, job-loss, or other types of events that may result in borrower default. The figure below provides a visual of historical and forecast ultimate claim rates for six endorsement years: 1985, 1990, 1995, 2000, 2005, and 2010.

**Figure 15: Historical and Forecast Ultimate Claim Rate Development**



This chart shows the claim rate forecast for FY 2010 endorsements (black line) continues to increase after 10 years of development, while historical endorsement years tend to flatten out claim rate development after 10 years. The driver of this expectation is that FY 2010 endorsements are expected to have an *average* life of over 10 years compared to an *average* life of approximately six years for the historical endorsement years. More specifically, after 10 years of development, 2010 endorsements are forecast to have IIF equal to 45% of the original risk, compared to an average IIF of only 15% of the original risk for historical endorsement years.

The next section discusses factors that impact and influence FHA-insured mortgage non-claim termination speeds other than the primary variable of decreasing interest rates.



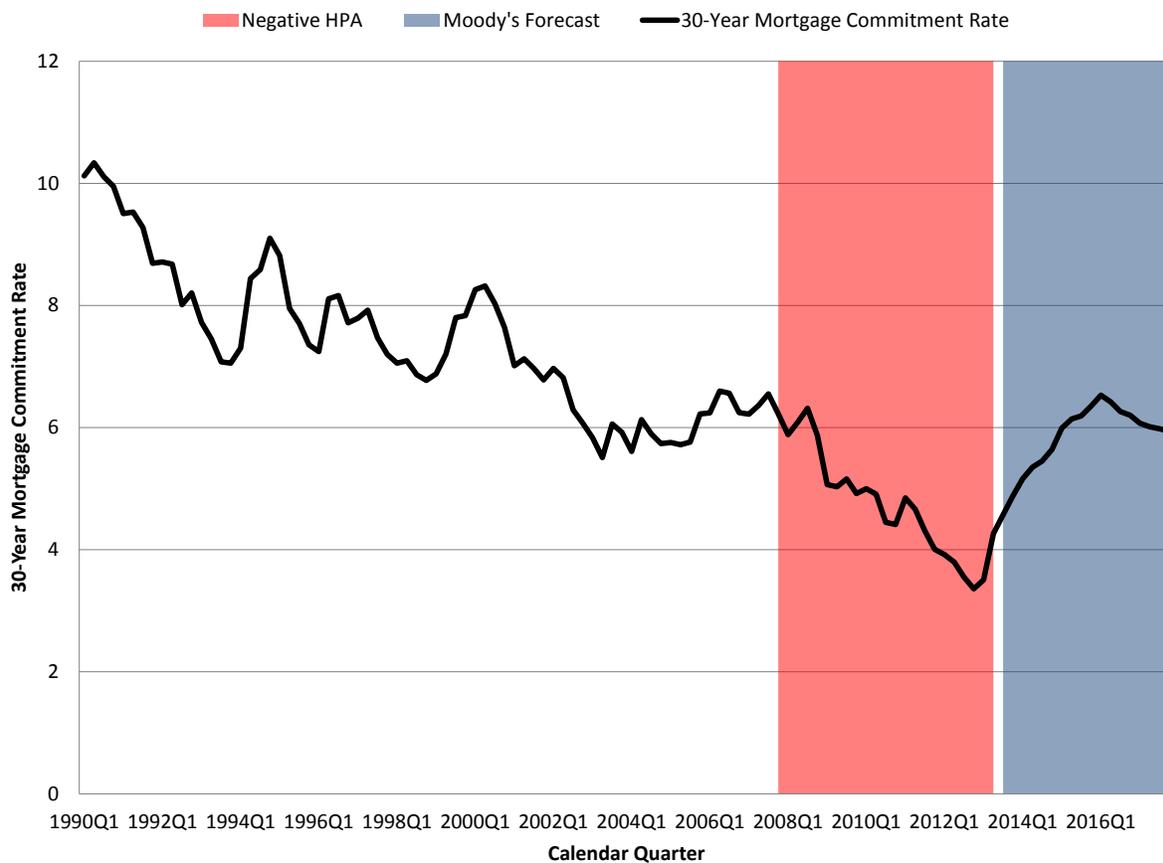
### Non-Claim Terminations

Mortgage non-claim terminations are influenced by a number of factors, including borrower life events (such as employment relocation, job loss, change in household status, retirement, and others), refinancing due to prevailing market interest rates compared to current note rates, equity position of the borrower, cheaper alternative mortgage insurance options, (including refinancing to eliminate mortgage insurance), and others.

Mortgage interest rates have generally been declining for over 30 years, from nearly 18% in 1980 to less than 4% in the second half of 2012 due to the Federal Reserve Board’s actions to stimulate the economy including recent open-market purchases of mortgage securities resulting in mortgage interest rates decreasing an additional 2% from approximately 6% to less than 4% from 2006 through 2013.

Figure 6 charts the historical and forecast values of average 30 year mortgage commitment rates for the United States from 1990 through 2017. The red area on the chart highlights periods of negative average home price appreciation for the United States, while the blue area highlights Moody’s Analytics forecast of the average 30 year mortgage commitment rate.

Figure 16: 30 year Commitment Rate by Year



Source: Moody's Analytics

If interest rates increase from 4% to 6% over the next two years, as per Moody's Analytics July 2013 forecast, FHA's portfolio will have a large number of mortgages with interest rates lower than the market rate and these mortgages should not have an incentive to refinance due to interest rates. Summit & Milliman identifies these mortgages as having a negative propensity to refinance.

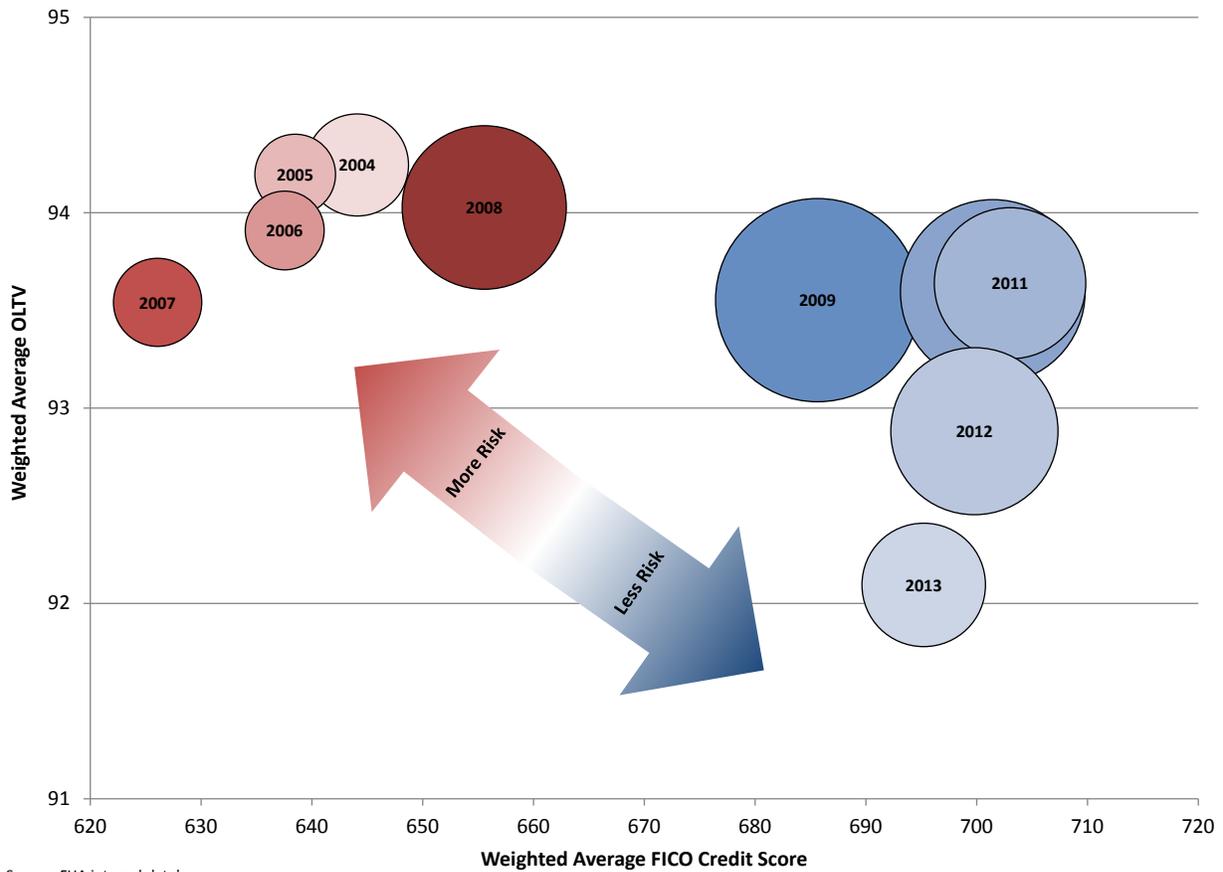
Note a period of generally declining interest rates has spanned across the past 30 years. Therefore, historical data evidencing prepayment patterns during a rising interest rate environment is limited. Historical data including both rising rates and improving credit characteristics is also not available. Assumptions and other market forces, as discussed below, were considered in developing the models to estimate the potential impact of increasing interest rates on non-claim termination rates.

Counteracting the negative propensity to refinance effect of rising interest rates are the relatively high credit quality (in terms of credit scores and down payments) of recent endorsements, forecasts of improving home price appreciation, and the relative payment difference in FHA-insured loans compared to non-FHA insured mortgages.

All else equal, it is generally believed that borrowers with higher credit scores and greater home equity will be more mobile in an improving employment economy and more likely to result in a non-claim termination.

The figure below provides a visual of the improvement in borrower credit quality. The figure shows the weighted-average credit score and LTV (weighted by original mortgage amount) for endorsement years 2004 through 2013; the sizes of the bubbles represent the volume of endorsements. Endorsement years 2004 through 2008 and shown in red; endorsement years 2009 through 2013 are shown in blue.

Figure 17: Weighted-Average FICO Credit Score and LTV by Endorsement Year



Source: FHA internal database

For 2004 through 2008 endorsements, the weighted-average FICO credit score was 640; for 2008 through 2013 endorsements, the weighted-average FICO credit score was 700. For 2004 through 2008 endorsements, the weighted-average LTV score was 94%; for 2008 through 2013 endorsements, the weighted-average FICO credit score was 93%. The weighted-average LTV for 2012 and 2013 endorsements was 92%.

The table below provides a snapshot of secondary market execution for FHA versus conventional loans.

**Table 18: Comparison of Mortgage Payment for an FHA-Insured Mortgage to a Privately-Insured Mortgage**

Underwriting Characteristics	FHA-Insured Mortgage	Conventional Mortgage			
		Lender Paid Mortgage Insurance	Borrower Paid Mortgage Insurance	Lender Paid Mortgage Insurance	Borrower Paid Mortgage Insurance
Loan Amount (\$)	150,000	150,000	150,000	150,000	150,000
Term (Months)	360	360	360	360	360
OLTV	95%	95%	95%	95%	95%
FICO Credit Score	700	700	700	660	660
Base Rate <sup>a</sup>	4.05	4.30	4.30	4.30	4.30
Annual Premium	1.30	0.70	0.89	0.90	1.15
Gross Rate	5.35	5.00	5.19	5.20	5.45
Payment (\$)	1,117	1,074	1,097	1,098	1,129
Difference	-	-43	-20	-19	12

Source: Summit & Milliman

<sup>a</sup>Base rate calculated using LLPA's, G-fee's, and market prices. Market prices obtained from [mortgagenewsdaily.com](http://mortgagenewsdaily.com); private mortgage insurance premiums were obtained from mortgage insurance rate cards as of October 2013.

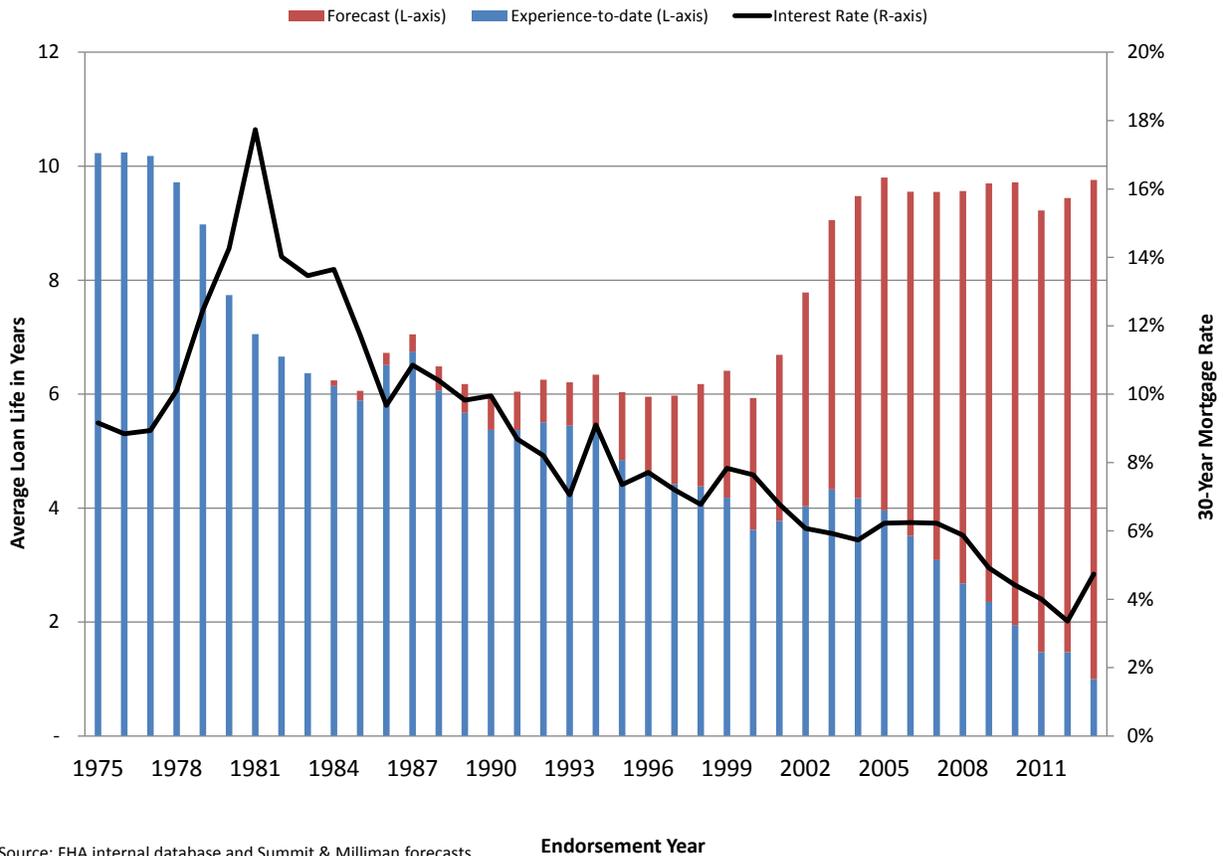
In this example, a loan with a 5% down payment, or 95% LTV, is evaluated based on current market securities pricing, mortgage insurance premium and in the case of conventional loans, by credit score. Relevant guaranty fees and loan level pricing adjustments have been estimated and applied to the conventional loan yield. In all scenarios except the lowest credit score, the conventional loan results in a lower monthly payment for borrowers.

In addition, mortgage insurance coverage for conventional loans may be cancelled when the loan amortizes to a 78% LTV ratio. Amortization to a 78% LTV would occur at approximately year seven based on current rates. FHA borrowers endorsed after June 3, 2013 will no longer be able to cancel payment of FHA premiums; therefore, borrowers who did not refinance out of their FHA loan would pay more in premium over the life of their loan compared to borrowers with private mortgage insurance.

The figure below provides a comparison of the average life for FHA-insured mortgages by endorsement year. Average forecasted life of recent endorsement years is approximately 10 years. This forecast is consistent with historical data on loans endorsed between FY 1975-1978 where mortgages also experienced an increasing mortgage rate environment.

Therefore, despite data limitations in modeling interest rate increases combined with borrower behavior in a technically-efficient loan processing environment, forecasts support a consistent 10 year mortgage life and corresponding premium stream for the most recent endorsement years.

Figure 19: Historical and Forecast Average Life by Endorsement Year



The longer duration of current endorsements compared to endorsements from 1980 through the late 2000's will result in two outcomes for the MMI Fund:

1. higher premium revenues, especially for 2013 endorsements and;
2. a marginal increase in the amount of claims due to the persisting credit risk of a mortgage insurance policy still in force.



## Appendix B: Technical Details of the Forward Model

This section of the document describes the model form and development of the Forward Model.

### Forward Model Diagram

Summit & Milliman reviewed industry models, academic research, and considered multiple model structures in developing the Forward Model.

The Forward Model uses a two-stage framework to forecast the performance of insured mortgages. Stage 1 uses a generalized linear model to forecast the probability of a mortgage transitioning from performing to either a non-claim termination or serious delinquency in each quarter.<sup>15</sup>

Once a mortgage becomes seriously delinquent, it is no longer considered a performing mortgage. Upon the first serious delinquency event, the mortgage transitions from Stage 1 to Stage 2 in the Forward Model.

Stage 2 of the Forward Model forecasts the ultimate performance of mortgages after they become seriously delinquent. Stage 2 of the model uses a hazard rate model to forecast the probability of a claim versus non-claim termination for each quarter, subsequent to delinquency. The hazard functions for claim and non-claim termination are forecast separately and combined in a competing risks framework.

It is possible for mortgages that enter the Stage 2 model to remain insured for the remaining life of the mortgage without a claim or early non-claim termination. In addition, after a mortgage enters Stage 2 of the model, it cannot revert to Stage 1.

As such, Stage 1 models performing mortgages, while Stage 2 models non-performing mortgages. Different factors affect mortgage performance in different ways during the periods before and after 90 day delinquency, so the two-stage model estimation allows Summit & Milliman to study the behavior of mortgages more precisely. In addition, the Stage 2 model allows Summit & Milliman to analyze and incorporate specific loss mitigation efforts for non-performing mortgages.

### Stage 1 Model Estimation Procedures

The Stage 1 model forecasts the probability of a mortgage transitioning from performing to non-claim termination or first-time 90 day delinquency for each quarter of a mortgage's life. The model forecasts these transition probabilities using borrower characteristics, underwriting characteristics, mortgage age, and economic conditions.

At this stage, non-claim terminations and first-time serious delinquency events are modeled for performing mortgages. The model forecasts the probabilities for non-claim termination and

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<sup>15</sup> A non-claim termination is a termination of insurance coverage in which FHA is no longer liable for the performance of the mortgage (e.g., early repayment of the mortgage note). A serious delinquency, in this context, refers to mortgages that are delinquent by 90 days or more.

serious delinquency using multinomial logistic cell regression. Cell regression is used to maximize the amount of data used to develop the model and minimize the required computing capacity. Equation 1 and Equation 2 are the model specifications for the mortgages that enter serious delinquency or non-claim termination paths, respectively<sup>16</sup>:

**Equation 1**

$$\log\left(\frac{P_D}{P_A}\right) = X_D\beta_D + \varepsilon_D$$

**Equation 2**

$$\log\left(\frac{P_P}{P_A}\right) = X_P\beta_P + \varepsilon_P$$

Where  $P_D$  is the probability of serious delinquency,  $P_P$  is the probability of non-claim termination,  $P_A$  is the probability of remaining as a performing mortgage, and  $\varepsilon_d$  and  $\varepsilon_p$  are i.i.d. error terms with logistic distribution.  $X_d$  and  $X_p$  are predictor vectors that include variables representing initial borrower and mortgage-level characteristics, mortgage age, and macroeconomic conditions.

After estimating model parameters  $\hat{\beta}_d$  and  $\hat{\beta}_p$ , based on the historical mortgage information, the future  $\hat{P}_d$  and  $\hat{P}_p$  for each of the successive mortgage ages (in quarters) are forecast, using the following formulas:

**Equation 3**

$$\hat{P}_D = \frac{e^{X_D\hat{\beta}_D}}{1 + e^{X_D\hat{\beta}_D} + e^{X_P\hat{\beta}_P}}$$

**Equation 4**

$$\hat{P}_P = \frac{e^{X_P\hat{\beta}_P}}{1 + e^{X_D\hat{\beta}_D} + e^{X_P\hat{\beta}_P}}$$

Each mortgage, in each cell, is associated with cell-specific probabilities of serious delinquency and non-claim termination. In this context, each cell is constructed using the values of explanatory variables in the regression—that is, a unique combination of regressor values defines each cell.

### Stage 2 Model Estimation Procedures

The Stage 2 model uses a mortgage-level Cox proportional hazard model to perform a survival analysis of new serious delinquencies. The Stage 2 component of the model has fewer data points compared to the Stage 1 (i.e. the model is developed using only loans that were ever 90 days delinquent), so a more granular model is able to be used for Stage 2. In all cases, new serious delinquencies ultimately terminate either in a claim or non-claim termination.

<sup>16</sup> Though presented as two independent binary logit equations, the estimation routine is based on a multinomial logistic model. Consequently, the specification for both equations is the same.

Each mortgage in the Stage 2 model starts as a new serious delinquency day, and the entire post-default mortgage life is modeled using two Cox regression equations. Specifications for these are given in Equation 5 (for claim) and Equation 6 (for non-claim termination), where time is measured from the date of the first delinquency through the evaluation period in quarters.

**Equation 5**

$$h_{ic}(t) = h_{0c}(t) \exp(\beta_c X_{ic}(t))$$

**Equation 6**

$$h_{ip}(t) = h_{0p}(t) \exp(\beta_p X_{ip}(t))$$

$h_{0c}(t)$  and  $h_{0p}(t)$  are the baseline hazard functions for claim and non-claim terminations, respectively, with  $t$  representing the time since the first-time delinquency. Specifically,  $h_{ic}(t)$  is the probability, per unit of time, that a mortgage will result in a claim, if it has not been terminated previously.  $h_{ip}(t)$  is the probability, per unit of time, that a mortgage will exit due to non-claim termination, if it has not been terminated previously.  $X_{ic}$  and  $X_{ip}$  are variable vectors that include variables representing mortgage-level characteristics, FHA-specific measures, and macroeconomic conditions. The variables for both regressions were selected based on the results of academic and industry research on the behavior of mortgages carried out by experts on Summit & Milliman.

Following similar steps as those in Stage 1, after estimating the Cox model parameters  $\hat{\beta}_c$  and  $\hat{\beta}_p$  and baseline hazard rates  $\hat{h}_{0c}(t)$  and  $\hat{h}_{0p}(t)$ , claim and non-claim termination hazard rates are forecast for each period, using Equation 7 (claim hazard rate), Equation 8 (non-claim termination hazard rate), and Equation 9 (corresponding total hazard rate).

**Equation 7**

$$\hat{h}_{ic}(t) = \hat{h}_{0c}(t) \exp(\hat{\beta}_c X_{ic}(t))$$

**Equation 8**

$$\hat{h}_{ip}(t) = \hat{h}_{0p}(t) \exp(\hat{\beta}_p X_{ip}(t))$$

**Equation 9**

$$\hat{h}_i(t) = \hat{h}_{ic}(t) + \hat{h}_{ip}(t)$$

Note that vectors  $X_{ic}$  and  $X_{ip}$  include values for the fixed and time-varying predictors already specified.

**Explanatory Variables**

Summit & Milliman analyzed a variety of explanatory variables that capture factors affecting each homeowner’s prepayment and default propensity. This section describes the explanatory variables used in delinquency, prepayment, and claim functions in both the Stage 1 and Stage 2 components of the Forward Model.

### Original Loan-to-Value Ratio

The LTV ratio captures the original mortgage equity position of a borrower. All else equal, higher original LTV ratios are associated with higher delinquency rates and higher claim rates.

In the Stage 1 model, LTV is used as cohort criteria in the first step. Then weighted average LTV ( $wa\_ltv$ ) is calculated for each cohort, using the following formula:

$$wa\ ltv_c = \left( \sum_{i=1}^n ltv_{c,i} * origamt_{c,i} \right) / \left( \sum_{i=1}^n origamt_{c,i} \right)$$

where

c= cohort

i= observation

In Stage 1, Summit & Milliman use splines, with knots at 60, 70, 85, 95, and 100, to estimate the non-linear impact of LTV on mortgage performance.

In the prepayment equation of the Stage 2 model, LTV splines are specified with knots at 60, 65, 80, 85, and 100.

In the claims equation of the Stage 2 model, LTV splines are created applying knots at 60, 65, 70, 75, 80, 85, 90, 95, and 100.

### Home Price Appreciation<sup>17</sup>

Summit & Milliman used cumulative (i.e. from origination) regional HPI return to estimate the effect of change in home prices on mortgage performance. Starting from the first quarter of amortization, each mortgage in each quarter of its existence is matched with the corresponding purchase-only HPI at the MSA-level. For those mortgages that do not have matching MSA-based HPI, the relevant state index in which the property is located is used. Cumulative changes in home prices are negatively correlated with delinquencies and claims and positively correlated with prepayments. In other words, the greater home price appreciation experienced by a cohort of mortgages, the lower the delinquency and claim rates and the higher the non-claim termination rate.

As in the case of LTV, HPA is used as one of the cohort criteria in the Stage 1 model, and a weighted average HPA is created for each cohort (i.e. cell) using the following formula:

$$wa\ hpa_c = \left( \sum_{i=1}^n hpa_{c,i} * origamt_{c,i} \right) / \left( \sum_{i=1}^n origamt_{c,i} \right)$$

where

c= cohort

<sup>17</sup> Summit & Milliman also explored using unemployment rates, and variations thereof, in their mortgage performance models. However, in the current environment, movements in home prices trumped the explanatory power of unemployment rates in the model, and the coefficients for unemployment rates were not significant and/or counterintuitive.

i= observation

To capture non-linear effects in relation to HPA, splines are created in the Stage 1 model with knots at -0.4, -0.3, -0.1, 0, .1, .2, and .4.

In the prepayment equation for the Stage 2 model, HPA splines are created with knots at -0.4, -0.3, .1, .2, .3, and .4.

In the claims equation for the Stage 2 model, hpa\_splines are created applying the following knots at -0.4, -0.2, -.1, 0, .1, .2, .3, and .4.

### **FICO Score / FICO Source**

Credit scores are powerful variables in estimating the probability of a credit event for mortgage borrowers. All else equal, higher credit scores are associated with smaller delinquency and claim rates.

The majority of FHA mortgages originated after 2004 are associated with original credit scores that were collected and reported to FHA at origination. Prior to 2004, FHA did not require credit scores to be reported, so credit score data were not collected. However, the data used for model estimation contain mortgages that were originated beginning in 1990. Rather than excluding mortgages without credit scores, thereby losing the majority of information associated with them, or excluding credit scores, which are considered a very potent predictor of mortgage behavior, Summit & Milliman incorporated credit score information for the mortgages originated prior to 2004 from one of three potential other sources:

1. Streamline refinance loan data;
2. FICO credit score data provided to Summit & Milliman from FHA on mortgages that were sampled by Fannie Mae in a priori analysis; and
3. Average FICO credit score data extracted from the CoreLogic servicing database.

A categorical variable, FICO\_Source, was added to the regression analysis to account for the varying quality of the FICO credit score information.

Imputing FICO credit score data from the CoreLogic data, Summit & Milliman calculated the average FICO credit score from the CoreLogic data, segmented by origination quarter and MSA. The data for these cohorts are reasonably consistent between the data sources.

As in the variables for LTV and HPA in the Stage 1 model, FICO credit score is first used as one of the criteria in creating cells, then the corresponding weighted average FICO credit score (wa\_fico) is calculated for each cell using the following formula:

$$wa\_credit\_score_c = \left( \sum_{i=1}^n CreditScore_{c,i} * origamt_{c,i} \right) / \left( \sum_{i=1}^n origamt_{c,i} \right)$$

To capture non-linear effects in relation to FICO credit score, splines are created in the Stage 1 model using knots at 600, 700, and 750.

### **First-Time Buyer**

This binary variable indicates whether or not a borrower purchased the home for the first time. The model results indicate that first-time buyers of FHA mortgages are associated with lower delinquency probabilities and higher non-claim termination rates. However, once first-time borrowers become seriously delinquent, they are associated with higher claim probabilities.

### **Mortgage Age**

This variable is calculated in calendar quarters, beginning from amortization date.

### **Buy Down Indicator**

This variable indicates whether or not the mortgage had an interest rate buy down to reduce the mortgage interest rate and/or take advantage of favorable pricing from a builder or lender. In the data, borrowers with a buy down are associated with higher rates of delinquencies, non-claim termination (for both Stage 1 and Stage 2), and higher claim probabilities. Therefore, the buy down indicator could be a sign of borrower financial weakness where borrowers use this option to obtain a more affordable mortgage. It could also signal borrowers who are conscious of available mortgage rates and are quick to refinance when rates decline.

### **Down Payment Assistance**

This is a binary variable that indicates whether or not the borrower received down payment assistance from third parties. Borrowers who receive down payment assistance are associated with higher levels of delinquency and claim, as well as lower levels of non-claim termination.

### **Seller Contribution Flag**

This variable indicates whether or not the borrower received any contribution from the seller at closing. Borrowers who receive a contribution from the seller have a higher probability of being delinquent and going into default and a lower probability of non-claim termination. The seller contribution flag is not significant in the Stage 2 model.

### **Amortization Term**

The amortization term is defined as 15 years, 16 to 29 years, or greater than 29 years. Mortgages with a term of 15 years usually have a lower delinquency and claim rate than those with longer term lengths.

### **Fixed Rate**

This is a binary variable indicating whether or not a mortgage has a fixed- or adjustable-rate mortgage. Mortgages with adjustable rates are associated with higher delinquency and claim rates compared to Fixed Rate Mortgages (FRMs). However, ARMs also have been historically associated with higher non-claim termination rates.

### **Loan Purpose**

This categorical variable classifies mortgages as “purchase,” “conventional refinance,” and “streamline refinance.” Mortgages categorized as “purchase” have lower delinquency and claim rates than those belonging to the other two categories.

## Refinance Incentive

This categorical variable classifies mortgages by percentage change in payment given refinance at current market interest rate. Lower market note rates, compared to the current note rate, result in lower monthly payments and provide an incentive for the borrower to refinance. Borrowers with a higher refinance incentive are associated with higher non-claim termination rates and lower probabilities of delinquency. This variable was not significant in the Stage 2 model.

### Grouping Mortgage Records for Use in Stage 1 Model Estimation

The Stage 1 regression is a multinomial logistic cell regression. Mortgages were aggregated into cells or cohorts based on frequency distribution of the following regressors for model estimation and forecasting:

1. Mortgage age (in quarters);
2. Down payment assistance;
3. Amortization term;
4. Amortization type;
5. Home price appreciation;
6. Origination loan-to-value ratio;
7. Seller contribution flag;
8. First-time buyer indicator;
9. Origination FICO credit score;
10. FICO credit score source;
11. Buy down indicator;
12. Mortgage purpose;
13. Refinance incentive class.

Each unique combination of values of the 13 variables defines a cohort or cell. Each cell includes the total number of active mortgages, as well as the total number of delinquencies and prepayments for each quarter. Weighted average values of the LTV ratio, HPA, and FICO credit scores are also maintained for each cohort.

### Results from Stage 1 Model Estimation

The estimation results of the Stage 1 model equations, specified above, are presented in the following regression tables. These tables present estimation results for the serious delinquency equation and prepayment (non-claim termination) equation. Many of the coefficients in the serious delinquency and prepayment equations are statistically significant at the 1% significance level and have signs that are consistent with expectations.

Regression Table 1: Stage 1 Model Coefficients

Variable Names	Class	Category/Spline Values	Coefficient Estimates By Outcome		
			Seriously Delinquent		Non Claim Termination
<b>CONSTANT</b>			-5.5563 ***		-8.6969 ***
<b>AGE_SPLINE</b>		0 - 3	1.3985 ***		1.1183 ***
		3<-7	0.1109 ***		0.0741 ***
		7<-25	-0.0132 ***		-0.0393 ***
		25<-60	-0.0038 ***		-0.0344 ***
		60<-High	-0.0146 ***		-0.0436 ***
<b>DOWN_PAY_ASSIST</b>	1	Yes	0.4184 ***		-0.0884 ***
	2	No	0		0
<b>AMORT_TERM</b>	1	15 Year	-0.7127 ***		-0.7158 ***
	2	16 - 29 Year	-0.1419 ***		-0.2789 ***
	3	30 Year	0		0
<b>FIXED_RATE</b>	1	No	0.1434 ***		0.2220 ***
	2	Yes	0		0
<b>HPA_SPLINE</b>		HPA <=-40%	-0.8291 ***		-1.0091 ***
		-40%<HPA<=-30%	-3.6449 ***		4.2046 ***
		-30%<HPA<=-10%	-1.6077 ***		0.3054 ***
		-10%<HPA<=0%	-5.1131 ***		-1.7835 ***
		0%<HPA<=20%	-0.8552 ***		4.3723 ***
		20%<HPA<=40%	-0.1149 ***		2.2875 ***
		40%<HPA	-0.1949 ***		0.7850 ***
<b>LTV_SPLINE</b>		0-60%	0.0105 ***		-0.0042 ***
		60<-70%	0.0154 ***		0.0021 ***
		70<-85%	0.0139 ***		0.0054 ***
		85<-95%	0.0201 ***		0.0053 ***
		95<-100%	0.0588 ***		0.0210 ***
		100<-High	0.0045 ***		-0.0242 ***

Standard indicators of statistical significance are marked as: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
 Source: Summit & Milliman

Regression Table 2: Stage 1 Model Coefficients (cont.)

Variable Names	Class	Category/Spline Values	Coefficient Estimates By Outcome			
			Seriously Delinquent		Non Claim Termination	
<b>SELLR_CONTRBTN</b>	1	Yes	0.0708	***	-0.0517	***
	2	No	0		0	
<b>FRST_TIME_BUYER</b>	1	Yes	-0.1553	***	0.1644	***
	2	No	0		0	
<b>FICO_SPLINE</b>		0-600	-0.0036	***	0.0029	***
		600<700	-0.0132	***	-0.0031	***
		700<-750	-0.0147	***	0.0067	***
		750<-High	-0.0065	***	-0.0003	*
<b>FICO_SOURCE</b>	1	CoreLogic	0.1195	***	0.0274	***
	2	FNMA	-0.0157	***	0.2950	***
	3	Streamline Refi	0.4501	***	-0.0920	***
	4	FHA	0		0	
<b>BUY_DOWN_IND</b>	1	Yes	0.2088	***	0.3211	***
	2	No	0		0	
<b>LOAN_PURP</b>	1	Refinance	0.4740	***	0.2122	***
	2	Streamline	0.0742	***	0.1635	***
	3	Purchase	0		0	
<b>REFI_INCNT_CLASS</b>	1	X<10%	0		0	
	2	10%<=X<20%	0.0569	***	0.4137	***
	3	20%<=X<30%	0.0198	***	0.5998	***
	4	30%<=X	-0.0850	***	0.6556	***

Standard indicators of statistical significance are marked as: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
Source: Summit & Milliman

Regression Table 3: Stage 1 Model Odds Ratios

Variable Names	Class	Category/Spline Values	Odds Ratios By Outcome	
			Seriously Delinquent	Non Claim Termination
<b>AGE_SPLINE</b>		0 - 3	4.0489	3.0598
		3<-7	1.1172	1.0769
		7<-25	0.9869	0.9615
		25<-60	0.9962	0.9662
		60<-High	0.9855	0.9573
<b>DOWN_PAY_ASSIST</b>	1	Yes vs. No	1.5196	0.9154
<b>AMORT_TERM</b>	1	15 Year vs. 30 Year	0.4903	0.4888
	2	16 - 29 Year vs. 30 Year	0.8677	0.7566
<b>FIXED_RATE</b>	1	No vs. Yes	1.1542	1.2485
<b>HPA_SPLINE</b>		HPA <=-40%	0.4365	0.3646
		-40%<HPA<=-30%	0.0261	66.9966
		-30%<HPA<=-10%	0.2003	1.3572
		-10%<HPA<=0%	0.0060	0.1680
		0%<HPA<=20%	0.4252	79.2268
		20%<HPA<=40%	0.8915	9.8498
		40%<HPA	0.8229	2.1924
<b>LTV_SPLINE</b>		0-60%	1.0106	0.9959
		60<-70%	1.0155	1.0021
		70<-85%	1.0139	1.0054
		85<-95%	1.0203	1.0054
		95<-100%	1.0606	1.0212
		100<-High	1.0045	0.9761

Source: Summit & Milliman

Regression Table 4: Stage 1 Model Odds Ratios (cont.)

Variable Names	Class	Category/Spline Values	Odds Ratios By Outcome	
			Seriously Delinquent	Non Claim Termination
<b>SELLR_CONTRBTN</b>	1	Yes vs. No	1.0733	0.9496
<b>FRST_TIME_BUYER</b>	1	Yes vs. No	0.8562	1.1786
<b>FICO_SPLINE</b>		0-600	0.9964	1.0029
		600<-700	0.9869	0.9969
		700<-750	0.9854	1.0068
		750<-High	0.9935	0.9997
<b>FICO_SOURCE</b>	1	Core vs. FHA	1.1269	1.0278
	2	FNMA vs. FHA	0.9844	1.3431
	3	Streamline Refi vs. FHA	1.5684	0.9121
<b>BUY_DOWN_IND</b>	1	Yes vs. No	1.2322	1.3786
<b>LOAN_PURP</b>	1	Refinance vs. Purchase	1.6065	1.2363
	2	Streamline vs. Purchase	1.0771	1.1776
<b>REFI_INCNT_CLASS</b>	2	10%<=X<20% vs. X<10%	1.0585	1.5124
	3	20%<=X<30% vs. X<10%	1.0200	1.8218
	4	30%<=X vs. X<10%	0.9185	1.9264

Source: Summit & Milliman

## Stage 2 Baseline Hazard Function

A Cox proportional hazard regression produces a baseline hazard function that describes the propensity of claim and non-claim terminations for baseline characteristics. Deviations from the baseline hazard function are applied as scalar adjustments to the baseline rate. Summit & Milliman defined baseline characteristics as<sup>18</sup>:

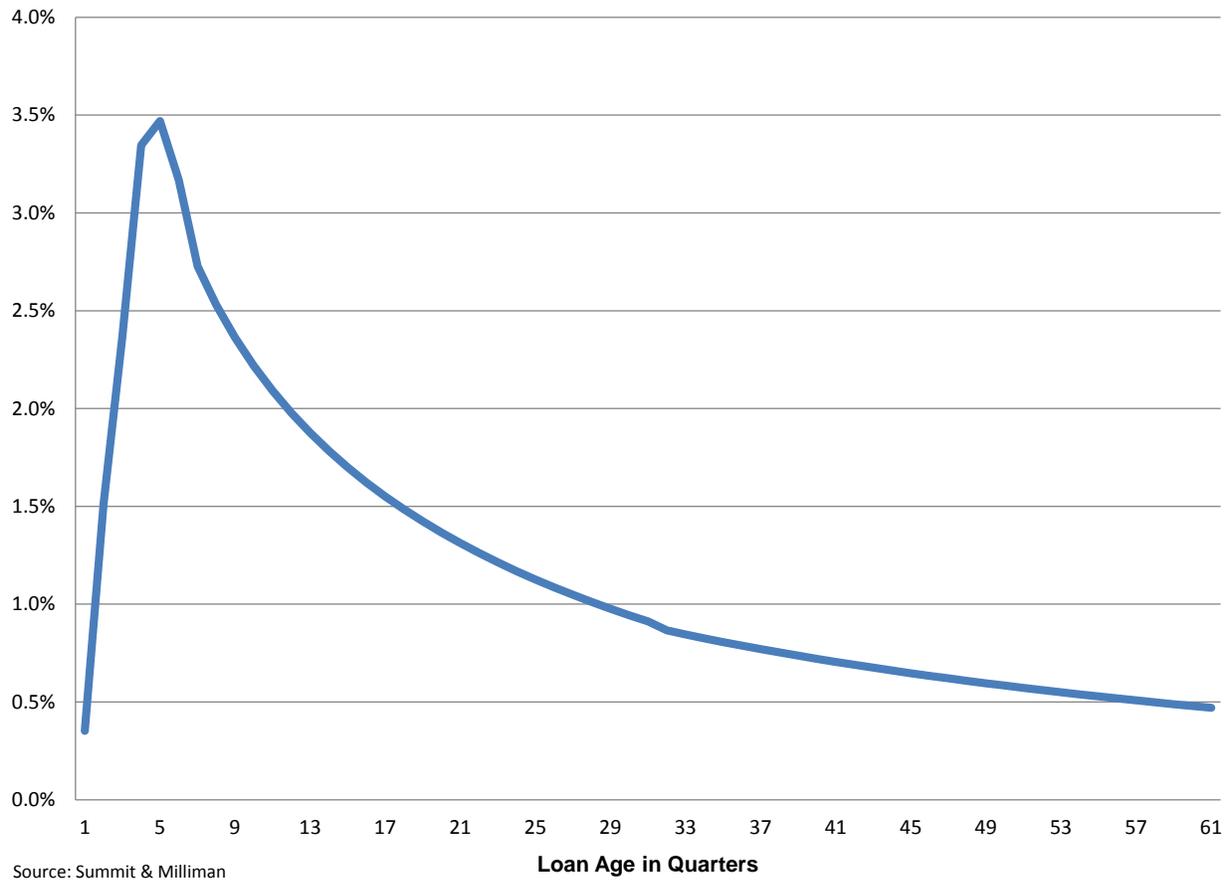
- Original LTV: 60%
- Home price appreciation: -40%
- Buy down indicator: No
- Down payment assistance indicator: No
- First-time buyer indicator: No
- Fixed-rate mortgage indicator: Yes
- Term: 30 year
- Loan Purpose: Purchase

The reference category is selected as the baseline category for all categorical variables, and for piecewise-linear spline variables, the lowest bucket of the spline is selected. The figure below shows the baseline hazard function for claim terminations.

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<sup>18</sup> In a Cox Proportional Hazard Model, the baseline hazard is defined from pre-selected characteristics. This set of values determines the *level* of the baseline hazard, but does not influence the *shape* of the baseline hazard function. Consequently, the definition of the baseline hazard does not influence model prediction.

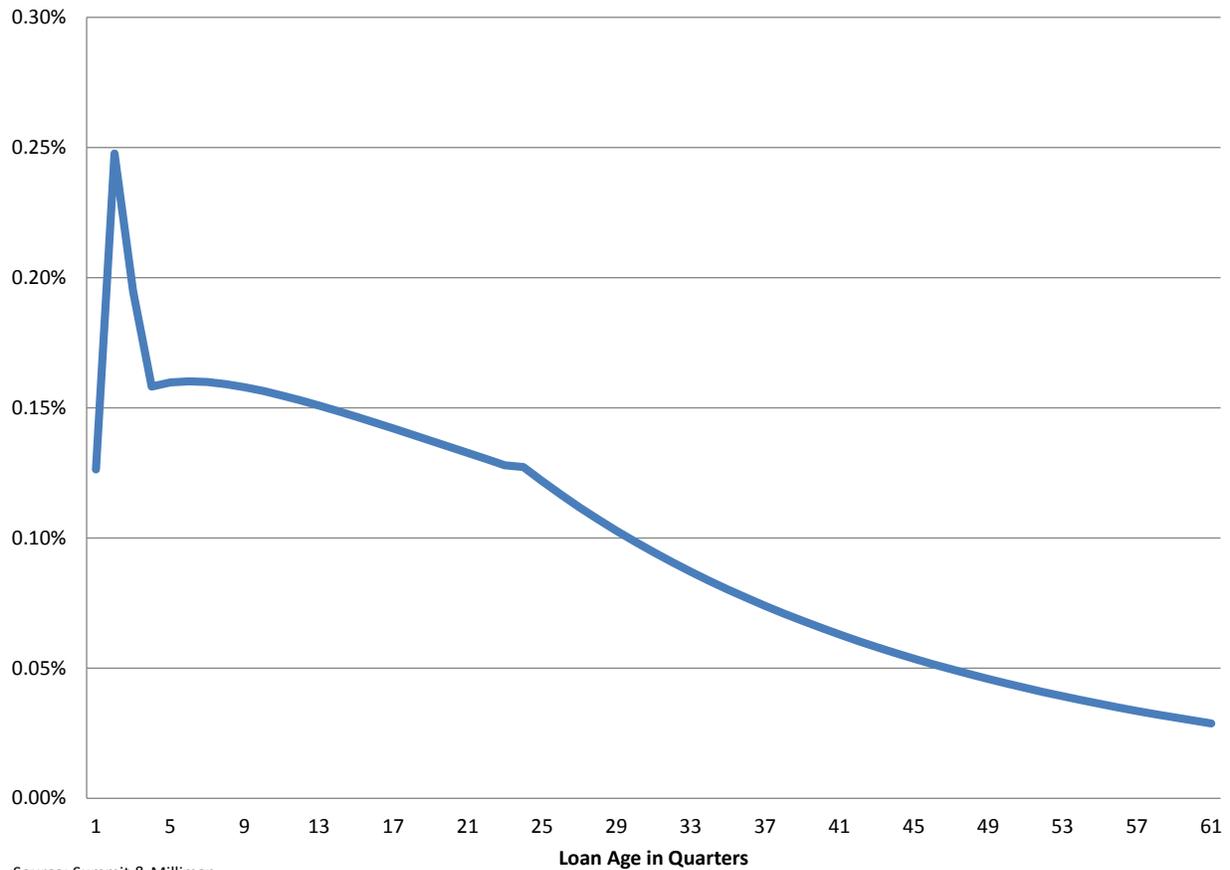
Figure 20: Stage 2 Claim Termination Baseline Hazard Function



The baseline hazard rate for claim terminations increases from less than 0.50% in the first quarter after origination to roughly 3.50% during the fifth quarter, then gradually declines thereafter.

The figure below shows the baseline hazard function for non-claim terminations.

**Figure 21: Stage 2 Non-Claim Termination Baseline Hazard Function**



The baseline hazard rate for non-claim terminations peaks in quarter two at 0.25% and declines over time. Note that the scale on the baseline non-claim termination hazard function is much smaller compared to the baseline hazard function for claim, indicating the probability of claim is larger given a 90-day delinquency episode compared to a non-claim termination, all else equal.

**Results from Stage 2 Model Estimation**

The estimation results of the Stage 2 model equations, specified above, are presented in the table below. The following regression tables present estimation results for the competing risks of claim or prepayment, conditional on serious delinquency. Most of the coefficients in the claim and prepayment hazard models are statistically significant at the 1% level.

Regression Table 5: Stage 2 Model Coefficients

Variable Names	Class	Category/Spline Values	Coefficient Estimates By Outcome			
			Claim		Non Claim Termination	
<b>DOWN_PAY_ASSIST</b>	1	Yes	0.1824	***	-0.1135	***
	2	No	0		0	
<b>AMORT_TERM</b>	1	15 Year	-0.5138	***	-0.0127	
	2	16 - 29 Year	-0.0336	***	-0.0410	***
	3	30 Year	0		0	
<b>FIXED_RATE</b>	1	No	0.1684	***	0.1034	***
	2	Yes	0		0	
<b>LTV_SPLINE</b>		0-60%	0.0063	**	-0.0059	***
		60<-65%	0.0524	***	-0.0153	***
		65<-70%	0.0297	***	-0.0069	***
		70<-75%	0.0301	***		
		75<-80%	0.0255	***		
		80<-85%	0.0398	***	-0.0058	***
		85<-90%	0.0378	***	-0.0074	***
		90<-95%	0.0140	***	-0.0110	***
		95<-100%	0.0459	***		
		100<-High	0.0167	***		

Standard indicators of statistical significance are marked as: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
Source: Summit & Milliman

Regression Table 6: Stage 2 Model Coefficients (cont.)

Variable Names	Class	Category/Spline Values	Coefficient Estimates By Outcome			
			Claim		Non Claim Termination	
<b>FRST_TIME_BUYER</b>	1	Yes	0.0957	***	0.1545	***
	2	No	0		0	
<b>BUY_DOWN_IND</b>	1	Yes	0.2732	***	0.1642	***
	2	No	0		0	
<b>HPA_SPLINE</b>		HPA <=-40%	-2.0103	***	3.4322	**
		-40%<HPA<=-30%	-3.9721	***	2.9235	***
		-30%<HPA<=-20%	-0.169	***	1.0935	***
		-20%<HPA<=-10%			5.4781	***
		-10%<HPA<=0%			10.0670	***
		0%<HPA<=10%			-1.3804	***
		10%<HPA<=20%	-2.5781	***	3.0647	***
		20%<HPA<=30%	-2.2578	***	4.8422	***
		30%<HPA<=40%	-1.6352	***	0.8903	***
		40%<HPA				
<b>LOAN_PURP</b>	1	Refinance	-0.0392	***	0.0568	***
	2	Streamline	-0.0087	**	0.1045	***
	3	Purchase	0		0	

Standard indicators of statistical significance are marked as: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
Source: Summit & Milliman

## Mortgages in Delinquency as of June 30, 2013

Summit & Milliman modeled certain delinquent mortgages separately from the two-stage model framework discussed in prior sections of this document. Specifically, Summit & Milliman identified three distinct groups of delinquencies, which received an adjustment from the two-stage framework. These three groups include:

### 1. Foreclosures and Probable Claims

- a. Defined as mortgages that are in some stage of the foreclosure process or otherwise have a high probability of resulting in a claim

### 2. Persistent Delinquencies

- a. Defined as mortgages that have been delinquent for more than nine months, missed at least three payments, and are not repaying their mortgage (specifically, where the number of missed payments and the number of months delinquent are within six months of each other)

### 3. 60 Days Delinquent

- a. Defined as mortgages that are two payments delinquent, not in one of the above categories, and the number of months since the first missed payment is less than or equal to three months

FHA provided Summit & Milliman with a list of mortgages that are delinquent by one or more payments. In the dataset provided to Summit & Milliman, as of June 30, 2013, there are 1,643,779 FHA-insured mortgages that were in one of the above delinquency categories.

## Foreclosures and Probable Claims

As a consequence of jurisdictional, legal and servicer delays following the FY 2009 financial crisis, there are mortgages undergoing the foreclosure process that are classified as non-performing mortgages, though no claim has been filed. Specifically, as of June 30, 2013 there were 1,643,779 delinquent or previously 90 day delinquent FHA-insured mortgages. Among this delinquent population, there are 234,322 mortgages in some stage of foreclosure, which historically have an ultimate claim probability of 98%. Summit & Milliman assigned a 100% claim probability to these 234,322 mortgages.

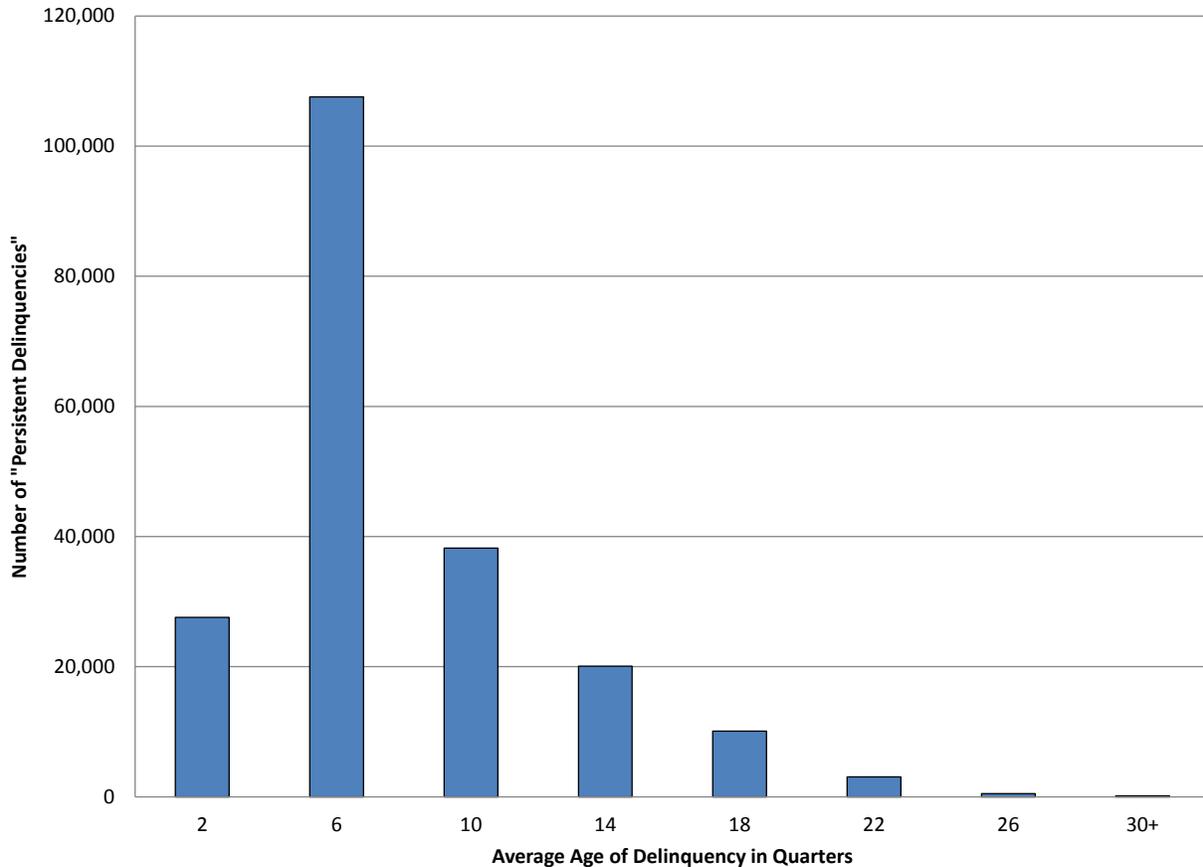
## Persistent Delinquencies

The delinquency inventory includes a significant number of “persistent delinquencies.” To be characterized as a “persistent delinquency,” a mortgage must have missed more than three payments, be more than six months delinquent, *and* the difference between the age of delinquency in months and number of missed payments must be six or fewer. The last portion of the definition is intended to identify only borrowers who have been delinquent for an extended period of time and are *not* repaying their mortgages. These data also include borrowers that have been delinquent for an extended period of time but are only a few payments behind. In other words, these latter borrowers have missed a few payments (possibly as a result of hardship) but subsequently have begun to repay their mortgages according to the

scheduled pattern. These latter mortgages are assigned to the two-stage model without any adjustment. However, the former mortgages that have been delinquent for an extended period of time and are not repaying their mortgages are treated differently, as described in this section.

The distribution of “persistent delinquencies” by age of delinquency in quarters is presented in the following chart.

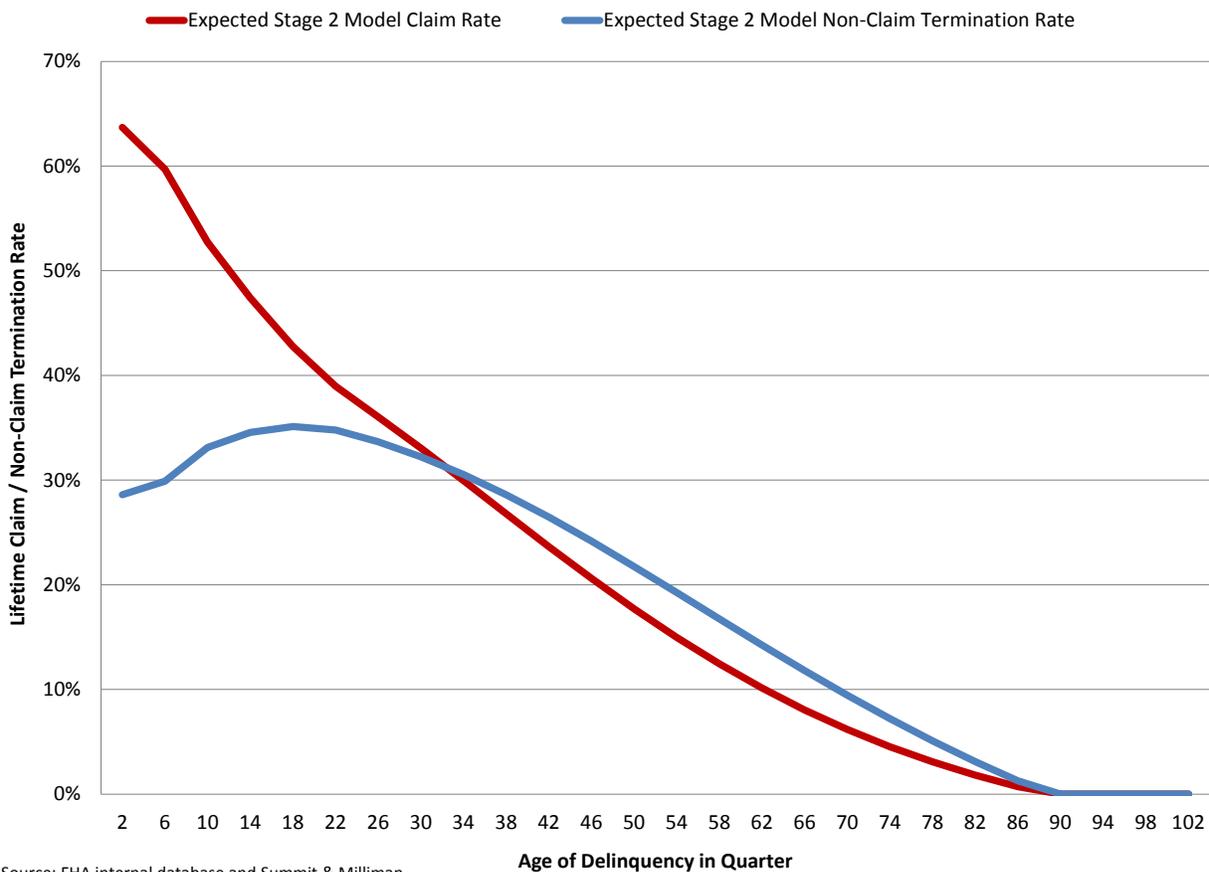
**Figure 22: Persistent Delinquencies**



Source: FHA internal database and Summit & Milliman

Mortgages that fit the definition of “persistent delinquency” are assumed to have a higher probability of claim than the Stage 2 model would suggest, due to the higher number of missed payments and the lack of a consistent payment history. The Stage 2 model baseline expected lifetime claim rates and non-claim termination rates are shown in the next figure.

Figure 23: Stage 2 Model Claim and Non-Claim Termination Predictions



As indicated in the figure above, the longer the duration between the first 90 day delinquency and the evaluation period, the lower the lifetime claim probability from the Stage 2 model. This relationship is due to Stage 2 model’s estimation of the ultimate performance of mortgages after the first 90 day delinquency episode. Generally, mortgages that become 90 days delinquent and do not claim are mortgages that cure and resume paying their mortgage. However, the inventory of delinquencies includes a significant portion of mortgages that are seriously delinquent but are not being pushed through the foreclosure process or being resolved by any other means. Therefore, the Stage 2 model likely underestimates the probability of claims for these persistently delinquent mortgages.

To more accurately forecast the claim probability for “persistent delinquencies,” a separate logistic regression model overrides the Stage 2 claim model. This model was created using a sample of 428,887 mortgages that were seriously delinquent at some point in time and eventually were resolved through claim or non-claim termination.

The model override was estimated using a logistic regression with the following explanatory variables:

### **Delinquency Age**

This categorical variable indicates age of delinquency, in quarters, from two-months to 20-months delinquent, with a reference value of 2.

### **HPA**

This variable indicates the cumulative change in HPI, from origination to claim termination. It is piecewise-linear and splined, with knots at every 10%, beginning at -40%.

### **Original LTV**

This variable indicates equity at origination. It is piecewise-linear and splined, with knots at every 5%, beginning at 60%.

Regression Table 7: Seriously Delinquent to Claim Model Coefficients

Variable Names	Class	Category/Spline Values	Coefficient Estimates	Claim Termination
<b>CONSTANT</b>			-0.2338	
<b>DLQ_AGE</b>	1	2	0	
	2	3	0.7276	***
	3	4	1.0731	***
	4	5	1.2394	***
	5	6	1.2318	***
	6	7	1.2155	***
	7	8	1.0386	***
	8	9	0.8622	***
	9	10	0.7581	***
	10	11	0.5856	***
	11	12	0.4198	***
	12	13	0.3122	**
	13	14	0.2257	***
	14	15	0.1766	***
	15	16	0.0789	***
	16	17	0.1308	
	17	18	-0.1222	
	18	19	-0.1683	
	19	20	-0.7383	***

Standard indicators of statistical significance are: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
 Source: Summit & Milliman

Regression Table 8: Seriously Delinquent to Claim Model Coefficients (cont.)

Variable Names	Class	Category/Spline Values	Coefficient Estimates	Claim Termination
<b>HPA_TO_TERM_SPLINE</b>		HPA <=-40%	-4.9670	*
		-40%<HPA<=-30%	-4.4849	***
		-30%<HPA<=-20%	-5.6346	***
		-20%<HPA<=-10%	-5.0186	***
		-10%<HPA<=0%	-4.2261	***
		0%<HPA<=10%	-4.2585	***
		10%<HPA<=20%	-7.4419	***
		20%<HPA<=30%	-4.5643	***
		30%<HPA<=40%	-5.7108	***
		40%< HPA	-2.6488	***
<b>LTV_SPLINE</b>		0-60%	0.0739	***
		60<-65%	0.0937	***
		65<-70%	0.0758	
		70<-75%	0.0546	
		75<-80%	0.0581	***
		80<-85%	0.0819	***
		85<-90%	0.0508	***
		90<-95%	0.0569	***
		95<-100%	0.0704	***
		100<-High	-0.0609	***

Standard indicators of statistical significance are: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
 Source: Summit & Milliman

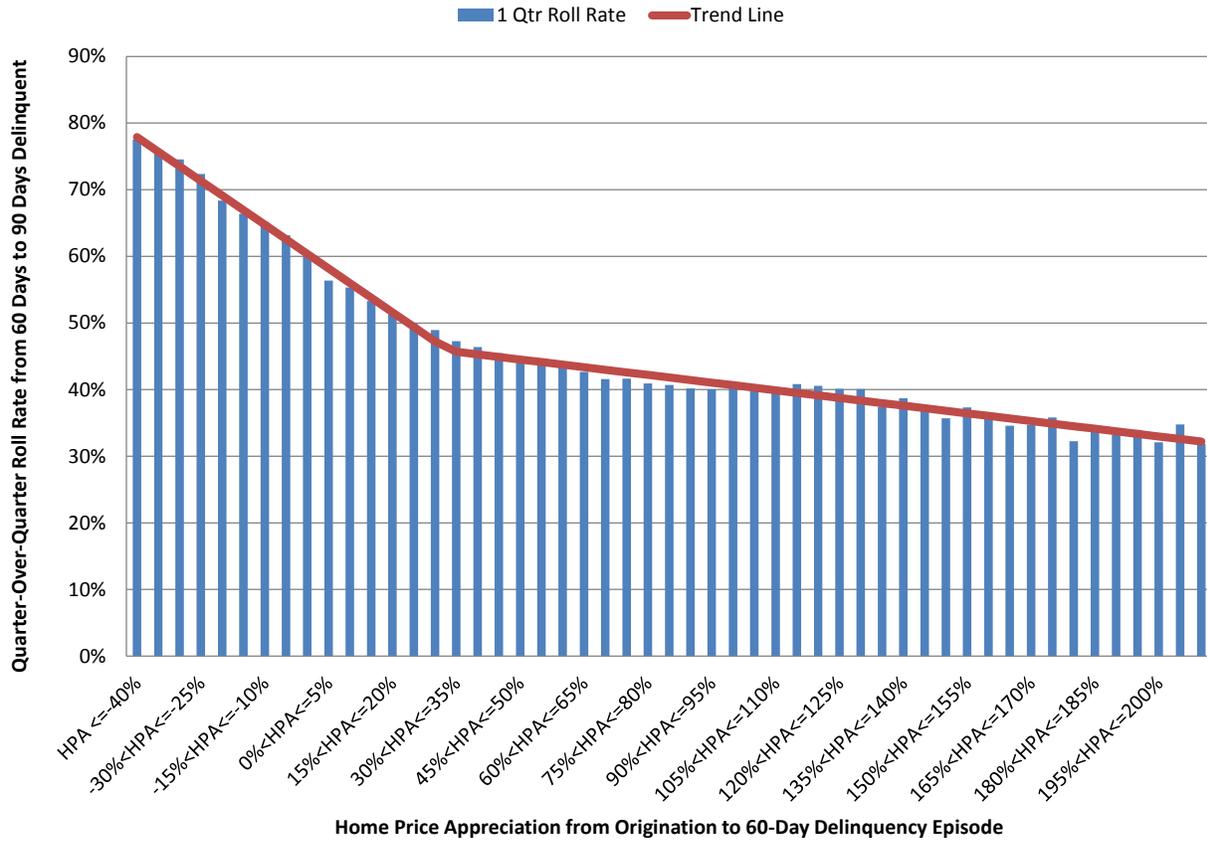
### Roll Rates from 60 Day to 90 Day Delinquency Status

Mortgages that are two payments behind on their mortgages (i.e. 60 day delinquencies) are more likely to fall behind by three payments compared to a mortgage that is current on its payments. However, the Stage 1 model does not differentiate between 60 day delinquencies and mortgages that are current on all payments because the model is estimated in quarterly intervals. Therefore, Summit & Milliman identified mortgages that are delinquent by two payments or 60 days, and rolled them forward by one quarter to 90 days delinquency, using the following model. Note, for this analysis, 60 day delinquencies are identified as mortgages that have missed two payments within the past six months.

The roll rate forecast was developed using a single-factor model based on the cumulative change in the local HPI, from origination through the evaluation date. The roll rate patterns were developed using the historical frequency of a mortgage reaching 90 days delinquency one quarter after reaching 60 days delinquency. The following figure shows the actual historical roll rate percentages, by HPA cohort, and the claim frequency forecast in the model. Claim frequency rates are calculated using the following equations:

- For  $HPA \leq 30\%$ : Roll Rate =  $59.28\% - 43.85\% \times HPA$ ; RSQ = 99.17%
- For  $HPA > 30\%$ : Roll Rate =  $48.17\% - 7.69\% \times HPA$ ; RSQ = 93.60%

Figure 24: 60 Day to 90 Day Roll Rates



Source: FHA internal database and Summit & Milliman

## Appendix C: Technical Details of Loss Severity Model

### Claim Types

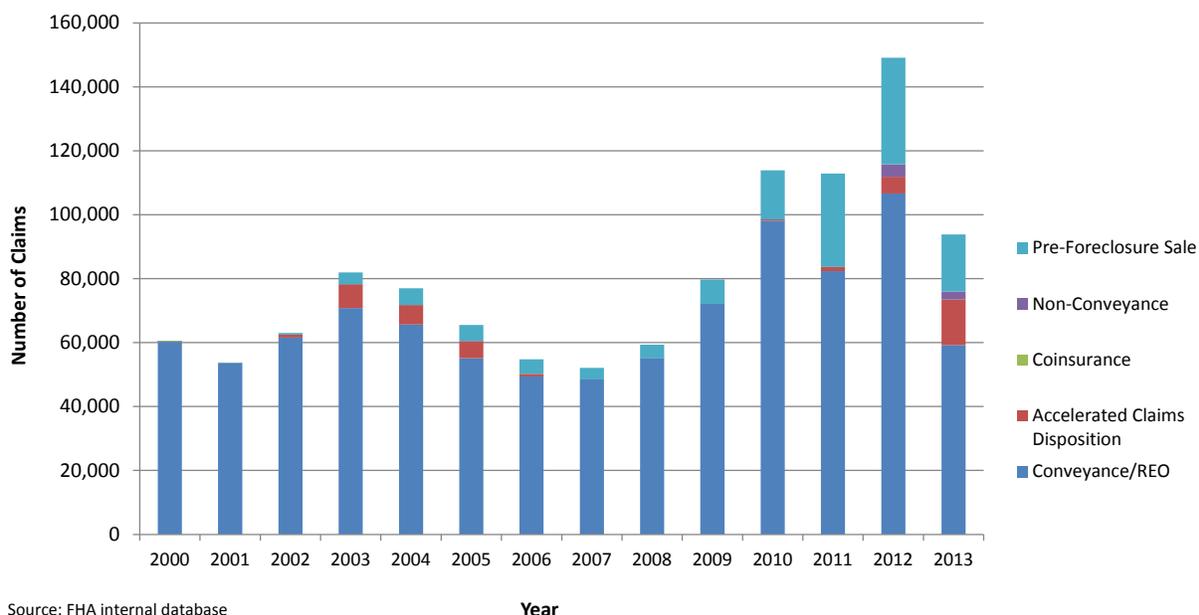
There are several different claim types for FHA-insured mortgages. The most common types of claims are:

1. **Conveyance:** During a foreclosure, the lender receives the property and transfers the deed to FHA.
2. **Pre-Foreclosure Sale:** As an alternative to foreclosure, servicers and borrowers may agree to sell a property for less than the unpaid principal balance of the mortgage with FHA approval. Borrowers have an incentive to enter into a pre-foreclosure sale in order to mitigate effects on their credit rating, and FHA has an incentive to enter into a pre-foreclosure sale because historical data indicate severity rates on pre-foreclosure sales are less than conveyance claims, all else equal.
3. **Note and Bulk Sales (Accelerated Claims Disposition):** FHA has initiated various programs in recent years to reduce the inventory of serious delinquencies and pending foreclosures. Two specific programs have been note and bulk sales. In each program, seriously delinquent mortgages or mortgages in foreclosure are sold competitively at market-determined prices that are generally below the outstanding principal balance to investors. The programs help remove pending claims from FHA and allow FHA to process claims efficiently. See Sections III and V for further details on these initiatives.
4. **Claim without Conveyance of Title (Non-Conveyance):** During a claim, the lender does not convey the property to FHA to receive insurance benefits. Rather, the property is sold and the sale proceeds go to HUD; the property goes to the non-HUD buyer. If the sale proceeds do not cover the UPB and expenses, a claim is filed for the difference. If the sale proceeds to cover these costs, no claim is filed. See Sections III and V for further details on these initiatives.
5. **Coinsurance:** During a default, a lender receives the property from a borrower and sells the property, splitting any loss with FHA at 90% to 10%.

The following figure shows FHA's distribution of claims from 2000 Q1 to 2013 Q2. Historically, the most common claim types are conveyance (i.e. REO), and PFS. The other claim types in the prior list are less common, so Summit & Milliman's Loss Severity Model will focus on conveyance and PFS.



Figure 25: Number of Claims Annually by Type



The most common claim type is conveyance, in which the property that collateralizes the mortgage is conveyed to FHA. The conveyance process generally follows three steps:

- (1) The mortgagee requests conveyance on a non-performing mortgage.
- (2) Non-conforming inspections are completed by a mortgage compliance manager (MCM).
- (3) After MCM approval, FHA pays a claim to the servicer and receives the title of the property.

The amount of the claim paid to the servicer is the acquisition cost of the property, which is the sum of the outstanding balance on the mortgage, debenture (i.e. forgone) interest, and other costs and adjustments:

**Equation 10**

$$Acquisition\ Cost_{REO} = UPB + Debentured\ Interest + Other\ Expenses\ and\ Adjustments$$

The other expenses and adjustments include incentive payments, property and preservation expenses, and adjustments for positive escrow amounts:

**Equation 11**

$$Other\ Expenses\ and\ Adjustment = Incentive\ Payments + Property\ and\ Preservation\ Expenses + Adjustments\ for\ Positive\ Escrow\ Amounts$$

After the mortgage is conveyed, FHA tries to sell the property through the REO process, which proceeds as follows:

- (1) The property enters the REO inventory.
- (2) The field service manager (FSM) inspects the property and ensures the property is in ready-to-show condition.

- (3) The property is assigned to an asset manager (AM).
- (4) The AM establishes a listing price, using an “as is” appraisal value and, if required, the post-repairs appraisal price.
- (5) At the beginning of the REO sale process, the property proceeds through the direct sale waterfall in the following order:
  - i. Tenant right of first refusal
  - ii. Asset control area program
  - iii. First look<sup>19</sup>
  - iv. Good neighbor next door program<sup>20</sup>
  - v. Lottery for non-profits and government entities
  - vi. Extended listing period
  - vii. Bulk sales post
  - viii. \$1 home sale<sup>21</sup>

FHA manages the property from the time of acquisition to the time of disposition. During this time, FHA incurs holding costs, such as maintenance, repairs, tax payments, and expenses related to preparing the property for sale.

At the time of disposition, FHA sells the property. The net sales proceeds are the contract sales price, less discounts, sales expenses, and holding costs:

**Equation 12**

$$Net\ Sales\ Proceeds = Contract\ Sales\ Price - Discounts - Sales\ Expenses - Holding\ Costs$$

The net sales proceeds are considered the recovery on the initial claim. As such, the nominal net loss of the REO claim is the net sales proceeds, less the acquisition:

**Equation 13**

$$Net\ Loss_{REO} = Net\ Sales\ Proceeds - Acquisition\ Cost$$

Note that for net loss, a positive value indicates a nominal net loss, and a negative value means a nominal net profit. For an REO claim, net loss is used to calculate loss severity, which is the net loss divided by the original mortgage amount at the time of termination:

**Equation 14**

$$Loss\ Severity_{REO} = LSR_{REO} = \frac{Net\ Loss_{REO}}{Original\ Mortgage\ Amount}$$

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<sup>19</sup> This Initiative gives state and local governments and nonprofit organizations participating in HUD’s Neighborhood Stabilization Program (NSP) preference to acquire homes from the Department’s inventory of foreclosed properties, or “HUD Homes.”

<sup>20</sup> Discounted list priced homes for law enforcement officers, Pre-K through 12<sup>th</sup> grade teachers and firefighters/emergency medical technicians. The borrower must commit to live in the property for 36 months as sole residence.

<sup>21</sup> HUD’s Dollar Homes initiative is designed to help local governments to foster housing opportunities for low to moderate income families and address specific community needs by offering them the opportunity to purchase qualified HUD-owned homes for \$1 each.

In the PFS program, the property is sold without completing the foreclosure process. Instead of acquiring the foreclosed property, FHA pays incentives depending on marketing and sale time directly to the borrower, who sells the property at a value less than the value of the outstanding mortgage balance. Note that a borrower must obtain prior approval from the servicer to initiate a PFS. In a PFS, the claim is equal to the difference between the net sales proceeds and the outstanding balance of the mortgage.

#### Equation 15

$$Net\ Loss_{PFS} = Net\ Sales\ Proceeds - Outstanding\ Balance$$

For a PFS claim, the net loss described above is used to calculate loss severity, which is the net loss divided by the original mortgage amount at the time of termination:

#### Equation 16

$$Loss\ Severity_{PFS} = LSR_{PFS} = \frac{Net\ Loss_{PFS}}{Original\ Mortgage\ Amount}$$

Summit & Milliman estimated loss severity rate (LSR) as the expected value of an REO claim and a PFS claim. Summit & Milliman estimated a separate model for the probability of a PFS claim. The complement of this probability is equal to the probability of an REO claim. The sum of the probability of a PFS sale and an REO claim is equal to one. The equation below shows the expression for LSR:

#### Equation 17

$$LSR = Prob(PFS) * LSR_{PFS} + (1 - Prob(PFS)) * LSR_{REO}$$

### Considered Variables

The following list of variables, though not exhaustive of all of the potential variables in the severity rate regression model, includes:

- **FICO Score:** The FICO credit score of a borrower captures the borrower's propensity to maintain credit. Borrowers with higher credit scores generally maintain their property more relative to borrowers with lower credit scores and are associated with lower loss severity rates. Summit & Milliman modeled FICO credit scores using the natural log of the borrower's FICO credit score and used a spline function in model estimation.
- **Loan Age:** This variable is the time (in quarters) from the beginning of loan amortization to the last payment made by borrower.
- **Original Loan-to-Value ratio:** The LTV ratio captures the borrower's original equity position. Higher original LTV ratios are associated with a higher loss severity rate. Summit & Milliman modeled LTV ratios using a spline function in model estimation.
- **Original Mortgage Amount:** This is the natural log of the original mortgage amount, which sets the ceiling for the maximum loss for a terminated loan.
- **Home Price Appreciation:** Appreciation or depreciation in HPI affects the sale of the property. Depreciation usually results in greater severity, while appreciation leads to lower loss severity. Note that these variables are calculated using state and MSA-level HPI. Two measurements exist: appreciation from beginning amortization to termination,

and appreciation from termination to disposition. Summit & Milliman modeled HPA using a spline function in model estimation.

- **Property Type:** The variable indicates the type of property underlying the endorsement. Property types include one unit, two units, three or more units, and condo.
- **Down Payment Assistance:** This variable indicates whether or not the borrower received down payment assistance. Borrowers that receive down payment assistance generally have fewer financial resources to maintain their property (e.g., they have insufficient funds to make a down payment at origination) and are associated with higher severity rates.
- **Product:** This variable identifies the type of mortgage of the borrower. There are six types of mortgages in this analysis: 30 year fixed, 15 year fixed, ARM, 30 year fixed rate streamline, 15 year fixed rate streamline, and ARM streamline.
- **Origination Mortgage Amount:** The origination mortgage amount of a mortgage has historically been correlated with varying levels of severity rates. Original mortgage amount enters the Loss Severity Model through spline functions for REO and PFS.
- **Time from Termination to Disposition:** This variable is the time from the foreclosure acquisition date to the termination date of the foreclosed loan. (If the foreclosure acquisition date is missing, then the model uses the processing date.)
- **Post 2010 Claim Flag:** For the probability of PFS, the data indicated a large jump in PFS claim type probabilities. This variable captures that dynamic shift in the data.
- **State Effects:** The foreclosure process in each state is different, and the cost of foreclosure for each process is different. The Loss Severity Model accounts for these differences.

### Results from Phase 1 Model Estimation

The estimation results from the Phase 1 model equations are presented in the regression tables on the following pages. These tables show that most of the coefficients are statistically significant to .01 and have the expected signs.

Regression Table 9: Loss Severity Model Coefficients

Variable Names	Class	Category/Spline Values	Coefficient Estimates by Outcome		
			PFS Probability	REO Loss Severity	PFS Loss Severity
<b>CONSTANT</b>			30.85000***	4.82200***	3.47600***
<b>LN_FICO_SPLINE</b>	(0,6.45]		1.53800***	-0.23000***	-0.31300***
	(6.45, MAX)		4.43900***	-0.26400***	-0.08770***
<b>AGE</b>			-0.02700***	0.00515***	0.00447***
<b>LTV_SPLINE</b>	(0,95]		0.00327***	0.00396***	0.00322***
	(95, MAX)		0.02600***	0.00201***	-0.00551***
<b>HPA_BEG_TO_CLAIM_SPLINE</b>	(-.5, -.1]		0.66300***	-0.64700***	-0.53100***
	(-.1,.1]		0.37500***	-1.24600***	-0.83600***
	(.1, .5)		-0.14400	-0.75300***	-0.33000***
<b>HPA_CLAIM_TO_DISP_SPLINE</b>	[-0.08, 0.04]			-1.03300***	
	(0.04,0.08]			-0.66900***	
<b>PROPERTY</b>	1 One Unit		0	0	0
	2 Two Units		-0.47600***	0.05750***	0.13700***
	3 Three or More Units		-0.76300***	0.09250***	0.14900***
	4 Condo		0.45500***	0.05030***	0.04450***
<b>PAY_ASSISTANCE</b>	1 Secondary Finance		-0.06800***	-0.01470***	-0.02950***
	2 Other Assistance		-0.04710***	0.02670***	0.00234**
	3 No Assistance		0	0	0
<b>PRODUCT</b>	1 30 Year Fixed		0	0	0
	2 15 Year Fixed		-0.11600**	-0.07200***	-0.03210***
	3 ARM		-0.10500***	-0.01950***	-0.01910***
	4 30 Year Fixed SR		-0.05430***	0.01380***	0.07400***
	5 15 Year Fixed SR		-0.17100	-0.14500***	-0.01880
	6 ARM SR		0.00516	0.00284***	0.04620***
<b>LN_ORIG_AMT</b>			1.48500***		
<b>LN_ORIG_AMT_SPLINE</b>	(0,11.7]			-0.24700***	-0.10600***
	(11.7, MAX)			-0.13100***	-0.03590***
<b>CLAIM_TO_DISP</b>				0.04850***	

Standard indicators of statistical significance are: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.  
 Source: Summit & Milliman

Regression Table 10: Loss Severity Model Coefficients (cont.)

Variable Names	Class	Category/Spline Values	Coefficient Estimates by Outcome		
			PFS Probability	REO Loss Severity	PFS Loss Severity
<b>POST_2010_CLAIM</b>	1	Claim Post 2010	0.73000***		
	2	Claim Pre 2010	0		
<b>STATE</b>	1	Alabama	0	0	0
	2	Alaska	-0.17300	0.01670	-0.03710*
	3	Arizona	1.32000***	-0.06730***	0.11600***
	4	Arkansas	1.02200***	-0.03190***	0.02990***
	5	California	1.00000***	-0.05610***	0.07100***
	6	Colorado	1.22200***	0.03270***	0.06110***
	7	Connecticut	1.49500***	0.08760***	0.04440***
	8	Delaware	1.47300***	0.04950***	0.04770***
	9	District of Columbia	0.97300***	0.14100***	0.21300***
	10	Florida	2.06700***	-0.01420***	0.12200***
	11	Georgia	0.78000***	-0.05220***	0.07330***
	12	Hawaii	1.36700***	-0.00282	0.02370
	13	Idaho	1.71100***	-0.05980***	0.03010***
	14	Illinois	1.16500***	0.10800***	0.09650***
	15	Indiana	1.10900***	0.07080***	0.03790***
	16	Iowa	1.29500***	0.09880***	0.04140***
	17	Kansas	1.24800***	0.03100***	-0.01340*
	18	Kentucky	1.05100***	0.04880***	0.02226***
	19	Louisiana	0.58800***	0.00329	0.03530***
	20	Maine	2.08000***	0.19700***	0.05540***

Standard indicators of statistical significance are: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.

Source: Summit & Milliman



Regression Table 11: Loss Severity Model Coefficients (cont.)

Variable Names	Class	Category/Spline Values	Coefficient Estimates by Outcome		
			PFS Probability	REO Loss Severity	PFS Loss Severity
STATE	21	Maryland	1.11700***	0.13800***	0.15100***
	22	Massachusetts	1.52200***	0.10400***	0.07830***
	23	Michigan	1.28500***	0.04910***	0.11500***
	24	Minnesota	1.09900***	0.04940***	0.05600***
	25	Mississippi	0.37700***	-0.05770***	-0.01940***
	26	Missouri	0.87700***	0.01810***	0.04970***
	27	Montana	1.04500***	0.01030*	-0.00390
	28	Nebraska	1.03900***	-0.02340***	-0.03080***
	29	Nevada	1.61000***	-0.08400***	0.09260***
	30	New Hampshire	0.93100***	0.05690***	0.03750***
	31	New Jersey	1.81700***	0.12800***	0.12700***
	32	New Mexico	1.22700***	-0.01320***	-0.01830**
	33	New York	1.90500***	0.20100***	0.09520***
	34	North Carolina	0.68800***	0.01440***	0.02050***
	35	North Dakota	1.50400***	0.05810***	0.01280
	36	Ohio	1.27100***	0.14400***	0.05980***
	37	Oklahoma	1.06300***	0.02440***	0.01510*
	38	Oregon	1.18000***	-0.00373	0.04600***
	39	Pennsylvania	1.42100***	0.20100***	0.04890***
	40	Puerto Rico	-1.17700***	-0.08830***	-0.14000***
	41	Rhode Island	1.48600***	0.06630***	0.09640***
	42	South Carolina	0.83000***	0.01300***	0.02410***
	43	South Dakota	1.25300***	0.07620***	-0.03290**
	44	Tennessee	0.74000***	-0.02080***	0.01900***
	45	Texas	0.92500***	-0.00253	0.04300***
	46	Utah	1.57000***	-0.02930***	0.03240***
	47	Vermont	1.31100***	0.16800***	0.01090
	48	Virginia	0.70200***	-0.00009	0.04870***
	49	Washington	0.74300***	0.01520***	0.04820***
	50	West Virginia	0.18100	0.06340***	0.01080***
	51	Wisconsin	0.81000***	0.10600***	0.03380***
	52	Wyoming	0.29800***	-0.01910***	-0.02590*

Standard indicators of statistical significance are: \*\*\* for 0.01 level (one-sided test), \*\* for 0.05 level and \* for 0.10 level.

Source: Summit & Milliman

## Appendix D: Technical Details of the Cash Flow Model

The economic value of the MMI Fund’s forward mortgage portfolio is calculated as the NPV of all future cash flows from September 30, 2013 and subsequent for all surviving forward mortgages in the portfolio, plus the MMI Fund’s capital resources as of September 30, 2013.<sup>22</sup> This calculation requires a forecast of nominal expected future cash flows and appropriate discount rates. To accomplish this, the model calculates a quarterly forecast of the cash flow components, as outlined in the following table.

**Table 22: Preliminary Cash Flow Components**

Output Variable	Flow	Definition
<b>Upfront Premiums</b>	+	The expected sum of upfront premiums for the given period
<b>Annual Premiums</b>	+	The expected sum of annual premiums for the given period
<b>Claim-PFS</b>	-	The expected claim from a pre-foreclosure sale for a given period
<b>Claim-REO</b>	-	The expected conveyance/REO claim for a given period
<b>Loss Mitigation Payments</b>	-	Any expected outflows associated with loss mitigation payments
<b>Premium Refunds</b>	-	The expected sum of premium refunds for the given period

<sup>a</sup>Plus signs indicate an inflow to FHA, and minus signs indicates an outflow from FHA, or a missing inflow

The following definitions describe the outputs that are critical to the calculation of the cash flow components:

**Claim Hazard Rate ( $P_c$ ):** This is the dollar-weighted, conditional probability of a mortgage claiming in a given period. The term conditional indicates that probability is conditioned on the mortgage’s survival until the beginning of the given period.

**Non-Claim Termination Hazard Rate ( $P_{NCT}$ ):** This is the dollar-weighted, conditional probability of a mortgage terminating in a non-claim termination in a given period. The term conditional indicates that probability is conditioned on the mortgage’s survival until the beginning of the given period.

**Survival Rate ( $S$ ):** This is the dollar-weighted probability, written as  $S(t, \tau)$ , of a mortgage surviving from period  $\tau$  to the beginning of period  $t$ . Period  $\tau$  represents the mortgage age, in quarters, as of September 30, 2013. The survival rate is expressed as:

### Equation 18

$$S(t, \tau) = \prod_{j=\tau}^{t-1} (1 - P_c(j) - P_{NCT}(j))$$

<sup>22</sup> The data provided to Summit & Milliman reflect insurance activity through June 30, 2013. Therefore, Summit & Milliman assumes forecasts of insurance activity from June 30, 2013 through September 30, 2013 is consistent with actual experience and reflected in the capital resources of FHA as of September 30, 2013.

**PFS Claim Rate ( $P_{PFS}$ ):** This is the dollar-weighted probability of a mortgage terminating in a PFS claim in a given period, given that the mortgage is terminating in a claim in that period.

**REO Claim Rate ( $P_{REO}$ ):** This is the dollar-weighted probability of a mortgage terminating in an REO claim in a given period, given that the mortgage is terminating in a claim in that period.

**PFS Loss Severity Rate: ( $L_{PFS}$ ):** This is the dollar-weighted PFS loss severity, calculated as a percentage of the outstanding balance at termination.

**REO Loss Severity Rate: ( $LSR_{REO}$ ):** This is the dollar-weighted REO loss severity, calculated as a percentage of the outstanding balance at termination.

**Unpaid Principal Balance (UPB):** This is the outstanding balance of the mortgage for a given period. *Amortized UPB (AUPB)* is the scheduled outstanding amount for a given period. *Amortized UPB* is calculated using a standard amortization formula based on the mortgage type, interest rate of the mortgage, mortgage insurance premium, and the mortgage term.

Amortization is estimated at the cohort-level, so first it is necessary to calculate weighted average interest rates, premium rates, and average final mortgage insurance premium billing dates. Each mortgage observation is weighted by the mortgage's share, in dollars, of the overall portfolio and then collapsed into a cohort-level dataset for amortization.

Next an all-in-rate (AIR) is calculated using the interest rate, the mortgage insurance premium rate, and the percentage of the premium paid upfront. The all-in-rate reflects the combined interest rate ( $i$ ) and premium rate (MIP) for each period, as well as the portion of the MIP that is paid upfront ( $U$ ).

**Equation 19**

$$AIR = i + (1 - U) * MIP \text{ Rate}$$

The all-in-rate is substituted for the interest rate in the standard amortization formula.

**Equation 20**

$$Sched \text{ Pmt} = (AIR * Original \text{ Mortgage Amt} * (1 + AIR)^{Term}) / ((1 + AIR)^{Term} - 1)$$

Once scheduled payments are calculated for the entire life of the mortgage, they are disaggregated into principal, interest, and premium payments based upon the latest outstanding principal balance in each period.

**Equation 21**

$$Sched \text{ All In Pmt} = AUPB * AIR$$

**Equation 22**

$$Sched \text{ Principal Pmt} = Sched \text{ Pmt} - Sched \text{ All In Pmt}$$

**Equation 23**

$$Sched \text{ Interest Pmt} = \frac{i}{AIR} * Sched \text{ All In Pmt}$$

#### Equation 24

$$\text{Sched Premium Pmt} = \text{Sched All In Pmt} - \text{Sched Interest Pmt}$$

The result is a decreasing schedule of UPBs for each year, from endorsement through maturity. These balances are defined as *Amortized UPB*. *Surviving UPB(t)* is the product of the *Amortized UPB(t)* and the probability of the mortgage surviving to the beginning of period *t* (i.e. not terminating). This represents the expected UPB for each period, after accounting for any expected terminations. Similarly, *Claim UPB(t)* is the *Amortized UPB(t)*, adjusted for a serious delinquency associated with a claim.

Several refinements are made for the amortization of ARMs, which comprise less than 3% of the forward mortgage portfolio. Interest rates on ARMs are assumed to vary by a margin of 2% over the one year Constant Maturity Treasury (CMT) index. In addition, adjustable interest rates are assumed to change only once per year, after the expiration of the mortgage's fixed-rate entry period (which may extend from one year to 10 years). In accordance with Mortgagee Letter 2004-10, interest rates on one year and three year ARMs are assumed to adjust by a maximum of 1% per year and a maximum of 5% over the life of the mortgage, depending upon movements in the one year CMT forecast. Likewise, interest rates on five year, seven year, and 10 year ARM rates are assumed to adjust by a maximum of 2% annually and a maximum of 6% over the life of the mortgage, depending upon movements in the one year CMT forecast. After the interest rates are calculated, the same amortization equations are used for both fixed-rate and adjustable-rate mortgages.

#### Cash Flow Components

Calculating the economic value of the forward fund involves forecasting the expected nominal future cash flows of the fund's surviving mortgages. This section describes the components of the final cash flow forecast and the methodology used in their calculation.

#### Premiums

There are two premiums received by FHA in the forward mortgage program: upfront premiums and annual premiums. Premium rates for individual mortgages depend on the year of mortgage endorsement and may vary by the original LTV ratio and the term of the mortgage. Summit & Milliman reviewed FHA's premium rate policy changes over the years and mapped these changes to forecast both the upfront premium and the annual premiums for FHA-insured mortgages. Premiums for future endorsement cohorts are assumed to follow the policy outlined in Mortgagee Letter 2013-04.

Premiums are calculated as follows:

**Upfront Premium:** This is a premium paid by mortgagees at origination. The upfront premium, a percentage of the original mortgage amount, is calculated as follows:

#### Equation 25

$$\text{Upfront Premium} = \text{Original Mortgage Amount} * \text{Upfront Premium Rate}$$

The upfront premium is equal to the product of the original mortgage amount and the upfront premium rate.

Borrowers may finance the upfront premium. This means that the upfront premium is added to the UPB of the mortgage at origination and is paid off, along with principal, throughout the term of the mortgage. FHA does not earn additional premiums on outstanding financed upfront fees.

**Annual Premiums:** These premiums—paid annually and collected monthly—are calculated based on the UPB of the mortgage. When a mortgage becomes delinquent, annual premiums are advanced to FHA by the servicer until the servicer submits a claim to FHA or the borrower cures the delinquency.

**Equation 26**

$$Expected\ Annual\ Premiums = Sched\ Premium\ Pmt * (S_t - \frac{1}{2(P_{NCT} + P_C)})$$

Since the premium is paid monthly and is contingent upon the survival of the mortgage, the premium for a given period *t* is calculated by multiplying the amortized scheduled premium against the likelihood of survival through the middle of the period, without ending in a claim or non-claim termination.

Changes to upfront and annual premiums are given in the following table as described in the cited Mortgagee Letters. Note that FHA’s upfront mortgage insurance premium refunds were revised in 1994 (ML 1994-01) and eliminated in 2005 (ML 2005-03) for all mortgages except on FHA-to-FHA refinances.

**Table 23: Upfront and Annualized Monthly Premiums**

Effective Date	Upfront Premium	Annualized Monthly Premium	Mortgagee Letter
1983	3.80%, 30 year 2.40%, 15 year	0%, all	N/A
July 1991	3.80%, FY 1991 & 1992 3.00%, FY 1993 & 1994 2.25%, FY 1993+ 2.00%, 15 year non-streamlined	0.50%, all except 0.55% of 30 year LTV>95% FY 1993+	1991-26
December 1992	3.00%, 30 year 2.00%, 15 year non-streamlined 2.40%, 15 year streamlined	0.50%, 30 year 0.25%, 15 year 0%, 15 year LTV<90% 0%, streamlined	1992-43
April 1994	2.25%, 30 year 2.00%, 15 year non-streamlined 2.40%, 15 year streamlined	0.50%, 30 year 0.25%, 15 year 0%, 15 year LTV<90% 0%, streamlined	1994-48

Effective Date	Upfront Premium	Annualized Monthly Premium	Mortgagee Letter
October 1996	2.25%, 30 year 3.80%, 30 year streamlined 2.00%, 30 year first-time home buyer 2.00%, 15 year non-streamlined 2.40%, 15 year streamlined	0.50%, 30 year 0.25%, 15 year 0%, 15 year LTV<90% 0%, streamlined	1996-48
September 1997	2.25%, 30 year 3.80%, 30 year streamlined 1.75%, 30 year first-time home buyer 2.00%, 15 year non-streamlined 2.40%, 15 year streamlined	0.50%, 30 year 0.25%, 15 year 0%, 15 year LTV<90% 0%, streamlined	1997-37
January 2001	1.50%, all	0.50%, 30 year 0.25%, 15 year 0%, 15 year LTV<90%	2000-38
July 2008	1.25%-2.25%, 30 year based on credit score and LTV 1.00%-2.00%, 15 year based on credit score and LTV	0.50%-0.55%, 30 year based on credit score and LTV 0%-0.25%, 15 year based on credit score and LTV	2008-16
October 2008	1.75%, Purchase Money Mortgages and Full-Credit Qualifying Refinances 1.50%, Streamline Refinances 3.00%, Delinquent Mortgagors	Purchase Money Mortgages, Full-Qualifying Refinances, and Streamline Refinances 0.50%, 30 year LTV≤95% 0.55%, 30 year LTV>95% 0%, 15 year LTV≤95% 0.25%, 15 year LTV>95% Delinquent Mortgagors 0.50%, LTV≤95% 0.55%, LTV>95%	2008-22
April 2010	2.25%, Purchase Money Mortgages, Full-Credit Qualifying Refinances, Streamline Refinances; 2.00%, Delinquent Mortgagors and Home Equity Conversion Mortgages	0.50%, 30 year LTV≤95% 0.55%, 30 year LTV>95% 0%, 15 year LTV≤95% 0.25%, 15 year LTV>95% 0.75%, Delinquent Mortgagors	2010-02
October 2010	1.00%, Purchase Money Mortgages, Full-Credit Qualifying Refinances, and Streamline Refinances	0.85%, 30 year and LTV≤95% 0.90%, 30 year and LTV>95% 0%, 15 year and LTV≤90% 0.25%, 15 year and LTV>90%	2010-28
April 2011	1.00%, Purchase Money	1.10%, 30 year and LTV≤95%	2011-35

Effective Date	Upfront Premium	Annualized Monthly Premium	Mortgagee Letter
	Mortgages, Full-Credit Qualifying Refinances, and Streamline Refinances	1.15%, 30 year and LTV>95% 0.50%, 15 year and LTV>90% 0.25%, 15 year and 78%<LTV≤90% 0%, 15 year and LTV≤78%	
April 2012	1.75%, Purchase Money Mortgages and Full-Credit Qualifying Refinances; 1.00%, Streamline Refinances	1.20%, 30 year and LTV≤95% 1.25%, 30 year and LTV>95% 0.60%, 15 year and LTV>90% 0.35%, 15 year and 78%<LTV≤90% 0%, 15 year and LTV≤78%	2012-4
June 2012	1.75%, Purchase Money Mortgages and Full-Credit Qualifying Refinances; 0.01%, Streamline Refinances endorsed on or before May 31, 2009	0.25%, increase for loans exceeding \$625,000; 0.55%, Streamline Refinances endorsed on or before May 31, 2009	2012-4
April 2013	1.75%, Purchase Money Mortgages and Full-Credit Qualifying Refinances; 0.01%, Streamline Refinances endorsed on or before May 31, 2009	30 year 1.30% ≤ \$625,500 LTV ≤ 95.00% 1.35% ≤ \$625,500 LTV > 95.00% 1.50% > \$625,500 LTV ≤ 95.00% 1.55% > \$625,500 LTV > 95.00% 15 year 0.45% ≤ \$625,500 LTV 78.01% - 90.00% 0.70% ≤ \$625,500 LTV > 90.00% 0.70% > \$625,500 LTV 78.01% - 90.00% 0.95% > \$625,500 LTV > 90.00% 0.45%, LTV ≤ 78.00 % 0.55%, Streamline Refinances endorsed on or before May 31, 2009	2013-04

Source: FHA



## Claims

Claim rates are forecast using the Forward Model discussed previously in this review. The cash flow components for claims are consolidated into two types: PFS and REO. The expected amount of claims for PFS claim types is calculated as:

### Equation 27

$$Claim_{PFS}(t) = P_c(t) * P_{PFS}(t) * L_{PFS}(t) * Claim_{UPB}(t)$$

Where the expected PFS claim dollars for a given period  $t$  are denoted as the product of the claim hazard rate, the PFS claim rate, the PFS loss severity rate, and the claim UPB for the period.

The expected amount of claims for REO claim types is calculated as:

### Equation 28

$$Claim_{REO}(t) = P_c(t) * P_{REO}(t) * Claim_{UPB}(t)$$

Where the expected REO claim dollars for a given period  $t$  are denoted as the product of the claim hazard rate, the REO claim rate, and the claim UPB for that period.

Unlike the PFS claim calculation, the REO calculation does not employ the LSR, which also is used in the recovery calculation. This captures the difference in the time value of claim and recovery dollars for REO claims versus PFS claims.

## Forecasting Loss Severity Rates/Recoveries

During a property acquisition, FHA receives the property from a borrower, and the servicer submits a claim to FHA, which includes the UPB, lost interest, administrative costs of foreclosure, and any other approved costs. FHA then pays costs associated with property upkeep until sale. The recovery comes when the property is sold to a second buyer, and FHA receives payment net of the property sale expenses. This recovery is calculated as follows:

### Equation 29

$$Recoveries_{REO}(t + s) = Claim_{REO}(t) * (1 - L_{REO}(t))$$

The expected recovery for period  $(t+s)$ , with  $s$  being the lag in quarters between REO claim (i.e. property acquisition) and recovery (i.e. property disposition), is the expected REO claim for period  $t$  multiplied by one minus the REO loss severity rate.

## Loss Mitigation Programs

FHA has several loss mitigation options available to borrowers to cure a default episode and avoid foreclosure. Four of the most common loss mitigation options are:

**Forbearance:** As a loss mitigation effort to cure a default episode, the servicer and borrower form a written or oral agreement to reduce or suspend mortgage payments for a mortgage that is delinquent by 90 days or more.

**Special Forbearance:** As a loss mitigation effort to cure a default episode resulting from unemployment, the servicer and borrower form a written agreement to reduce or suspend mortgage payments for at least 12 months for a mortgage that is delinquent by 90 days or more.

**Mortgage Modification:** As a loss mitigation effort to cure a default episode, the servicer may modify the terms and reinstate a mortgage in order to make the payments more affordable for the borrower.

**Partial Claim:** As a loss mitigation effort to cure a default episode, the servicer may advance funds to a borrower's delinquent mortgage account to bring the loan current. In exchange, the servicer makes a partial claim to FHA.

Summit & Milliman forecast loss mitigation separately for HAMP modifications (which are estimated separately as discussed above) and all other loss mitigation programs.

For HAMP modifications, loss mitigation costs are estimated as the sum of the incentive payment from FHA (generally \$1,000 for all incentive payments) and the partial claim cost. The partial claim cost is estimated as a percent of the original mortgage amount and is applied only to HAMP modifications that result in a claim. Summit & Milliman estimates the average partial claim payment on a HAMP modification to be 12.5% of the original mortgage amount. This assumption is based on recent experience.

All other loss mitigation costs are estimated as a percentage of new serious delinquencies in each period. New serious delinquencies were forecast using data provided by FHA and the Stage 1 model described in this document. The loss mitigation cost factor is equal to the product of the lost mitigation rate and loss mitigation cost, which were developed from recent experience. Formulaically,

**Equation 30**

$$\text{Loss Mitigation}_t = \text{New Serious Delinquencies}_{t-s} * \text{Loss Mitigation Rate} * \text{Loss Mitigation Cost}$$

The lost mitigation rate represents the lifetime percent of mortgages that are ever 90 days delinquent and receive a loss mitigation claim expense; Summit & Milliman assumes this rate is 25% of ever 90 day delinquencies. The loss mitigation cost represents the average cost of a loss mitigation claim expense, expressed as a percent of the original mortgage amount; Summit & Milliman assumes this rate is 1.0% of the original mortgage amount. These assumptions were developed from a review of recent loss mitigation experience, with a focus on loss mitigation activity in calendar year 2013 under the loss mitigation waterfall described in ML 2012-22.

### Premium Refund Payments

Upfront premiums are considered to be earned in the first five to seven years that a mortgage is outstanding. As a result, some mortgages that refinance qualify for a refund of the prorated upfront fee. The forecast of this refund is calculated as follows:

#### Equation 31

$$= P_{NCT} * \text{Upfront Premium Pmt} * \text{Refund Rate}(t) * \text{FHA} - \text{to} - \text{FHA Refinance Factor}$$

The refund payment for a given period is the product of the original upfront fee, the conditional probability of refinance, the refund rate, and the estimated percent of mortgages that refinance from an existing FHA loan to another FHA loan.

Historical refund rates are derived directly from all applicable FHA Mortgagee Letters. Future endorsement cohorts follow the specific policy outlined by Mortgagee Letter 2005-03, which eliminated the refund of the upfront MIP, except in cases when the borrower refinances to another FHA-insured mortgage.<sup>23</sup>

The FHA-to-FHA refinance factor is assumed to be 35% based on historical data.

### Discounting Methodology and Assumptions

The economic value of the MMI Fund is calculated by discounting the cash flow components, described in prior sections, to an NPV, which is added to the current capital resources of the fund. To calculate the NPV, each cash flow component is discounted at the cohort-level, using a set of PV factors. These PV factors are derived from the same weighted average discount rates, or SERs.

The methodology described in this section was used to calculate PV factors. FHA provided Summit & Milliman with the latest SERs, calculated as of the close of FY 2013. The SERs provided by FHA are listed in the following table.

<sup>23</sup> ML 2005-03 allows refund credits from FHA to FHA refinances up to a three year period.

**Table 24: FHA Single Effective Rates (SERs), 1992-2013**

Endorsement Year Cohort	SER
1992	7.36%
1993	6.68%
1994	6.86%
1995	7.22%
1996	6.80%
1997	6.59%
1998	5.93%
1999	5.93%
2000	6.20%
2001	6.12%
2002	5.48%
2003	4.76%
2004	3.71%
2005	2.33%
2006	4.55%
2007	4.61%
2008	4.88%
2009	4.47%
2010	1.67%
2011	3.73%
2012	2.04%
2013	2.40%

Source: FHA

SERs were not available for endorsement year cohorts 1983 through 1991, but were back cast using a linear regression model. The SER represents the average long-run cost of money for the forward portfolio, so the predicted rate likely will change in concert with movements in the 30 year CMT rate.

The 30 year CMT rate was discontinued between 2003 and 2005, so historical data are not available for those years. As a proxy, these missing values were replaced with the 30 year interest rates listed for FY 2003 through FY 2005 in the Office of Management and Budget’s (OMB’s) Credit Subsidy Calculator 2 (CSC2; version 1.4.4b, released November 2012).

To model the relationship between the SER and the proxy-adjusted CMT, Summit & Milliman developed a linear regression model with four variables. First, an implied interest rate was created by merging the 30 year CMT rate for 1983-2002 and 2006-2012 (2013 SER was not available at the time of estimation) with the 30 year CSC2 rate for 2003-2005. Second, a dummy variable was used to mark the years in which the CSC2 rate was used as a proxy for the CMT

rate. Third, an interaction term between the proxy rate and the CMT rate was used to isolate the impact of the proxy. Fourth, a dummy variable was employed to model the unique experience of FY 2010, which saw an unusually large drop in interest rates.

The model is expressed as shown in Equation 31, where  $i$  represents the proxy-adjusted interest rate,  $p$  represents the proxy indicator,  $x$  represents the interaction of  $p$  and  $i$ , and  $y$  represents the dummy variable for FY 2010:

**Equation 32**

$$SER = \beta_1 i + \beta_2 p + \beta_3 x + \beta_4 y + \varepsilon$$

The regression results show a highly significant positive correlation between the SER and the applied 30 year CMT. These coefficients are used to predict SER values for endorsement year cohorts 1983 through 1991, as shown in the following table.

**Table 25: Predicted Single Effective Rate (SER) Values, 1983-1991**

Endorsement Year Cohort	SER
1983	11.06%
1984	12.57%
1985	11.34%
1986	8.47%
1987	8.20%
1988	9.09%
1989	8.77%
1990	8.51%
1991	8.36%

Source: Summit & Milliman

Quarterly discount rates are derived from each actual and predicted SER, using the standard conversion formula:

**Equation 33**

$$\text{Quarterly Discount Rate} = (1 + \text{Single Effective Rate})^{\frac{1}{4}} - 1$$

PV factors are calculated using the following equation, where *n* represents the number of discounted periods (given in quarters):

**Equation 34**

$$\text{Quarterly PV Factor} = 1 / (1 + \text{Quarterly Discount Rate})^n$$

For mortgages endorsed in the FY 2014 cohort, the CSC2 (version 1.4.4b, released November 2012) is used to calculate PV factors, based upon the discount rate assumptions in the President’s Budget Year 2014.

In the absence of updated budget assumptions for FY 2015 through FY 2020, it is necessary to derive future PV factors not produced by the CSC2. This derivation is done by fixing the 2014 PV factors for the first economic valuation year. The derivation for subsequent valuation years is conducted as shown in the following equation, the PV factor for evaluation period *t*, when estimating the economic value for period *y* is the present value factor for period *t* divided by the present value factor for period end *y*.

**Equation 35**

$$PV(t, y) = \frac{PV(t)}{PV(y)}$$

The following table contains a sample of the present value factors, as calculated from the prior equation, by evaluation and end periods.

**Table 26: Derived Future Present Value Factors for Selected Evaluation Periods**

Evaluation Period	Credit Subsidy Cohorts	Present Value Factor 2014 End	Present Value Factor 2015 End	Present Value Factor 2016 End	Present Value Factor 2017 End	Present Value Factor 2018 End	Present Value Factor 2019 End	Present Value Factor 2020 End
2015q1	2014-15	0.9997	1.0017	1.0057	1.0164	1.0356	1.0627	1.0935
2015q2	2014-15	0.9992	1.0012	1.0052	1.0159	1.0351	1.0621	1.0929
2015q3	2014-15	0.9986	1.0006	1.0046	1.0153	1.0345	1.0615	1.0923
2015q4	2014-15	0.9980	1.0000	1.0040	1.0146	1.0339	1.0609	1.0916
2016q1	2014-16	0.9971	0.9991	1.0031	1.0138	1.0330	1.0600	1.0907
2016q2	2014-16	0.9962	0.9982	1.0022	1.0128	1.0320	1.0590	1.0897
2016q3	2014-16	0.9951	0.9971	1.0011	1.0117	1.0309	1.0578	1.0885
2016q4	2014-16	0.9940	0.9960	1.0000	1.0106	1.0298	1.0566	1.0873
2017q1	2014-17	0.9919	0.9939	0.9979	1.0084	1.0276	1.0544	1.0850
2017q2	2014-17	0.9897	0.9917	0.9956	1.0062	1.0253	1.0520	1.0825
2017q3	2014-17	0.9867	0.9887	0.9927	1.0032	1.0222	1.0489	1.0793
2017q4	2014-17	0.9836	0.9856	0.9895	1.0000	1.0190	1.0456	1.0759
2018q1	2014-18	0.9796	0.9815	0.9855	0.9959	1.0148	1.0413	1.0715
2018q2	2014-18	0.9754	0.9773	0.9812	0.9916	1.0104	1.0368	1.0668
2018q3	2014-18	0.9704	0.9724	0.9763	0.9866	1.0053	1.0316	1.0614
2018q4	2014-18	0.9653	0.9672	0.9711	0.9814	1.0000	1.0261	1.0558
2019q1	2014-19	0.9596	0.9615	0.9653	0.9756	0.9941	1.0200	1.0496
2019q2	2014-19	0.9537	0.9556	0.9594	0.9696	0.9880	1.0138	1.0431
2019q3	2014-19	0.9473	0.9492	0.9530	0.9631	0.9813	1.0070	1.0361
2019q4	2014-19	0.9407	0.9426	0.9464	0.9564	0.9746	1.0000	1.0290
2020q1	2014-20	0.9342	0.9361	0.9398	0.9498	0.9678	0.9931	1.0218
2020q2	2014-20	0.9276	0.9294	0.9332	0.9430	0.9609	0.9860	1.0146
2020q3	2014-20	0.9210	0.9228	0.9265	0.9363	0.9541	0.9790	1.0073
2020q4	2014-20	0.9142	0.9161	0.9197	0.9295	0.9471	0.9718	1.0000

Source: Summit & Milliman forecasts

Net cash inflows and outflows to FHA are multiplied by the corresponding PV factors for each cash flow period to calculate the NPV for each cohort. The sum of the NPV for each cohort is added to the existing capital resources of the MMI Fund and the annual return on investment (ROI) of the MMI Fund. Capital resources refer to the starting fund balance at the beginning of the fiscal year, and the ROI on the MMI Fund is the annual interest accrued on the start-of year Fund balance, which is calculated using the quarterly discount rates implied by the PV factors for each year.

Thus, the economic value can be summarized as follows:

**Equation 36**

$$EV = \text{Capital Resources} + ROI \text{ on Fund} + NPV \text{ of Future Cash Flows}$$

**Return on Investment**

As a generalization of projected fiscal year activities, FY 2013 capital resources may be assigned an ROI. This ROI calculation applies continuous compounding using Moody’s Analytics 1 year CMT forecast rates and assumes net gains from investment, income, property, and accounts are averaged out by the forecast interest rate. The rates are calculated as averages of the quarterly 1 year CMT rates over the projected fiscal year.

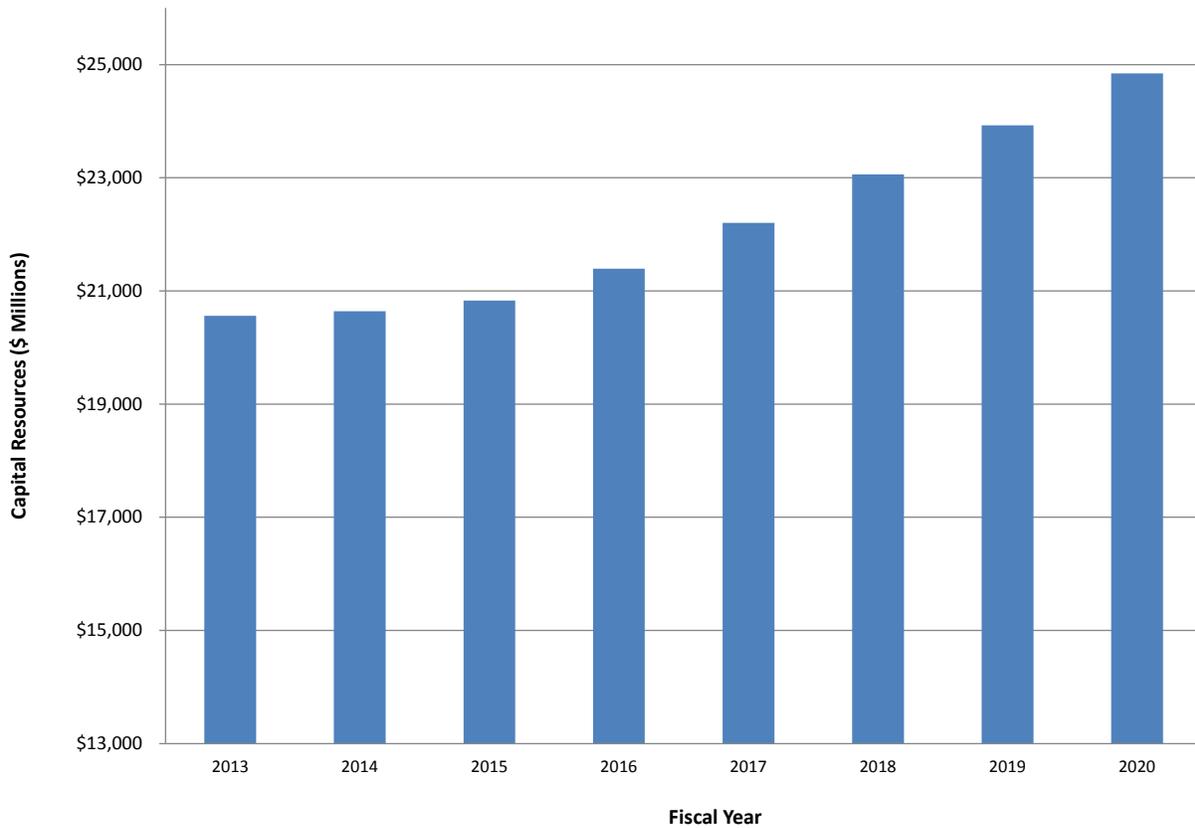
**Table 27: Fiscal Year Average of Moody’s Analytics 1 year CMT Rate Forecast**

Fiscal Year	1yr CMT
2013	0.18%
2014	0.39%
2015	0.90%
2016	2.67%
2017	3.73%
2018	3.77%
2019	3.70%
2020	3.76%

Source: Moody's Analytics

If the FY 2013 capital resources were reinvested each subsequent fiscal year at the interest rates given in the above table, overall growth would reach 21% by FY 2020. The average annual return on invested capital resources is presented in the next figure.

Figure 26: Return on Investment of FY 2013 Capital Resources (\$ Millions)



Source: Summit & Milliman forecasts

Under the aforementioned assumptions, FY 2013 capital resources of \$20.6 billion would grow to \$24.8 billion by FY 2020.

## Appendix E: Technical Details of Forward Volume Demand Model

Summit & Milliman developed a Volume Demand Model to project market mortgage originations and FHA insurance activity for the next seven years. Using industry, economic, and FHA data, Summit & Milliman forecast dollar volumes of future FHA market share, as a proportion of the future market for mortgage originations for purchase and refinanced mortgages. The future dollar volumes of FHA endorsements were used to carry out the economic valuation of the MMI Fund for forward mortgages.

The historical nature of FHA market share of purchases and refinances is charted visually in the following figures.

**Figure 27: FHA Market Share of Total Purchase Originations**

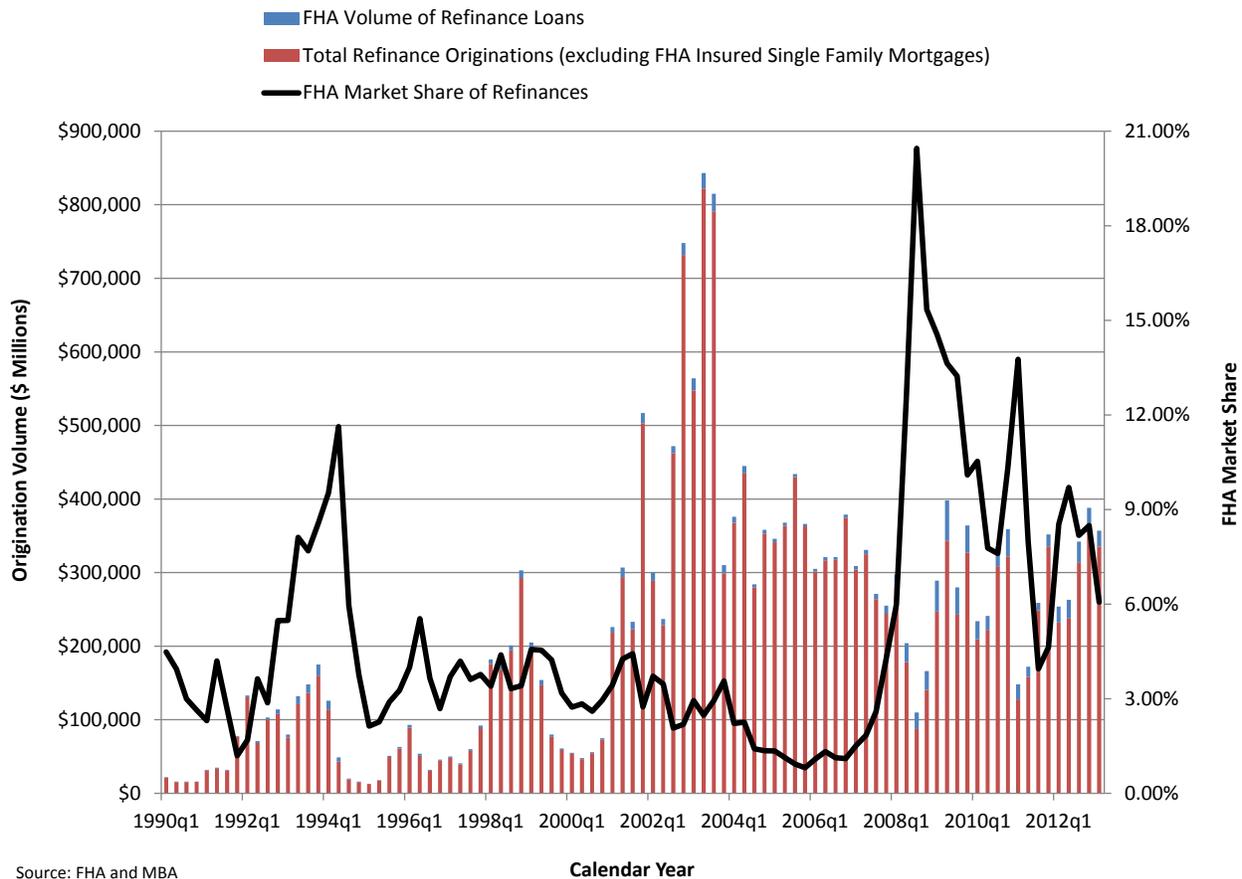
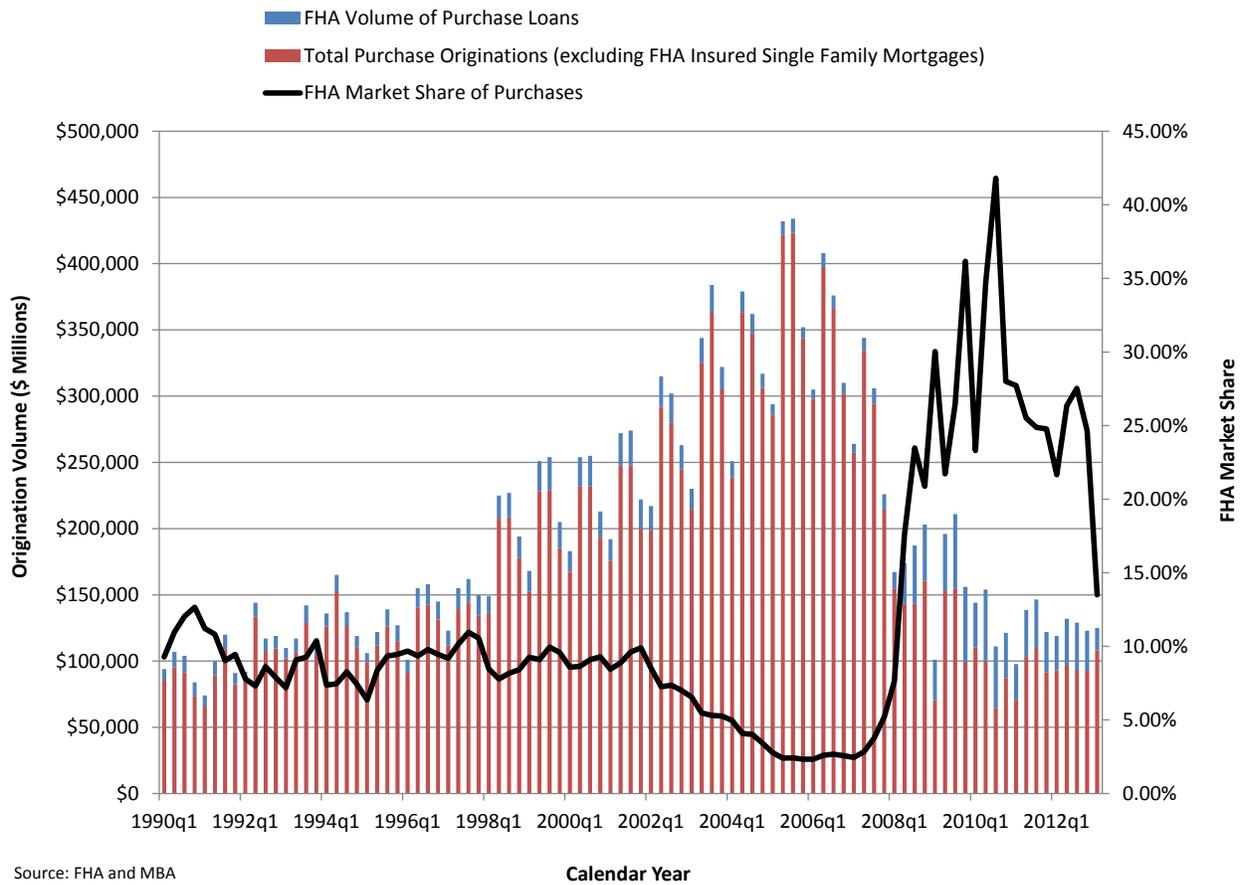


Figure 28: FHA Market Share of Total Refinance Originations



Source: FHA and MBA

Two sets of models were estimated to capture the different dynamics of mortgage originations according to type: (1) FHA dollar share of market originations for purchase mortgages and (2) FHA dollar share of market originations for refinance mortgages. The sum of (1) and (2) represent the total FHA dollar share of total mortgage originations. In the previous figures, the difference in stochastic structure of the dollar volume time series for purchase and refinance mortgages is clear. The differences in patterns are best approached using differentiated covariates for each volume forecast equation.

The frameworks used for the FHA Market Share and Mortgage Volume models are summarized in the following figures. Each set of models is comprised of two forecast equations, using time series methods to first forecast dollar volumes for mortgage originations by type and then forecast FHA’s market share of the dollar volume. Summit & Milliman postulated that dependent variables for volumes and FHA market shares are motivated by time series regimes (either policy periods or patterns of boom/bust in the market), lagged values of the dependent variable, HPA, movements of mortgage rates, premium spreads between alternative insurance providers, and interest rate spreads between securities in the secondary market. These factors influence best execution pricing and delivery for mortgage loans. The sources of data available



to develop this model include FHA, CoreLogic, the Mortgage Bankers Association (MBA), and Moody's Analytics.

The four forecast equations are fitted with exogenous input (ARMAX), using an autoregressive moving average process, to forecast projections for:

- Dollar Value of Market Originations for Purchase Mortgages
- FHA Share of Purchase Volumes
- Dollar Value of Market Originations for Refinance Mortgages
- FHA Share of Refinance Volumes

The forecast for market originations for purchase and refinance mortgages then can be further informed by weighting it (i.e. incorporating adjustments) based on alternative volume forecasts for purchase and refinance mortgages sourced from Moody's Analytics, Fannie Mae, or the MBA.

Figure 29: Estimation Framework for FHA Dollar Share of Purchase Volumes

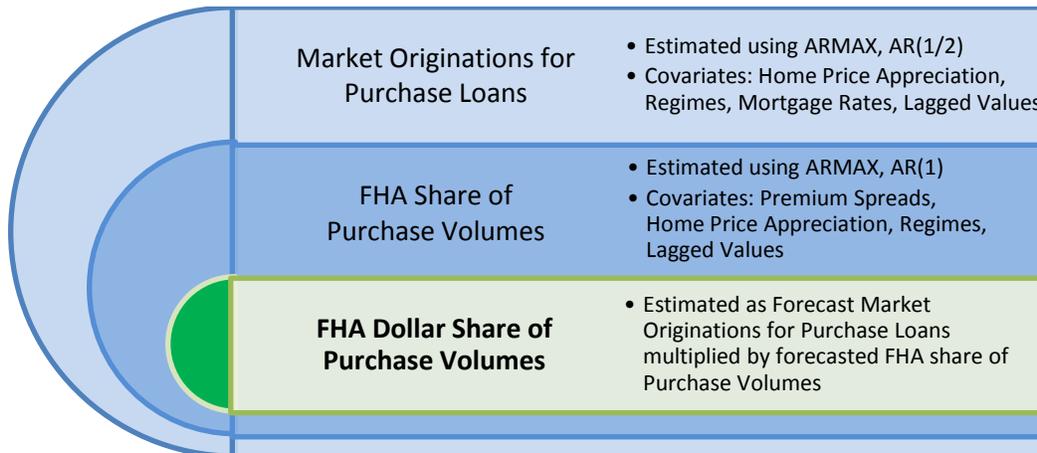
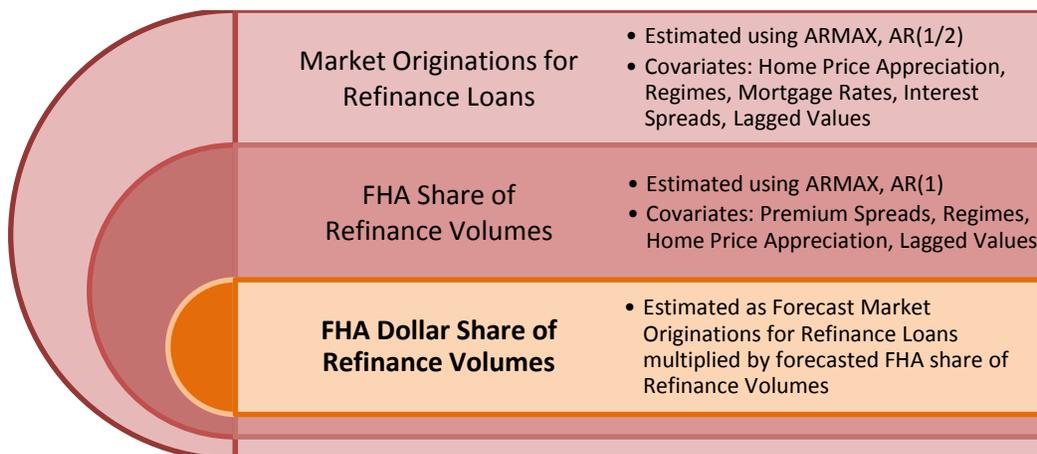


Figure 30: Estimation Framework for FHA Dollar Share of Refinance Volumes



The covariates used in the model are defined in the following table. Different lag structures for these covariates were considered, and variable selection was based on a variable’s predictive ability, graphical examination of model fit, and the impact that a variable’s inclusion has on information criterion statistics. Alternate time spans for growth rates also were considered (e.g., percent change in HPI over a one year period, percent change in HPI over a six-month period, and so on, as well as plausible combinations of these growth rates and their lags). The number of autoregressive and moving average lags for each forecast equation were selected by examining the autocorrelation and partial autocorrelation functions of each dependent variable. An augmented Dickey-Fuller test was performed on the model residuals for each forecast equation in order to ensure stationarity of model errors. The forecasts were evaluated using out-of-time testing for 2012 Q1 through 2013 Q1. In addition, the fit was examined both graphically and through forecast evaluation measures, including mean forecast error and root mean squared deviation.

**Table 28: Variable Names and Definitions in Forecast Equations**

Forecast Equation	Variable Name	Lag (Quarters)	Variable Definition
<b>Market Originations for Purchase Loans</b>	qtr2-qtr4	-	Binary indicator for calendar quarters 2, 3, and 4
	regimepost08q1	-	Binary indicator for dates greater than or equal to 2008q1
	PurchHPA	1	Purchase-only home price appreciation (% change in HPI from last quarter), lagged 1 quarter
	Dthirtyyr_fixedmort	-	1 quarter difference in the 30 year fixed mortgage rate
<b>FHA share of Purchase Volumes</b>	qtr2-qtr4	-	Binary indicator for calendar quarters 2, 3, and 4
	PurchHPA	3	Purchase-only home price appreciation (% change in HPI from last quarter), lagged 3 quarters
	Dcomp_spread_minyr	-	1 quarter difference between the FHA monthly premium (measured as the highest premium charged by FHA) and the private market monthly premium
<b>Market Originations for Refinance Loans</b>	qtr2-qtr4	-	Binary indicator for calendar quarters 2, 3, and 4

Forecast Equation	Variable Name	Lag (Quarters)	Variable Definition
	regime01q2to08q1	-	Binary indicator for dates greater than 2001q2 and less than or equal to 2008q1
	regimepost08q2	-	Binary indicator for dates greater than or equal to 2008q2
	HPA2	3	Home price appreciation (6-month % change in HPI), lagged 3 quarters
	Dspread	-	1 quarter difference in the spread between 10-Yr and 1-Yr Constant Maturity Securities
	Dthirtyyr_fixedmort	-	1 quarter difference in the 30 Year Fixed Mortgage Rate
<b>FHA share of Refinance Volumes</b>	qtr2-qtr4	-	Binary indicator for calendar quarters 2, 3, and 4
	regime01q3to08q1	-	Binary indicator for dates greater than 2001q3 and less than or equal to 2008q1
	HPA4	4	Home price appreciation (1 year % change in HPI), lagged 4 quarters
	Dcomp_spread_minyr	-	1 quarter difference between the FHA monthly premium (measured as the highest premium charged by FHA) and the private market monthly premium

Source: Summit & Milliman

### Forecast Results

When alternate forecasts were available, an average of Summit & Milliman’s projections and other available projections were used. For quarters with no available alternate forecasts, the projections produced by Summit & Milliman’s model were used. For 2014 Q1 through 2015 Q1, a blended forecast of projections from the MBA, Fannie Mae, and Summit & Milliman was used. The resulting FHA dollar volume for endorsements in FY 2014 through FY 2020 is summarized in the following table.

**Table 29: FHA Volume by Fiscal Year (\$ Billions)**

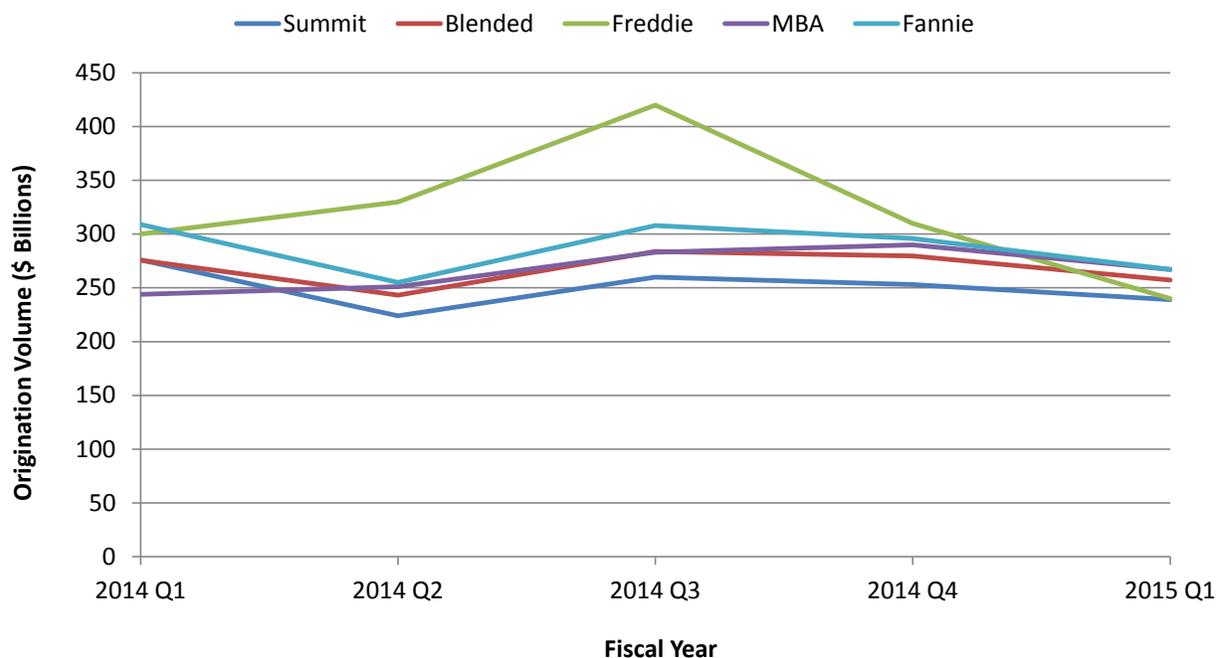
Fiscal Year	Total FHA Volume	FHA Market Share
2014	118	10.9%
2015	107	11.0%
2016	103	11.4%
2017	107	11.1%
2018	116	11.1%
2019	123	10.9%
2020	133	10.8%

Source: Summit & Milliman forecasts

FHA dollar volumes for 2013 consist of actuals through July and forecasts for August and September, provided by FHA. For model estimation, actuals for FY 2013 Q1 and forecasts based on volumes from December through February were used for FY 2013 Q2.

A comparison of Summit & Milliman’s total mortgage market forecast and those produced by the MBA, Freddie Mac, and Fannie Mae for 2014 Q1 through 2015 Q1 are shown in the following figures and tables. The magnitude and trend of Summit & Milliman’s total market volume forecasts are similar to the benchmark forecasts over this period. The blended forecast represents the average of MBA, Fannie Mae, and Summit & Milliman projections in each quarter.

**Figure 31: Comparative Forecasts of Total Market Originations**



Source: Fannie Mae, Freddie Mac, MBA and Summit & Milliman forecasts

**Table 30: Forecast Comparison of Purchase and Refinance Originations (\$ Billions)**

FY Quarter	Purchases				Refinances			
	Fannie	MBA	Summit	Blended	Fannie	MBA	Summit	Blended
2014 Q1	153	132	148	144	155	112	127	131
2014 Q2	131	146	132	136	124	105	92	107
2014 Q3	204	181	180	188	104	102	81	96
2014 Q4	204	194	183	194	92	96	70	86
2015 Q1	180	182	162	175	86	85	77	83

Source: Fannie Mae, Freddie Mac, MBA and Summit & Milliman forecasts

**Table 31: Forecast Comparison of Total Market Originations (\$ Billions)**

FY Quarter	Fannie	MBA	Freddie	Summit	Blended
2014 Q1	309	244	300	276	276
2014 Q2	255	251	330	224	243
2014 Q3	308	283	420	260	284
2014 Q4	296	290	310	253	280
2015 Q1	267	267	240	239	257

Source: Fannie Mae, Freddie Mac, MBA and Summit & Milliman forecasts

### Assumptions for Future FHA Volumes

The second quarter of FY 2013 is used to represent future cohorts for FY 2014 through FY 2020. A factor is applied at the cohort-level to adjust the dollar volume of endorsements to equal the dollar volume of endorsements, as predicted by the volume model for each future cohort.

### Economic Assumptions for Future Endorsement Cohorts

Summit & Milliman’s economic assumptions related to the HPI and interest rates were used as the basis for all forecasts. Summit & Milliman elected to use the Moody’s Analytics forecasts of the state- and MSA-level HPI to determine HPI at the time of mortgage origination, as well as Moody’s Analytics forecasts for 30 year mortgage and London Interbank Offered Rate (LIBOR) rates, to compute initial interest rates on mortgages at the time of endorsement. Moody’s Analytics forecasts contained values up to 2043 Q4; all evaluation quarters beyond 2043 Q4 use the most recent forecast values. Summit & Milliman also used Moody’s Analytics forecast for 30 year mortgage and LIBOR rates to compute initial interest rates on mortgages at the time of determination.

## Appendix F: Historical and Forecast Results

**Federal Housing Administration  
Mutual Mortgage Insurance Fund  
All Mortgages - Cumulative Claim Rates**

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	0.02	0.65	2.40	4.69	7.41	9.87	11.63	12.72	13.50	14.10	14.50	14.81	15.00	15.12	15.23	15.30	15.36	15.39	15.42	15.44	15.45	15.46	15.47	15.47	15.48	15.48	15.48	15.48	15.49	15.49
1984	0.05	1.29	4.46	8.45	11.86	14.20	15.57	16.54	17.24	17.76	18.12	18.35	18.53	18.69	18.79	18.86	18.91	18.95	18.98	19.00	19.01	19.02	19.03	19.03	19.03	19.04	19.04	19.04	19.04	19.05
1985	0.05	1.06	4.07	7.51	10.04	11.81	13.12	14.11	14.81	15.30	15.64	15.86	16.03	16.18	16.28	16.35	16.40	16.43	16.45	16.47	16.48	16.49	16.49	16.50	16.51	16.51	16.52	16.52	16.53	16.54
1986	0.04	0.71	2.41	4.29	5.92	7.31	8.45	9.36	10.06	10.58	10.97	11.30	11.54	11.72	11.84	11.92	11.97	12.02	12.05	12.06	12.08	12.09	12.09	12.10	12.11	12.12	12.13	12.14	12.16	12.17
1987	0.05	0.60	1.76	3.07	4.33	5.47	6.43	7.21	7.81	8.28	8.71	9.04	9.27	9.43	9.52	9.59	9.65	9.69	9.72	9.73	9.74	9.75	9.77	9.78	9.79	9.80	9.81	9.84	9.85	9.86
1988	0.04	0.54	1.73	3.25	4.76	6.03	7.06	7.84	8.41	8.89	9.27	9.55	9.74	9.85	9.94	10.01	10.06	10.09	10.11	10.13	10.14	10.15	10.17	10.18	10.20	10.22	10.25	10.26	10.27	10.28
1989	0.03	0.51	1.77	3.33	4.81	6.05	6.98	7.69	8.27	8.71	9.02	9.23	9.37	9.46	9.55	9.60	9.64	9.66	9.68	9.70	9.72	9.74	9.76	9.77	9.79	9.83	9.84	9.85	9.86	9.86
1990	0.02	0.47	1.70	3.21	4.50	5.43	6.10	6.70	7.15	7.46	7.67	7.80	7.90	7.97	8.03	8.07	8.10	8.12	8.14	8.16	8.18	8.20	8.21	8.23	8.26	8.28	8.29	8.29	8.30	8.30
1991	0.02	0.44	1.54	2.76	3.77	4.57	5.31	5.86	6.24	6.52	6.68	6.80	6.89	6.95	6.99	7.02	7.04	7.06	7.08	7.10	7.12	7.14	7.16	7.20	7.23	7.24	7.24	7.25	7.26	7.26
1992	0.02	0.30	1.02	1.85	2.70	3.56	4.29	4.82	5.17	5.38	5.54	5.64	5.71	5.75	5.78	5.81	5.83	5.85	5.87	5.89	5.91	5.94	5.98	6.01	6.02	6.03	6.03	6.04	6.04	6.05
1993	0.01	0.25	0.85	1.65	2.61	3.44	4.07	4.47	4.70	4.87	5.00	5.08	5.13	5.16	5.18	5.20	5.22	5.25	5.27	5.29	5.32	5.38	5.40	5.42	5.43	5.43	5.44	5.44	5.45	5.45
1994	0.02	0.33	1.08	2.17	3.26	4.09	4.65	4.97	5.22	5.39	5.50	5.57	5.62	5.65	5.68	5.71	5.75	5.78	5.81	5.84	5.92	5.95	5.97	5.98	5.99	6.00	6.01	6.01	6.02	6.02
1995	0.02	0.42	1.72	3.52	5.05	6.07	6.74	7.24	7.66	7.92	8.07	8.18	8.24	8.31	8.37	8.45	8.50	8.55	8.61	8.72	8.77	8.80	8.82	8.84	8.85	8.86	8.87	8.88	8.89	8.89
1996	0.01	0.46	1.87	3.55	4.82	5.67	6.35	6.88	7.22	7.41	7.54	7.63	7.71	7.79	7.88	7.94	8.01	8.09	8.22	8.29	8.32	8.35	8.36	8.38	8.39	8.40	8.41	8.42	8.43	8.44
1997	0.02	0.53	1.89	3.31	4.39	5.33	6.04	6.48	6.77	6.94	7.07	7.17	7.27	7.38	7.46	7.54	7.64	7.80	7.88	7.92	7.95	7.97	7.99	8.01	8.02	8.03	8.04	8.05	8.06	8.07
1998	0.02	0.46	1.47	2.47	3.44	4.31	4.86	5.21	5.43	5.59	5.73	5.87	6.01	6.12	6.24	6.35	6.56	6.66	6.72	6.76	6.79	6.81	6.83	6.85	6.87	6.88	6.89	6.91	6.92	6.92
1999	0.02	0.44	1.40	2.70	3.99	4.84	5.36	5.68	5.91	6.09	6.27	6.46	6.62	6.78	6.93	7.19	7.32	7.40	7.46	7.50	7.53	7.57	7.59	7.62	7.64	7.66	7.67	7.69	7.70	7.71
2000	0.02	0.62	2.30	4.27	5.55	6.29	6.74	7.05	7.32	7.55	7.78	7.95	8.12	8.28	8.54	8.68	8.77	8.82	8.87	8.91	8.94	8.97	8.99	9.02	9.03	9.05	9.07	9.08	9.09	9.10
2001	0.02	0.59	2.14	3.57	4.53	5.12	5.54	5.88	6.20	6.52	6.78	7.03	7.25	7.61	7.80	7.92	8.01	8.08	8.14	8.19	8.23	8.27	8.30	8.33	8.36	8.38	8.40	8.42	8.43	8.45
2002	0.02	0.67	1.98	3.12	3.92	4.50	4.98	5.45	5.93	6.30	6.68	7.02	7.53	7.82	8.01	8.15	8.26	8.36	8.44	8.52	8.58	8.64	8.68	8.73	8.77	8.80	8.83	8.86	8.88	8.90
2003	0.05	0.77	1.84	2.77	3.52	4.23	4.96	5.76	6.42	7.13	7.73	8.60	9.12	9.47	9.75	9.98	10.18	10.36	10.51	10.65	10.76	10.87	10.96	11.04	11.11	11.17	11.23	11.28	11.33	11.36
2004	0.19	1.05	2.26	3.47	4.66	5.86	7.13	8.13	9.25	10.16	11.49	12.29	12.86	13.31	13.69	14.01	14.30	14.54	14.76	14.95	15.12	15.27	15.40	15.51	15.61	15.71	15.79	15.86	15.92	15.97
2005	0.12	1.04	2.75	4.71	6.86	9.08	10.82	12.78	14.35	16.53	17.89	18.84	19.62	20.27	20.85	21.35	21.79	22.18	22.51	22.81	23.07	23.30	23.51	23.69	23.85	24.00	24.13	24.24	24.34	24.42
2006	0.09	1.15	3.43	6.44	9.65	12.09	14.75	16.89	19.67	21.36	22.52	23.46	24.25	24.93	25.53	26.06	26.51	26.92	27.27	27.58	27.86	28.10	28.32	28.51	28.68	28.84	28.98	29.10	29.22	29.31
2007	0.09	1.51	4.58	8.39	11.08	14.58	17.70	21.21	23.27	24.66	25.76	26.68	27.47	28.17	28.77	29.30	29.77	30.17	30.53	30.85	31.13	31.38	31.60	31.80	31.97	32.13	32.28	32.41	32.52	32.62
2008	0.07	1.20	3.99	6.44	9.82	12.94	16.45	18.48	19.83	20.88	21.75	22.51	23.17	23.75	24.26	24.71	25.10	25.44	25.75	26.01	26.25	26.46	26.65	26.82	26.97	27.11	27.23	27.35	27.45	27.54
2009	0.05	0.75	1.97	3.89	5.84	8.18	9.63	10.64	11.47	12.18	12.81	13.37	13.86	14.30	14.68	15.02	15.32	15.59	15.82	16.03	16.21	16.38	16.52	16.66	16.77	16.88	16.98	17.07	17.15	17.21
2010	0.03	0.33	1.16	2.21	3.73	4.75	5.53	6.22	6.83	7.38	7.87	8.32	8.72	9.07	9.39	9.66	9.91	10.13	10.32	10.49	10.64	10.78	10.90	11.01	11.11	11.19	11.27	11.35	11.41	11.47
2011	0.03	0.32	0.84	1.72	2.36	2.90	3.39	3.84	4.25	4.62	4.95	5.25	5.52	5.76	5.97	6.15	6.32	6.46	6.59	6.70	6.80	6.89	6.98	7.05	7.11	7.17	7.23	7.28	7.32	7.36
2012	0.02	0.20	0.65	1.10	1.57	2.04	2.50	2.93	3.32	3.68	4.00	4.29	4.54	4.77	4.97	5.15	5.31	5.45	5.57	5.68	5.78	5.87	5.95	6.02	6.08	6.14	6.19	6.24	6.28	6.32
2013	0.02	0.20	0.57	1.07	1.63	2.21	2.77	3.29	3.76	4.19	4.58	4.92	5.23	5.51	5.75	5.96	6.15	6.32	6.48	6.61	6.73	6.84	6.93	7.02	7.10	7.17	7.23	7.29	7.35	7.39
2014	0.00	0.12	0.44	0.93	1.50	2.10	2.68	3.23	3.73	4.18	4.59	4.95	5.27	5.56	5.82	6.04	6.25	6.42	6.58	6.73	6.85	6.97	7.07	7.16	7.24	7.31	7.38	7.44	7.50	7.55
2015	0.00	0.12	0.46	0.97	1.58	2.21	2.82	3.40	3.93	4.41	4.84	5.23	5.57	5.88	6.14	6.38	6.59	6.78	6.94	7.09	7.22	7.34	7.44	7.54	7.62	7.70	7.77	7.83	7.89	7.95
2016	0.00	0.12	0.46	0.98	1.59	2.23	2.85	3.43	3.95	4.43	4.85	5.23	5.56	5.85	6.11	6.33	6.53	6.71	6.86	7.00	7.13	7.24	7.34	7.43	7.51	7.58	7.65	7.71	7.76	7.81
2017	0.00	0.12	0.46	0.97	1.57	2.20	2.80	3.36	3.88	4.35	4.76	5.14	5.46	5.75	6.01	6.24	6.44	6.62	6.77	6.91	7.04	7.15	7.25	7.34	7.42	7.49	7.56	7.62	7.68	7.73
2018	0.00	0.12	0.45	0.95	1.54	2.14	2.72	3.26	3.76	4.21	4.60	4.96	5.27	5.55	5.80	6.01	6.21	6.38	6.53	6.66	6.78	6.89	6.98	7.07	7.15	7.22	7.28	7.34	7.39	7.44
2019	0.00	0.12	0.44	0.93	1.50	2.08	2.64	3.16	3.64	4.07	4.45	4.79	5.09	5.36	5.59	5.80	5.98	6.15	6.29	6.42	6.53	6.64	6.73	6.81	6.89	6.95	7.02	7.07	7.12	7.17
2020	0.00	0.11	0.43	0.91	1.47	2.04	2.58	3.09	3.56	3.97	4.35	4.68	4.97	5.23	5.46	5.66	5.84	6.00	6.14	6.27	6.38	6.48	6.57	6.65	6.72	6.79	6.85	6.90	6.95	7.00

Federal Housing Administration  
 Mutual Mortgage Insurance Fund  
 All Mortgages - Conditional Claim Rates

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	0.02	0.63	1.79	2.44	3.93	4.79	4.09	2.94	2.40	2.22	1.97	1.97	1.53	1.12	1.10	0.92	0.85	0.58	0.49	0.31	0.36	0.22	0.19	0.15	0.09	0.11	0.05	0.10	0.06	0.08
1984	0.05	1.25	3.29	5.83	6.83	5.85	4.07	3.34	2.89	2.74	2.44	2.00	1.69	1.65	1.24	1.08	0.81	0.75	0.50	0.48	0.15	0.28	0.26	0.11	0.11	0.18	0.19	0.09	0.07	0.11
1985	0.05	1.01	3.57	5.23	4.54	3.68	3.14	2.88	2.82	2.77	2.48	1.79	1.66	1.61	1.20	1.14	0.87	0.71	0.53	0.48	0.28	0.26	0.19	0.27	0.24	0.25	0.26	0.13	0.25	0.50
1986	0.04	0.68	1.78	2.07	1.90	1.73	1.55	1.53	1.73	1.58	1.34	1.28	1.07	1.02	0.83	0.60	0.53	0.50	0.45	0.31	0.28	0.23	0.20	0.23	0.30	0.29	0.21	0.33	0.68	0.35
1987	0.05	0.56	1.19	1.38	1.40	1.36	1.32	1.43	1.33	1.14	1.16	1.01	0.90	0.73	0.47	0.44	0.51	0.44	0.32	0.25	0.18	0.21	0.31	0.31	0.27	0.20	0.38	0.78	0.40	0.23
1988	0.04	0.51	1.23	1.64	1.76	1.85	2.19	2.09	1.71	1.70	1.49	1.38	1.14	0.80	0.68	0.67	0.65	0.51	0.41	0.28	0.33	0.31	0.42	0.33	0.39	0.50	1.00	0.51	0.29	0.21
1989	0.03	0.48	1.31	1.72	2.04	2.57	2.48	2.11	2.05	1.75	1.57	1.29	0.95	0.79	0.86	0.69	0.60	0.55	0.42	0.37	0.50	0.58	0.56	0.45	0.57	1.32	0.67	0.37	0.26	0.21
1990	0.02	0.45	1.28	1.87	2.54	2.36	1.95	2.01	1.75	1.51	1.28	0.89	0.80	0.81	0.71	0.65	0.59	0.55	0.51	0.56	0.62	0.56	0.50	0.63	1.34	0.67	0.37	0.27	0.22	0.19
1991	0.02	0.42	1.21	1.98	2.04	1.80	1.95	1.70	1.50	1.36	0.90	0.79	0.80	0.68	0.65	0.54	0.43	0.54	0.48	0.67	0.64	0.61	0.67	1.51	0.80	0.45	0.33	0.26	0.24	0.22
1992	0.02	0.29	0.84	1.10	1.24	1.43	1.39	1.31	1.06	0.73	0.67	0.60	0.63	0.43	0.43	0.39	0.41	0.46	0.50	0.46	0.55	0.66	1.34	0.72	0.43	0.31	0.25	0.23	0.21	0.19
1993	0.01	0.25	0.65	0.95	1.24	1.20	1.10	0.86	0.55	0.51	0.50	0.48	0.42	0.33	0.30	0.31	0.43	0.54	0.51	0.49	0.76	1.50	0.77	0.44	0.32	0.25	0.22	0.20	0.19	0.17
1994	0.02	0.31	0.79	1.27	1.41	1.30	1.02	0.67	0.64	0.57	0.55	0.48	0.37	0.34	0.29	0.45	0.67	0.51	0.55	0.80	1.58	0.82	0.48	0.35	0.28	0.25	0.22	0.21	0.19	0.16
1995	0.02	0.42	1.45	2.29	2.56	2.09	1.55	1.49	1.68	1.49	1.26	1.04	0.82	0.91	1.01	1.25	0.98	1.00	1.36	2.46	1.31	0.77	0.57	0.47	0.41	0.37	0.35	0.32	0.30	0.27
1996	0.01	0.45	1.52	2.33	2.13	1.62	1.67	1.78	1.71	1.39	1.14	1.03	0.98	1.10	1.37	1.06	1.28	1.49	2.80	1.52	0.90	0.66	0.53	0.47	0.43	0.40	0.37	0.34	0.32	0.29
1997	0.02	0.52	1.68	2.15	1.87	2.17	2.24	2.12	1.87	1.48	1.32	1.26	1.31	1.59	1.25	1.39	1.71	3.17	1.74	1.04	0.78	0.63	0.57	0.52	0.48	0.44	0.41	0.39	0.36	0.33
1998	0.02	0.46	1.14	1.23	1.48	1.76	1.83	1.68	1.42	1.25	1.19	1.39	1.54	1.33	1.48	1.63	3.19	1.81	1.10	0.83	0.68	0.61	0.55	0.51	0.47	0.44	0.41	0.38	0.35	0.32
1999	0.02	0.43	1.02	1.70	2.28	2.43	2.14	1.76	1.48	1.42	1.59	1.77	1.68	1.71	1.82	3.46	2.03	1.29	1.00	0.83	0.74	0.68	0.62	0.58	0.53	0.49	0.46	0.43	0.40	0.36
2000	0.02	0.60	2.55	4.50	4.76	4.06	3.38	2.93	2.97	2.87	3.11	2.56	2.61	2.75	4.94	2.97	1.93	1.52	1.28	1.16	1.05	0.97	0.90	0.84	0.78	0.72	0.67	0.63	0.59	0.53
2001	0.02	0.62	2.17	3.50	3.45	2.99	2.57	2.50	2.58	3.00	2.62	2.71	2.66	4.69	2.93	2.00	1.61	1.40	1.27	1.17	1.08	1.00	0.93	0.86	0.80	0.74	0.69	0.64	0.60	0.54
2002	0.02	0.71	2.17	2.66	2.57	2.26	2.21	2.40	2.77	2.38	2.69	2.61	4.45	2.88	2.06	1.71	1.50	1.38	1.28	1.19	1.10	1.02	0.94	0.88	0.81	0.75	0.70	0.65	0.61	0.53
2003	0.05	0.79	1.46	1.64	1.59	1.71	1.93	2.40	2.14	2.55	2.41	4.04	2.70	2.03	1.77	1.58	1.47	1.38	1.29	1.20	1.11	1.03	0.96	0.89	0.82	0.76	0.71	0.66	0.61	0.52
2004	0.19	0.95	1.66	1.96	2.21	2.47	2.90	2.51	3.04	2.81	4.68	3.23	2.48	2.19	2.01	1.85	1.73	1.63	1.52	1.41	1.31	1.21	1.13	1.05	0.97	0.90	0.84	0.77	0.71	0.54
2005	0.12	0.98	2.06	2.65	3.20	3.68	3.16	3.88	3.52	5.67	3.98	3.09	2.74	2.53	2.40	2.24	2.11	1.98	1.85	1.73	1.60	1.49	1.39	1.29	1.21	1.12	1.04	0.97	0.88	0.73
2006	0.09	1.10	2.56	3.78	4.77	4.06	4.91	4.64	7.06	4.89	3.74	3.27	2.99	2.82	2.67	2.49	2.34	2.19	2.05	1.91	1.78	1.66	1.54	1.44	1.34	1.25	1.17	1.09	1.02	0.86
2007	0.09	1.46	3.58	5.45	4.34	6.25	6.60	8.79	5.98	4.50	3.89	3.51	3.29	3.10	2.92	2.73	2.55	2.38	2.22	2.07	1.93	1.80	1.68	1.57	1.46	1.37	1.28	1.20	1.13	0.98
2008	0.07	1.18	3.73	3.73	5.72	6.47	8.79	5.88	4.31	3.67	3.28	3.07	2.90	2.75	2.60	2.43	2.28	2.14	2.01	1.88	1.76	1.65	1.54	1.44	1.35	1.27	1.19	1.12	1.06	0.94
2009	0.05	0.76	1.46	2.46	3.10	4.47	3.08	2.39	2.13	1.98	1.89	1.80	1.74	1.68	1.62	1.54	1.47	1.40	1.33	1.27	1.20	1.13	1.07	1.01	0.95	0.90	0.85	0.81	0.76	0.68
2010	0.03	0.31	0.90	1.27	2.15	1.62	1.38	1.32	1.29	1.27	1.25	1.23	1.21	1.18	1.15	1.11	1.07	1.03	0.98	0.94	0.89	0.84	0.80	0.75	0.71	0.67	0.64	0.61	0.58	0.49
2011	0.03	0.29	0.59	1.15	0.96	0.92	0.95	0.97	0.99	1.00	0.99	0.97	0.96	0.94	0.92	0.88	0.86	0.83	0.79	0.76	0.72	0.69	0.65	0.62	0.59	0.56	0.53	0.50	0.48	0.41
2012	0.02	0.18	0.51	0.59	0.71	0.82	0.89	0.94	0.96	0.97	0.97	0.95	0.92	0.90	0.86	0.82	0.78	0.75	0.72	0.69	0.66	0.63	0.60	0.57	0.54	0.51	0.48	0.46	0.44	0.39
2013	0.02	0.18	0.43	0.66	0.83	0.95	1.03	1.06	1.08	1.07	1.06	1.03	1.00	0.97	0.93	0.89	0.86	0.83	0.79	0.76	0.73	0.69	0.66	0.62	0.59	0.56	0.54	0.51	0.49	0.40
2014	0.00	0.11	0.37	0.63	0.82	0.95	1.03	1.08	1.09	1.09	1.08	1.05	1.02	1.00	0.98	0.96	0.93	0.90	0.86	0.82	0.78	0.75	0.71	0.67	0.64	0.61	0.58	0.55	0.53	0.50
2015	0.00	0.12	0.38	0.65	0.85	0.98	1.06	1.10	1.12	1.12	1.13	1.13	1.12	1.10	1.08	1.06	1.02	0.98	0.94	0.89	0.85	0.81	0.77	0.73	0.69	0.65	0.62	0.59	0.56	0.54
2016	0.00	0.12	0.39	0.65	0.85	0.98	1.07	1.16	1.21	1.24	1.25	1.24	1.23	1.21	1.18	1.15	1.11	1.06	1.01	0.96	0.91	0.86	0.82	0.78	0.74	0.70	0.66	0.63	0.60	0.57
2017	0.00	0.12	0.38	0.64	0.84	0.96	1.04	1.08	1.10	1.14	1.16	1.16	1.15	1.13	1.11	1.08	1.04	1.00	0.96	0.91	0.87	0.82	0.78	0.74	0.70	0.67	0.64	0.61	0.58	0.55
2018	0.00	0.12	0.38	0.63	0.82	0.95	1.02	1.07	1.09	1.12	1.14	1.15	1.13	1.12	1.10	1.07	1.03	0.99	0.95	0.91	0.86	0.82	0.78	0.74	0.70	0.67	0.63	0.60	0.58	0.55
2019	0.00	0.11	0.37	0.62	0.81	0.93	1.01	1.05	1.08	1.12	1.14	1.14	1.13	1.12	1.10	1.07	1.03	0.99	0.95	0.90	0.86	0.82	0.78	0.74	0.70	0.67	0.64	0.61	0.58	0.56
2020	0.00	0.11	0.36	0.61	0.80	0.92	1.00	1.04	1.08	1.13	1.14	1.15	1.13	1.12	1.10	1.07	1.03	0.99	0.95	0.91	0.86	0.82	0.78	0.74	0.70	0.67	0.64	0.61	0.58	0.56

Federal Housing Administration  
 Mutual Mortgage Insurance Fund  
 All Mortgages - Cumulative Non Claim Termination Rates

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	0.37	1.21	3.96	26.12	41.28	47.09	51.26	54.78	59.48	65.48	69.98	72.83	73.97	75.23	76.28	78.01	78.87	79.25	79.62	80.03	80.48	80.72	80.90	81.03	81.14	81.31	81.37	81.43	81.50	81.75
1984	0.29	2.58	27.06	41.63	48.07	52.17	55.39	59.05	63.73	67.53	70.10	71.11	72.21	73.10	74.15	75.45	75.81	76.19	76.53	76.89	77.27	77.57	77.70	77.79	77.90	78.16	78.22	78.34	78.42	78.55
1985	0.50	14.62	29.96	36.86	41.87	46.30	52.62	61.12	67.42	70.90	72.16	73.61	74.72	76.02	77.09	78.37	78.86	79.35	79.76	80.09	80.52	80.67	80.77	80.87	81.05	81.15	81.24	81.28	81.35	81.43
1986	0.96	4.09	6.90	10.10	13.82	19.12	32.23	50.00	57.15	60.01	63.53	66.37	70.65	73.58	75.26	78.04	79.76	81.34	82.30	83.18	83.68	83.95	84.16	84.42	84.57	84.78	84.91	85.03	85.13	85.23
1987	0.53	1.93	4.13	7.16	11.24	21.61	39.34	47.19	50.73	55.13	58.83	64.77	69.05	71.28	74.70	78.33	81.12	82.67	83.89	84.67	85.17	85.49	85.83	86.08	86.37	86.67	86.83	86.95	87.07	87.17
1988	0.60	2.47	5.60	11.01	26.56	47.10	55.60	58.91	62.92	66.04	70.54	73.84	75.53	77.70	79.90	82.25	83.41	84.34	84.99	85.35	85.63	85.86	86.03	86.24	86.41	86.59	86.71	86.82	86.93	87.03
1989	0.71	2.71	7.77	23.89	47.20	56.25	59.65	63.71	66.82	71.50	74.80	76.42	78.61	80.78	82.80	84.32	85.33	85.93	86.25	86.48	86.72	86.87	87.06	87.20	87.33	87.43	87.53	87.63	87.72	87.81
1990	0.56	3.41	17.78	45.93	56.13	59.87	64.24	67.56	72.58	76.07	77.72	80.05	82.35	84.51	85.88	87.17	87.80	88.12	88.34	88.57	88.75	88.91	89.04	89.16	89.26	89.35	89.45	89.53	89.62	89.69
1991	0.71	8.29	36.67	47.68	52.09	57.64	61.94	68.85	73.32	75.43	78.67	81.74	84.62	86.26	87.55	88.53	88.91	89.18	89.42	89.59	89.79	89.93	90.06	90.19	90.31	90.43	90.53	90.63	90.73	90.81
1992	1.26	15.23	23.65	29.43	37.07	43.61	55.07	62.33	65.89	71.68	77.28	82.55	85.16	86.83	87.99	89.05	89.45	89.76	90.01	90.23	90.47	90.66	90.83	90.99	91.14	91.27	91.39	91.50	91.61	91.71
1993	3.68	8.58	13.85	21.18	28.13	40.14	48.76	53.72	61.86	70.34	79.10	83.04	85.46	86.94	88.18	89.53	89.94	90.27	90.55	90.82	91.10	91.29	91.46	91.61	91.75	91.88	92.00	92.10	92.21	92.30
1994	1.45	5.72	13.04	20.38	32.70	41.67	47.11	55.84	64.85	74.74	79.52	82.46	84.32	85.65	87.12	88.29	88.67	89.01	89.35	89.65	89.90	90.12	90.32	90.50	90.66	90.81	90.95	91.08	91.20	91.30
1995	2.98	10.49	19.71	36.61	45.99	50.96	59.57	67.56	75.37	79.50	82.07	83.63	84.63	85.23	85.75	86.31	86.54	86.76	87.02	87.28	87.51	87.72	87.91	88.07	88.23	88.37	88.50	88.63	88.74	88.85
1996	1.01	6.73	26.04	37.00	42.94	53.68	63.63	73.46	78.49	81.51	83.31	84.44	85.12	85.64	86.12	86.65	86.91	87.20	87.50	87.77	88.00	88.21	88.40	88.57	88.72	88.87	89.00	89.13	89.24	89.35
1997	1.72	18.64	32.00	39.29	52.23	62.82	73.09	78.33	81.56	83.47	84.66	85.34	85.82	86.16	86.53	86.99	87.31	87.67	87.98	88.25	88.49	88.70	88.89	89.06	89.22	89.36	89.50	89.62	89.74	89.85
1998	3.78	10.84	17.42	31.45	47.46	65.70	74.17	79.04	81.64	83.23	84.21	85.01	85.56	86.05	86.61	87.29	87.75	88.15	88.49	88.79	89.05	89.28	89.48	89.67	89.85	90.00	90.15	90.29	90.41	90.53
1999	1.23	5.28	22.36	40.61	60.97	70.66	76.34	79.37	81.17	82.28	83.19	83.81	84.37	84.96	85.62	86.16	86.62	87.01	87.34	87.63	87.89	88.11	88.32	88.51	88.68	88.84	88.99	89.13	89.25	89.37
2000	1.79	33.61	53.88	68.95	76.10	80.34	82.62	83.94	84.66	85.16	85.46	85.72	85.99	86.36	86.75	87.08	87.36	87.60	87.80	87.99	88.15	88.29	88.42	88.54	88.65	88.76	88.85	88.94	89.02	89.09
2001	7.27	28.03	56.89	68.81	75.49	78.82	80.73	81.89	82.95	83.54	84.03	84.58	85.21	85.78	86.26	86.66	87.00	87.28	87.53	87.75	87.95	88.12	88.28	88.43	88.56	88.68	88.79	88.90	89.00	89.08
2002	8.11	38.97	55.37	65.38	70.52	73.65	75.52	77.39	78.48	79.36	80.40	81.52	82.40	83.13	83.75	84.27	84.70	85.07	85.40	85.69	85.94	86.17	86.38	86.56	86.74	86.89	87.04	87.17	87.30	87.41
2003	8.96	26.23	41.54	49.94	55.14	58.22	61.47	63.71	65.54	68.11	70.64	72.24	73.52	74.62	75.63	76.46	77.16	77.77	78.32	78.80	79.23	79.61	79.96	80.27	80.56	80.82	81.07	81.30	81.51	81.70
2004	8.79	25.63	36.15	42.84	46.56	50.47	53.02	55.16	58.27	61.46	63.47	65.09	66.45	67.72	68.80	69.69	70.46	71.14	71.75	72.28	72.76	73.19	73.58	73.93	74.26	74.56	74.84	75.10	75.34	75.51
2005	6.49	15.79	23.41	28.04	32.79	35.90	38.51	42.87	47.05	49.45	51.30	52.90	54.35	55.69	56.87	57.87	58.76	59.56	60.27	60.90	61.46	61.97	62.44	62.86	63.25	63.61	63.95	64.26	64.55	64.78
2006	3.14	10.00	16.89	26.17	30.34	33.69	39.15	43.68	45.84	47.51	48.92	50.24	51.45	52.53	53.50	54.35	55.12	55.80	56.40	56.94	57.42	57.86	58.25	58.62	58.95	59.26	59.55	59.82	60.07	60.28
2007	3.24	12.80	25.44	29.70	32.95	38.11	42.39	44.35	45.80	47.03	48.13	49.16	50.13	51.01	51.81	52.51	53.15	53.72	54.23	54.68	55.08	55.45	55.79	56.09	56.38	56.64	56.88	57.11	57.33	57.51
2008	4.33	24.04	30.35	34.45	41.93	47.13	49.05	50.33	51.47	52.53	53.60	54.68	55.66	56.55	57.40	58.17	58.85	59.45	59.99	60.47	60.89	61.28	61.63	61.94	62.23	62.50	62.75	62.99	63.21	63.40
2009	8.06	15.60	20.27	32.97	41.78	45.05	47.81	50.32	52.58	54.59	56.40	58.24	60.09	61.77	63.28	64.65	65.83	66.86	67.76	68.55	69.24	69.85	70.40	70.89	71.34	71.75	72.13	72.48	72.80	73.09
2010	3.17	7.09	16.61	27.11	33.23	38.24	42.68	46.57	49.97	52.96	55.83	58.72	61.26	63.53	65.66	67.44	68.96	70.28	71.41	72.39	73.24	73.99	74.65	75.24	75.78	76.26	76.70	77.11	77.50	77.81
2011	1.40	10.62	22.69	31.44	39.02	45.34	50.55	54.89	58.55	61.67	64.38	66.84	69.24	71.33	73.19	74.81	76.17	77.35	78.37	79.24	80.00	80.67	81.26	81.78	82.25	82.68	83.07	83.43	83.76	84.03
2012	2.38	12.25	23.11	32.55	40.38	46.75	51.95	56.28	59.94	63.07	65.75	68.05	70.03	71.75	73.38	74.87	76.20	77.41	78.47	79.40	80.21	80.92	81.54	82.10	82.60	83.06	83.48	83.86	84.22	84.52
2013	3.98	13.56	22.95	31.06	37.89	43.57	48.37	52.51	56.11	59.25	61.97	64.33	66.38	68.21	70.15	71.81	73.32	74.65	75.82	76.83	77.72	78.50	79.19	79.81	80.38	80.89	81.35	81.79	82.20	82.51
2014	2.53	11.86	21.28	29.31	36.06	41.80	46.73	51.07	54.85	58.13	60.97	63.42	66.05	68.41	70.40	72.19	73.72	75.03	76.16	77.14	78.00	78.75	79.42	80.02	80.57	81.06	81.51	81.93	82.32	82.68
2015	2.48	11.31	20.13	27.61	34.05	39.68	44.68	49.11	52.99	57.26	61.08	64.24	66.86	69.27	71.34	73.00	74.39	75.59	76.62	77.51	78.29	78.97	79.58	80.13	80.63	81.08	81.49	81.88	82.23	82.57
2016	2.45	11.16	19.76	27.12	33.69	40.13	47.11	52.94	57.76	61.73	65.01	67.92	70.45	72.52	74.24	75.64	76.82	77.82	78.68	79.42	80.07	80.65	81.17	81.63	82.05	82.43	82.78	83.11	83.41	83.68
2017	2.45	11.05	19.65	27.17	33.90	39.90	45.15	49.81	55.23	59.66	63.29	66.26	68.81	71.11	73.00	74.53	75.82	76.93	77.87	78.69	79.41	80.04	80.61	81.12	81.58	82.00	82.38	82.73	83.05	83.36
2018	2.45	11.13	19.98	27.87	34.91	41.08	46.41	51.07	56.48	60.87	64.43	67.34	69.89	72.12	73.95	75.42	76.69	77.76	78.67	79.47	80.16	80.78	81.33	81.82	82.27	82.67	83.04	83.38	83.69	83.98
2019	2.47	11.36	20.59	28.83	36.07	42.36	47.74	52.81	58.11	62.37	65.81	68.61	71.06	73.19	74.95	76.36	77.58	78.61	79.48	80.25	80.92	81.51	82.04	82.51	82.94	83.33	83.68	84.00	84.30	84.58
2020	2.51	11.64	21.13	29.54	36.90	43.24	48.62	54.08	59.26	63.41	66.75	69.46	71.91	73.96	75.66	77.03	78.20	79.19	80.04	80.77	81.42	81.99	82.51	82.97	83.38	83.75	84.09	84.40	84.68	84.95

Federal Housing Administration  
 Mutual Mortgage Insurance Fund  
 All Mortgages - Conditional Non Claim Termination Rates

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	0.37	0.85	2.80	23.67	21.91	11.33	9.68	9.49	14.45	22.21	22.01	18.40	9.24	11.39	10.87	20.37	12.82	6.63	6.84	8.28	10.00	5.83	4.72	3.54	3.19	5.05	1.82	1.92	2.26	8.46
1984	0.29	2.30	25.46	21.28	12.89	10.24	9.57	12.61	19.18	19.96	17.46	8.54	10.44	9.59	12.82	18.46	6.34	7.21	7.01	7.97	9.19	8.17	3.83	2.59	3.64	8.47	2.15	4.35	3.02	5.02
1985	0.50	14.20	18.19	10.45	9.01	9.21	15.10	24.80	25.44	19.55	9.13	11.88	10.55	14.04	13.74	19.25	9.33	10.45	9.74	8.55	12.59	4.88	3.70	3.70	6.71	4.03	3.73	2.15	3.26	3.58
1986	0.96	3.16	2.95	3.53	4.34	6.60	17.82	29.96	17.60	8.70	11.98	11.15	19.14	16.47	11.39	21.60	17.08	19.17	14.41	15.67	10.43	6.44	5.20	7.05	4.20	6.29	4.31	4.10	3.45	3.55
1987	0.52	1.41	2.25	3.23	4.55	12.28	24.31	14.47	7.76	10.62	10.12	18.30	16.34	10.27	17.74	23.00	23.07	16.86	15.93	12.27	8.83	6.32	7.19	5.77	6.81	7.83	4.61	3.53	3.68	3.33
1988	0.60	1.88	3.22	5.85	18.13	29.92	18.13	8.85	12.05	10.90	17.94	16.34	10.19	14.68	17.72	23.12	15.02	14.14	11.81	7.21	6.20	5.37	4.31	5.50	4.94	5.34	3.57	3.71	3.75	3.47
1989	0.71	2.02	5.23	17.82	32.02	18.86	9.03	12.16	10.87	18.81	16.67	10.02	15.26	18.06	20.69	19.85	16.67	11.79	7.30	5.66	6.38	4.14	5.47	4.38	4.31	3.58	3.68	3.71	3.74	3.63
1990	0.56	2.87	14.94	34.96	20.06	9.50	12.59	11.21	19.48	17.22	10.02	15.93	18.96	22.10	18.22	21.24	13.29	7.82	5.78	6.43	5.51	5.18	4.59	4.18	3.89	3.89	3.86	3.85	3.88	3.62
1991	0.71	7.64	31.09	17.83	8.90	12.57	11.38	21.10	17.67	10.33	17.93	20.97	25.12	19.30	18.98	17.94	8.62	6.56	6.38	4.85	6.28	4.39	4.53	4.67	4.69	4.60	4.51	4.46	4.46	4.38
1992	1.25	14.15	9.97	7.68	11.12	10.86	21.69	17.88	10.82	20.02	24.41	30.66	22.09	18.35	15.57	17.02	7.80	6.61	5.76	5.26	6.25	5.23	5.02	4.97	4.83	4.66	4.52	4.44	4.42	4.23
1993	3.68	5.09	5.77	8.60	9.01	17.35	15.27	10.52	19.45	25.36	35.34	24.77	20.39	15.76	15.62	20.41	7.71	6.75	6.27	6.64	7.15	5.25	5.13	4.92	4.70	4.48	4.31	4.21	4.17	3.87
1994	1.45	4.34	7.79	8.55	15.91	14.01	10.02	18.10	22.98	33.07	24.03	19.65	15.53	13.16	16.95	16.26	6.31	6.09	6.45	6.31	5.47	5.31	5.07	4.83	4.61	4.41	4.29	4.22	4.20	3.60
1995	2.98	7.74	10.36	21.50	15.67	10.15	20.05	23.70	31.02	24.32	20.42	15.87	12.18	8.40	8.10	9.44	4.43	4.50	5.48	5.92	5.81	5.60	5.37	5.16	4.99	4.86	4.77	4.72	4.68	4.43
1996	1.01	5.78	20.80	15.21	9.99	20.55	24.48	32.75	25.56	21.13	16.25	12.33	8.63	7.19	7.37	8.79	4.86	5.71	6.36	6.23	5.96	5.69	5.45	5.25	5.09	4.97	4.88	4.83	4.82	4.53
1997	1.72	17.22	16.54	11.02	22.54	24.41	32.25	25.13	21.27	16.37	12.38	8.22	6.38	4.92	5.78	7.53	5.97	7.05	6.86	6.55	6.21	5.92	5.69	5.50	5.36	5.24	5.15	5.10	5.09	4.85
1998	3.78	7.35	7.42	17.29	24.23	37.16	28.23	23.20	16.54	12.26	8.84	7.95	6.05	5.72	7.17	9.47	7.27	7.00	6.60	6.21	5.83	5.53	5.29	5.11	4.96	4.81	4.70	4.63	4.58	4.38
1999	1.23	4.11	18.11	23.94	35.91	27.65	23.19	16.57	12.05	8.60	7.78	5.91	5.74	6.55	7.99	7.26	6.86	6.42	5.98	5.59	5.24	4.98	4.77	4.60	4.45	4.31	4.20	4.12	4.06	3.75
2000	1.79	32.40	30.82	34.40	26.71	23.12	17.04	12.40	7.95	6.24	4.19	3.76	4.33	6.22	7.32	7.04	6.57	6.15	5.77	5.46	5.19	4.98	4.81	4.65	4.51	4.39	4.29	4.21	4.14	3.84
2001	7.27	22.40	40.43	29.09	24.19	16.68	11.90	8.45	8.67	5.44	4.89	6.02	7.49	7.57	7.28	6.69	6.22	5.78	5.39	5.08	4.81	4.58	4.39	4.22	4.07	3.93	3.82	3.73	3.65	3.47
2002	8.11	33.58	27.17	23.46	16.33	12.25	8.55	9.59	6.34	5.67	7.26	8.65	7.72	7.24	6.80	6.30	5.71	5.30	4.97	4.68	4.40	4.16	3.96	3.79	3.64	3.50	3.39	3.29	3.21	2.90
2003	8.96	18.98	20.97	14.84	10.99	7.46	8.65	6.66	6.01	9.16	10.22	7.38	6.71	6.32	6.37	5.64	5.17	4.87	4.60	4.33	4.05	3.82	3.63	3.46	3.31	3.18	3.07	2.99	2.91	2.58
2004	8.59	18.50	14.35	10.86	6.94	8.01	5.83	5.38	8.48	9.80	7.10	6.46	6.03	6.12	5.70	5.06	4.74	4.48	4.23	3.98	3.73	3.54	3.37	3.22	3.09	2.97	2.87	2.78	2.65	2.01
2005	6.36	9.96	9.16	6.27	7.07	5.14	4.76	8.59	9.43	6.22	5.44	5.17	5.13	5.17	4.90	4.49	4.29	4.11	3.88	3.67	3.46	3.29	3.15	3.02	2.91	2.79	2.71	2.62	2.50	2.09
2006	3.08	7.09	7.76	11.64	6.19	5.59	10.06	9.84	5.46	4.83	4.55	4.61	4.61	4.44	4.28	4.07	3.91	3.71	3.50	3.30	3.11	2.96	2.82	2.71	2.60	2.50	2.42	2.35	2.29	1.95
2007	3.19	9.89	14.75	6.10	5.25	9.22	9.04	4.91	4.21	3.96	3.89	3.97	4.01	3.92	3.82	3.65	3.52	3.33	3.14	2.96	2.80	2.66	2.54	2.43	2.34	2.25	2.17	2.11	2.06	1.84
2008	4.29	20.61	8.44	6.24	12.67	10.77	4.81	3.72	3.64	3.70	4.05	4.36	4.28	4.24	4.29	4.22	3.95	3.74	3.56	3.35	3.16	2.99	2.84	2.71	2.59	2.49	2.40	2.33	2.27	2.11
2009	7.95	8.21	5.58	16.34	13.95	6.25	5.90	5.89	5.77	5.60	5.46	5.98	6.50	6.45	6.31	6.22	5.82	5.43	5.14	4.80	4.49	4.22	3.98	3.77	3.60	3.44	3.31	3.21	3.13	2.89
2010	3.14	4.04	10.29	12.77	8.66	7.94	7.79	7.52	7.20	6.92	7.23	7.96	7.73	7.56	7.76	7.14	6.62	6.24	5.77	5.36	4.98	4.64	4.35	4.10	3.88	3.69	3.54	3.41	3.32	2.85
2011	1.39	9.36	13.55	11.45	11.35	10.77	10.07	9.43	8.87	8.37	8.05	8.02	8.58	8.29	8.12	7.77	7.13	6.75	6.28	5.83	5.41	5.04	4.73	4.45	4.22	4.01	3.84	3.70	3.59	3.01
2012	2.37	10.11	12.41	12.38	11.80	10.97	10.15	9.52	8.98	8.51	8.06	7.60	7.16	6.78	6.92	6.89	6.66	6.53	6.18	5.82	5.43	5.06	4.74	4.47	4.23	4.02	3.85	3.71	3.61	3.25
2013	3.97	9.97	10.89	10.60	10.07	9.40	8.84	8.46	8.16	7.82	7.44	7.04	6.67	6.47	7.38	6.86	6.81	6.50	6.11	5.74	5.35	5.02	4.73	4.49	4.27	4.08	3.92	3.80	3.72	3.04
2014	2.53	9.56	10.71	10.25	9.68	9.19	8.80	8.56	8.28	7.93	7.53	7.12	6.79	6.66	7.52	7.04	6.50	6.13	5.69	5.30	4.98	4.69	4.45	4.23	4.04	3.88	3.75	3.66	3.61	3.11
2015	2.48	9.05	9.96	9.42	9.02	8.75	8.60	8.43	8.18	7.90	7.67	7.27	6.80	6.74	7.37	6.75	6.32	5.83	5.41	5.04	4.74	4.47	4.23	4.03	3.84	3.69	3.56	3.47	3.38	2.85
2016	2.45	8.93	9.69	9.23	9.13	8.96	12.11	11.64	11.04	10.38	9.69	9.65	9.42	8.64	7.94	7.12	6.56	6.00	5.54	5.15	4.81	4.52	4.26	4.03	3.84	3.65	3.50	3.38	3.26	3.15
2017	2.45	8.82	9.68	9.41	9.37	9.29	9.08	8.94	11.59	10.83	10.07	9.31	8.90	8.94	8.20	7.25	6.75	6.22	5.74	5.34	4.98	4.68	4.42	4.19	3.98	3.80	3.65	3.49	3.36	3.26
2018	2.45	8.90	9.97	9.92	9.88	9.70	9.40	9.16	11.85	11.03	10.20	9.39	9.22	8.96	8.21	7.27	6.82	6.24	5.77	5.36	5.01	4.71	4.45	4.22	4.02	3.83	3.65	3.48	3.35	3.25
2019	2.47	9.11	10.43	10.43	10.32	10.06	9.68	10.23	12.03	11.14	10.26	9.41	9.21	8.94	8.20	7.26	6.81	6.24	5.77	5.37	5.02	4.72	4.46	4.23	4.03	3.81	3.62	3.46	3.33	3.22
2020	2.51	9.36	10.76	10.72	10.59	10.28	9.83	11.18	12.09	11.17	10.25	9.38	9.45	8.88	8.15	7.26	6.77	6.20	5.73	5.33	4.99	4.70	4.44	4.21	3.98	3.75	3.56	3.40	3.28	3.17

Federal Housing Administration  
Mutual Mortgage Insurance Fund

All Mortgages - Loss Rates<sup>a</sup>

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	43.16	46.57	47.70	47.40	50.45	49.21	47.45	46.89	46.15	45.09	43.05	43.93	44.61	49.26	47.98	49.37	49.13	46.56	42.83	46.57	39.03	38.62	62.13	64.18	86.86	74.23	75.91	106.97	58.21	24.45
1984	50.02	48.46	50.24	52.10	51.73	52.00	51.43	51.21	53.13	51.06	52.05	52.92	54.24	74.70	62.98	58.25	53.93	49.41	71.49	52.82	82.90	58.67	87.60	114.58	89.57	110.37	128.05	72.78	53.36	82.83
1985	43.87	49.17	51.12	50.02	49.06	48.32	48.03	46.78	46.37	48.26	46.82	46.27	49.13	51.59	53.00	50.29	55.18	51.02	46.30	52.71	61.15	59.50	92.80	86.73	59.49	83.98	46.27	55.44	82.35	82.92
1986	47.60	50.53	49.63	46.92	45.66	43.46	42.67	40.09	38.34	37.26	36.29	36.74	36.75	36.57	34.47	36.75	35.55	35.57	32.65	49.58	37.98	55.06	67.68	46.94	52.98	51.70	50.35	72.67	74.19	76.89
1987	51.99	47.01	45.71	45.03	43.44	42.61	40.06	38.25	36.69	37.09	36.43	37.13	37.34	36.16	35.63	36.42	38.59	38.44	44.98	47.57	63.46	62.38	57.03	67.33	51.31	51.08	72.80	73.95	75.94	77.70
1988	51.56	44.70	45.43	43.90	43.80	42.96	42.93	42.76	42.47	41.78	44.56	42.41	43.46	41.73	39.93	38.03	44.62	49.93	51.10	71.24	78.24	68.35	79.98	57.56	50.80	69.85	71.48	73.88	75.85	77.53
1989	49.53	47.59	44.12	44.90	45.19	45.47	45.35	46.39	45.73	45.88	45.83	43.80	41.35	41.76	40.91	46.44	53.38	61.07	79.95	78.93	71.33	72.94	73.20	59.20	69.56	70.63	72.73	74.71	76.30	77.72
1990	50.27	45.16	43.86	45.45	47.53	47.77	49.24	48.73	48.79	49.00	46.40	42.84	45.28	44.49	44.81	51.86	66.06	75.91	78.75	73.78	83.12	70.15	58.01	69.04	70.42	72.63	74.81	76.54	78.05	79.84
1991	49.27	42.90	43.77	45.85	46.80	48.72	49.46	49.17	47.34	42.97	42.05	38.04	39.29	40.51	50.18	60.26	83.59	81.62	70.69	72.25	66.52	53.19	65.04	65.57	67.48	69.72	71.75	73.51	75.34	76.89
1992	38.58	42.21	42.18	42.85	44.29	45.16	44.76	44.61	39.49	33.69	31.75	30.77	34.93	47.79	47.65	69.13	65.99	64.19	68.54	64.70	54.37	59.49	59.83	62.13	64.68	66.90	68.83	70.64	72.30	74.08
1993	39.34	39.35	39.69	40.90	42.83	41.52	39.40	34.87	30.39	27.80	28.06	35.45	39.52	49.38	61.43	66.42	59.54	60.99	56.18	50.47	56.79	57.89	60.04	62.06	63.88	65.58	67.29	68.88	70.78	72.74
1994	36.62	37.89	39.77	40.19	39.77	37.83	33.89	28.90	27.70	27.75	30.61	39.83	46.64	63.06	64.63	58.53	62.78	59.66	55.52	55.20	55.51	57.34	59.39	61.35	63.16	64.91	66.52	68.41	70.55	72.66
1995	37.17	38.10	39.83	39.56	39.86	38.09	32.73	32.00	32.56	34.93	40.37	46.56	69.84	67.55	66.93	68.89	68.25	58.47	54.22	54.69	56.48	58.51	60.45	62.28	64.08	65.68	67.56	69.73	71.91	74.05
1996	35.43	38.71	38.07	37.21	35.07	32.01	30.72	30.88	33.92	39.22	47.86	61.43	67.99	67.04	70.02	68.77	60.46	53.11	53.43	54.77	56.49	58.21	59.87	61.59	63.17	65.04	67.18	69.34	71.47	73.56
1997	37.61	38.53	37.38	34.64	31.90	30.59	30.91	33.70	37.93	44.75	62.06	69.48	66.37	70.90	64.68	62.64	52.98	52.31	53.07	54.56	56.15	57.78	59.36	60.81	62.62	64.75	66.90	68.98	71.11	73.14
1998	34.83	36.61	32.66	29.70	28.79	29.39	31.52	36.85	44.76	61.41	65.31	65.59	67.72	67.53	65.56	51.96	51.61	51.70	52.59	53.67	55.03	56.39	57.66	59.33	61.43	63.58	65.66	67.75	69.77	71.79
1999	31.98	33.22	29.93	28.42	29.55	32.10	36.74	43.19	58.99	64.92	64.76	67.76	69.24	64.45	51.28	51.02	50.78	51.39	52.26	53.51	54.62	55.54	56.89	58.83	60.95	63.02	65.09	67.09	69.12	71.17
2000	33.08	31.43	30.85	33.18	35.97	40.25	47.74	61.21	69.18	70.20	75.60	75.57	71.86	51.80	51.70	51.09	51.26	51.82	52.68	53.80	54.64	55.64	57.28	59.26	61.28	63.34	65.36	67.38	69.47	71.55
2001	25.88	30.38	32.77	35.48	38.89	44.35	57.45	65.81	66.41	70.24	71.49	66.44	52.60	51.76	50.16	49.67	49.78	50.16	50.67	50.94	51.45	52.51	54.11	55.98	57.96	59.93	61.96	64.07	66.22	68.31
2002	24.82	32.06	35.11	38.06	42.37	52.99	59.53	61.61	66.10	66.88	63.77	53.81	52.59	50.31	49.27	49.02	49.12	49.18	48.95	48.99	49.74	51.00	52.65	54.51	56.42	58.41	60.52	62.67	64.84	66.89
2003	31.38	34.20	35.60	39.44	49.64	55.23	57.31	60.86	60.59	58.82	55.66	54.85	51.90	49.97	49.02	48.84	48.74	48.11	47.45	47.49	48.17	49.17	50.69	52.40	54.25	56.22	58.33	60.49	62.70	64.67
2004	30.59	35.04	38.40	46.82	54.09	58.24	60.59	62.47	61.06	58.86	58.36	55.19	52.92	51.61	51.00	50.71	49.97	49.04	48.55	48.71	49.29	50.35	51.73	53.33	55.11	57.04	59.07	61.21	63.18	65.07
2005	31.88	38.43	47.19	55.04	58.86	62.53	63.81	62.40	63.45	63.05	60.07	57.74	56.22	55.20	54.40	53.38	52.18	51.20	50.71	50.70	51.06	51.75	52.87	54.31	55.94	57.68	59.60	61.38	63.22	64.98
2006	33.78	45.76	55.10	59.83	63.90	65.72	65.45	65.41	65.39	62.73	60.49	59.07	58.02	57.05	55.74	54.39	53.22	52.24	51.58	51.36	51.51	52.07	53.12	54.50	56.03	57.75	59.39	61.14	62.94	64.73
2007	41.02	52.92	59.04	64.01	65.83	66.92	64.62	64.51	62.32	60.41	59.08	58.09	57.21	55.97	54.52	53.29	52.25	51.27	50.49	50.13	50.24	50.90	51.99	53.35	54.90	56.43	58.09	59.82	61.62	63.43
2008	44.53	52.08	57.82	60.12	59.96	56.61	56.18	54.01	52.29	51.06	50.25	49.52	48.45	47.11	45.84	44.75	43.81	43.09	42.86	43.21	44.01	45.19	46.72	48.46	50.18	52.04	53.98	55.91	57.88	59.87
2009	37.03	48.42	50.64	50.17	45.42	44.63	42.08	40.42	39.51	39.10	38.70	37.88	36.70	35.52	34.63	34.21	34.47	35.27	36.41	37.91	39.70	41.65	43.67	45.61	47.60	49.58	51.55	53.57	55.66	57.72
2010	40.56	42.20	42.27	39.88	38.98	36.60	35.34	34.76	34.54	34.18	33.39	32.29	31.28	30.68	30.59	31.20	32.26	33.59	35.22	37.03	39.03	41.09	43.05	45.04	47.03	49.02	51.07	53.15	55.23	57.18
2011	34.33	36.72	31.88	31.24	29.41	28.52	28.09	27.93	27.60	26.91	26.17	25.81	25.93	26.42	27.46	28.93	30.59	32.35	34.23	36.26	38.31	40.23	42.21	44.19	46.17	48.20	50.26	52.32	54.30	56.34
2012	34.59	30.06	29.13	27.38	26.83	26.63	26.59	26.29	25.64	24.87	24.38	24.28	24.54	25.39	26.68	28.36	30.23	32.08	34.04	36.03	37.92	39.90	41.88	43.85	45.87	47.92	49.96	51.94	53.99	56.00
2013	33.06	31.69	29.86	29.22	29.08	29.12	28.90	28.22	27.25	26.27	25.51	25.07	25.13	25.67	26.76	28.28	30.07	31.97	33.89	35.73	37.63	39.57	41.52	43.52	45.55	47.57	49.51	51.55	53.56	55.53
2014	32.62	30.98	29.90	29.48	29.49	29.36	28.81	27.90	26.93	25.97	25.08	24.60	24.62	25.23	26.34	27.83	29.72	31.60	33.41	35.30	37.20	39.13	41.12	43.14	45.16	47.10	49.13	51.14	53.16	55.53
2015	33.56	32.71	31.87	31.32	30.87	30.27	29.46	28.56	27.60	26.60	25.66	25.13	25.02	25.56	26.63	28.14	29.98	31.72	33.56	35.45	37.34	39.32	41.33	43.34	45.28	47.30	49.30	51.32	53.69	57.17
2016	34.10	33.48	32.80	31.99	30.98	30.02	29.22	28.36	27.34	26.32	25.46	25.01	25.03	25.66	26.77	28.34	30.06	31.84	33.68	35.56	37.51	39.51	41.52	43.45	45.47	47.46	49.47	51.84	55.31	57.33
2017	34.19	33.72	32.81	31.49	30.20	29.32	28.56	27.65	26.62	25.57	24.87	24.58	24.75	25.56	26.83	28.34	30.10	31.88	33.68	35.57	37.55	39.54	41.47	43.48	45.47	47.46	49.82	53.28	55.30	57.31
2018	34.13	33.39	32.03	30.38	29.22	28.47	27.67	26.77	25.72	24.76	24.29	24.20	24.61	25.54	26.78	28.32	30.11	31.87	33.69	35.62	37.60	39.50	41.51	43.49	45.48	47.83	51.27	53.29	55.30	57.31
2019	33.86	32.67	30.92	29.36	28.41	27.69	26.91	25.99	24.97	24.25	23.90	24.03	24.62	25.50	26.75	28.32	30.08	31.85	33.71	35.67	37.57	39.55	41.52	43.51	45.85	49.28	51.28	53.29	55.30	57.31
2020	33.47	31.93	30.14	28.74	27.91	27.25	26.47	25.57	24.68	24.10	23.92	24.12	24.63	25.49	26.74	28.32	30.08	31.86	33.76	35.64	37.61	39.56	41.54	43.87	47.28	49.28	51.28	53.29	55.30	57.31



Federal Housing Administration  
Mutual Mortgage Insurance Fund

43. All Mortgages - PFS Probability\*

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	1.15	2.20	0.78	0.52	1.44	0.15	0.00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	2.29	1.29	1.00	1.24	0.65	1.02	0.00	0.97	1.67	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	
1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	2.48	2.84	1.70	0.78	0.87	1.24	0.34	0.35	0.00	0.00	0.00	1.58	0.00	0.00	0.00	3.14	0.00	0.00	0.00	0.00	0.50	0.51	
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.54	2.19	3.08	1.23	1.73	1.23	1.40	0.39	0.69	1.23	1.09	0.00	1.37	0.00	1.91	0.00	0.00	3.43	1.34	0.00	2.13	0.97	0.89	0.77	
1987	0.00	0.00	0.00	0.00	0.00	0.63	1.87	2.67	1.53	1.69	2.20	1.19	1.30	1.48	0.73	0.55	0.52	0.50	0.46	0.50	0.00	0.00	0.91	1.26	1.36	2.31	0.95	0.90	0.83	0.76	
1988	0.00	0.00	0.00	0.00	0.47	1.36	1.71	0.98	2.67	2.50	1.76	1.40	1.72	0.59	0.62	0.96	0.59	1.73	1.17	1.30	0.00	0.00	3.36	0.00	2.43	1.03	0.98	0.86	0.76	0.68	
1989	0.00	0.00	0.00	0.49	1.51	1.83	2.72	3.24	3.53	2.44	1.51	2.62	1.72	0.49	2.03	1.24	1.45	0.00	0.92	0.00	1.29	1.68	0.88	1.62	1.26	1.22	1.07	0.94	0.83	0.74	
1990	0.00	0.00	0.64	2.10	2.30	3.08	5.19	5.48	4.11	2.31	2.16	1.97	2.35	0.97	0.00	1.38	1.47	0.63	0.69	0.99	2.82	0.00	2.19	1.44	1.35	1.20	1.07	0.97	0.87	0.79	
1991	0.00	1.32	2.56	2.69	4.33	5.97	6.56	5.79	3.78	3.93	3.07	2.12	1.45	2.30	0.66	2.30	2.18	2.39	1.54	0.50	0.97	4.03	1.57	1.57	1.41	1.26	1.12	1.00	0.90	0.81	
1992	2.17	2.93	3.51	6.60	9.46	9.29	7.65	5.84	5.02	2.03	3.00	0.79	2.22	3.24	2.00	1.53	0.00	0.00	1.40	1.40	3.18	2.02	1.97	1.76	1.57	1.40	1.25	1.13	1.02	0.92	
1993	3.73	3.74	9.19	11.87	10.85	7.59	7.49	4.82	4.03	2.63	2.57	1.77	1.14	0.97	2.06	0.00	0.82	3.03	2.78	5.66	2.59	2.48	2.22	2.00	1.82	1.64	1.49	1.34	1.21	1.10	
1994	4.02	9.74	12.38	11.31	8.22	6.67	4.41	3.37	2.96	1.51	1.51	2.89	1.54	2.09	1.76	0.88	2.57	4.66	6.25	2.76	2.67	2.41	2.17	1.96	1.76	1.60	1.45	1.30	1.18	1.05	
1995	11.19	12.14	11.32	7.58	5.59	4.39	4.24	3.10	1.86	2.32	1.62	3.43	0.82	0.00	1.48	2.93	2.70	4.09	2.89	2.80	2.50	2.20	1.95	1.73	1.56	1.40	1.26	1.13	1.02	0.91	
1996	28.58	15.30	8.89	7.07	4.87	4.04	3.50	2.41	2.33	2.70	1.40	2.16	1.47	1.65	2.24	2.70	5.00	3.29	3.11	2.79	2.48	2.22	1.98	1.78	1.60	1.44	1.29	1.16	1.04	0.94	
1997	29.02	10.85	7.02	6.12	4.36	4.07	3.04	3.14	2.63	2.33	3.14	1.13	1.68	3.23	5.62	4.65	3.68	3.52	3.17	2.81	2.50	2.23	2.00	1.80	1.62	1.45	1.31	1.18	1.06	0.95	
1998	26.39	10.54	7.68	6.19	5.00	3.41	2.86	3.06	2.85	2.19	1.15	2.48	5.01	5.15	5.36	4.83	4.54	4.07	3.64	3.27	2.93	2.64	2.38	2.14	1.92	1.73	1.56	1.40	1.26	1.14	
1999	24.13	12.14	9.32	6.41	4.33	4.70	5.09	4.03	2.54	2.11	3.15	3.11	5.80	6.54	5.73	5.39	4.85	4.33	3.88	3.48	3.13	2.81	2.53	2.28	2.05	1.85	1.66	1.50	1.35	1.22	
2000	21.83	13.83	8.78	5.94	6.05	5.81	4.44	4.48	3.35	3.90	4.32	6.64	7.97	6.29	5.85	5.26	4.71	4.22	3.78	3.41	3.06	2.75	2.48	2.23	2.01	1.81	1.63	1.46	1.32	1.19	
2001	32.59	15.32	9.33	8.80	7.72	6.41	5.42	3.72	4.73	5.83	8.77	9.32	8.56	7.94	7.14	6.41	5.77	5.19	4.67	4.21	3.79	3.42	3.08	2.77	2.50	2.25	2.03	1.83	1.64	1.48	
2002	35.77	15.08	11.34	10.13	8.93	6.90	5.81	7.29	8.23	10.96	11.87	10.41	9.73	8.80	7.94	7.19	6.50	5.87	5.29	4.77	4.31	3.89	3.51	3.16	2.85	2.57	2.32	2.09	1.88	1.71	
2003	16.07	15.22	13.42	12.13	8.97	8.14	9.66	11.26	14.63	15.27	13.64	12.80	11.69	10.57	9.55	8.67	7.89	7.13	6.44	5.81	5.25	4.76	4.30	3.88	3.50	3.16	2.85	2.57	2.32	2.10	
2004	13.19	14.82	13.67	10.84	9.37	9.71	11.92	14.77	15.75	14.55	13.77	12.53	11.23	10.10	9.11	8.28	7.51	6.78	6.13	5.53	5.01	4.54	4.10	3.70	3.34	3.01	2.72	2.46	2.22	2.02	
2005	24.87	17.74	12.94	10.23	11.11	13.12	16.94	17.83	16.11	15.33	14.00	12.55	11.32	10.25	9.30	8.47	7.69	6.97	6.31	5.71	5.18	4.70	4.25	3.84	3.46	3.13	2.83	2.56	2.31	2.10	
2006	29.90	19.17	14.59	15.28	16.92	20.95	19.76	18.93	18.02	16.49	14.79	13.34	12.09	11.00	10.01	9.13	8.30	7.53	6.83	6.19	5.62	5.09	4.61	4.17	3.77	3.41	3.07	2.77	2.50	2.27	
2007	40.83	18.99	16.65	19.36	25.83	19.02	21.98	20.99	19.26	17.35	15.70	14.28	13.03	11.90	10.87	9.93	9.04	8.22	7.47	6.78	6.15	5.58	5.05	4.57	4.13	3.73	3.37	3.04	2.75	2.48	
2008	44.16	29.59	27.32	35.48	29.16	29.23	27.91	25.94	23.71	21.69	19.89	18.27	16.77	15.37	14.06	12.88	11.78	10.74	9.78	8.91	8.11	7.38	6.71	6.09	5.53	5.02	4.55	4.12	3.73	3.38	
2009	71.86	45.51	44.29	40.90	35.65	33.73	31.84	29.69	27.57	25.54	23.62	21.80	20.08	18.47	16.97	15.61	14.34	13.15	12.05	11.03	10.09	9.22	8.41	7.67	6.98	6.35	5.77	5.24	4.75	4.31	
2010	70.81	64.95	53.78	37.82	35.93	34.25	32.29	30.27	28.29	26.36	24.50	22.72	21.02	19.42	17.93	16.59	15.31	14.09	12.95	11.88	10.89	9.97	9.11	8.32	7.58	6.91	6.28	5.71	5.18	4.71	
2011	92.65	68.70	41.27	39.28	37.60	35.70	33.69	31.68	29.70	27.76	25.89	24.09	22.39	20.77	19.24	17.87	16.54	15.26	14.05	12.91	11.86	10.87	9.94	9.09	8.30	7.56	6.89	6.27	5.70	5.17	
2012	91.19	40.89	39.89	38.98	37.39	35.48	33.49	31.50	29.53	27.61	25.75	23.97	22.28	20.67	19.16	17.78	16.45	15.17	13.97	12.84	11.78	10.80	9.88	9.03	8.23	7.51	6.84	6.22	5.65	5.13	
2013	42.21	42.87	41.99	40.20	38.20	36.14	34.09	32.05	30.05	28.08	26.19	24.37	22.64	21.01	19.47	18.03	16.67	15.38	14.16	13.01	11.94	10.96	10.03	9.16	8.36	7.63	6.96	6.33	5.75	5.26	
2014	46.64	45.12	43.39	41.39	39.28	37.15	35.02	32.91	30.83	28.81	26.86	24.99	23.22	21.55	19.97	18.49	17.11	15.78	14.53	13.36	12.27	11.27	10.31	9.42	8.61	7.86	7.17	6.53	5.93	5.39	
2015	45.91	44.26	42.53	40.61	38.59	36.51	34.40	32.30	30.25	28.26	26.33	24.50	22.75	21.10	19.54	18.08	16.72	15.41	14.18	13.03	11.97	10.98	10.05	9.18	8.38	7.65	6.98	6.35	5.77	5.24	
2016	45.25	43.56	41.82	39.93	37.96	35.91	33.81	31.74	29.70	27.72	25.82	24.01	22.28	20.65	19.11	17.68	16.34	15.06	13.85	12.72	11.67	10.71	9.80	8.95	8.17	7.45	6.80	6.19	5.62	5.10	
2017	45.27	43.55	41.81	39.95	37.98	35.90	33.80	31.71	29.68	27.71	25.82	24.01	22.29	20.67	19.14	17.70	16.37	15.08	13.87	12.74	11.69	10.73	9.82	8.97	8.19	7.47	6.82	6.19	5.63	5.11	
2018	45.28	43.58	41.86	40.01	38.00	35.88	33.76	31.67	29.64	27.67	25.79	23.99	22.28	20.66	19.13	17.70	16.37	15.08	13.87	12.74	11.70	10.73	9.82	8.97	8.19	7.47	6.81	6.19	5.62	5.11	
2019	45.29	43.62	41.93	40.05	37.99	35.85	33.72	31.63	29.60	27.64	25.75	23.96	22.26	20.65	19.12	17.69	16.36	15.07	13.86	12.73	11.69	10.73	9.81	8.97	8.18	7.45	6.80	6.19	5.62	5.11	
2020	45.31	43.68	42.00	40.08	37.98	35.82	33.69	31.61	29.57	27.62	25.74	23.96	22.26	20.64	19.12	17.69	16.35	15.07	13.86	12.73	11.69	10.72	9.81	8.96	8.17	7.44	6.80	6.18	5.62	5.10	

\*Probability is weighted by origination mortgage amount.

Federal Housing Administration  
Mutual Mortgage Insurance Fund

50. All Mortgages - REO Loss Rates<sup>a</sup>

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1983	41.13	45.14	45.68	46.30	49.31	48.24	46.08	45.41	45.28	44.47	42.88	44.07	44.60	48.99	48.25	49.32	49.13	46.56	42.83	46.57	39.03	39.40	62.13	64.18	86.86	74.23	75.91	106.97	58.21	24.45
1984	43.46	44.59	47.77	50.36	50.50	50.72	50.00	50.25	52.39	50.89	51.49	53.29	54.53	74.90	63.14	58.25	54.00	49.79	71.77	52.82	82.90	58.67	87.60	114.58	89.57	110.37	128.05	72.78	53.36	82.91
1985	40.89	47.18	49.35	48.77	47.58	46.94	46.97	46.48	46.44	48.07	47.07	46.27	49.34	51.84	53.19	50.25	55.18	51.02	46.30	53.15	61.15	59.50	92.80	88.83	59.49	83.98	46.27	55.44	82.44	83.01
1986	45.18	48.65	48.14	45.25	44.30	42.51	42.03	39.87	38.33	37.08	36.47	36.85	36.77	36.63	34.55	36.89	35.61	35.57	32.64	49.58	38.08	55.06	67.87	47.53	52.86	51.70	50.41	72.78	74.29	76.78
1987	49.43	44.32	43.47	43.26	42.09	41.99	39.74	38.16	36.64	37.37	36.35	37.29	37.54	36.42	35.73	36.47	38.70	38.49	45.00	47.72	63.46	62.38	57.53	67.05	51.32	51.66	72.92	74.06	76.05	77.80
1988	44.98	38.97	41.58	42.15	42.50	42.37	42.60	42.70	42.94	41.99	44.83	42.70	43.76	41.87	40.05	37.99	44.74	50.13	51.39	71.61	78.24	68.35	81.99	57.56	51.01	69.95	71.58	73.98	75.94	77.61
1989	40.79	40.88	40.71	43.21	44.40	45.25	45.70	46.92	46.32	46.34	46.32	44.28	41.73	41.89	41.35	46.71	53.96	61.07	80.53	78.93	71.99	72.74	73.42	58.55	69.70	70.76	72.85	74.82	76.40	77.81
1990	38.89	38.81	41.05	44.49	47.42	48.21	50.50	49.95	49.70	49.57	46.94	43.32	45.78	44.74	44.81	52.06	66.20	76.15	78.98	73.96	84.42	70.15	58.64	69.21	70.58	72.78	74.95	76.67	78.17	79.95
1991	42.58	39.08	42.70	45.71	47.63	49.93	50.98	50.54	48.13	43.85	42.77	38.31	39.41	40.87	50.36	60.84	85.02	82.86	71.12	72.42	66.56	54.64	65.22	65.74	67.64	69.88	71.90	73.65	75.46	77.00
1992	32.30	40.23	42.40	43.98	46.21	46.85	46.22	45.79	40.18	34.01	31.84	30.87	35.37	48.00	48.06	69.75	65.99	64.19	68.70	64.84	54.42	59.69	60.02	62.31	64.86	67.08	68.98	70.78	72.43	74.19
1993	35.57	39.63	41.34	43.10	44.64	42.82	40.66	35.51	30.96	27.94	28.42	35.83	39.65	49.52	62.17	66.42	59.55	62.29	56.75	51.74	57.00	58.09	60.25	62.26	64.07	65.75	67.44	69.01	70.91	72.86
1994	36.73	38.99	42.20	42.05	41.12	39.01	34.47	29.23	27.88	27.76	30.75	40.37	47.18	63.76	65.37	58.80	63.52	60.46	56.78	55.43	55.72	57.55	59.60	61.55	63.35	65.07	66.67	68.55	70.68	72.78
1995	35.05	40.78	42.08	40.97	40.98	38.79	33.03	32.19	32.82	35.33	40.63	47.48	70.28	67.55	67.37	69.62	68.63	58.73	54.54	54.99	56.76	58.76	60.67	62.49	64.26	65.84	67.71	69.87	72.03	74.16
1996	43.12	41.95	39.76	38.53	35.81	32.50	31.08	31.12	34.24	39.47	48.11	61.88	68.63	67.77	70.81	69.50	61.59	53.47	53.75	55.06	56.76	58.45	60.09	61.78	63.34	65.20	67.33	69.47	71.60	73.68
1997	44.94	41.06	38.90	35.69	32.41	30.94	31.21	33.95	38.32	45.22	63.23	70.01	66.95	71.38	66.12	63.26	53.44	52.71	53.42	54.87	56.43	58.03	59.58	61.00	62.80	64.92	67.05	69.12	71.24	73.26
1998	41.56	39.01	33.86	30.42	29.36	29.71	31.86	37.24	45.41	62.23	65.76	66.44	69.00	69.08	66.44	52.58	52.13	52.14	52.98	54.01	55.33	56.65	57.88	59.53	61.62	63.75	65.82	67.90	69.91	71.91
1999	37.56	35.73	31.15	29.13	30.03	32.53	37.57	44.00	59.92	65.78	65.72	68.54	70.52	65.73	52.05	51.70	51.35	51.88	52.68	53.87	54.93	55.81	57.12	59.04	61.15	63.20	65.26	67.25	69.26	71.31
2000	38.92	33.77	32.03	33.99	36.75	41.17	48.63	62.89	70.68	71.35	76.85	77.34	73.00	52.75	52.53	51.79	51.87	52.33	53.13	54.19	54.96	55.93	57.53	59.49	61.50	63.54	65.54	67.55	69.63	71.70
2001	30.78	32.97	34.23	36.71	40.22	45.74	59.28	67.29	67.88	71.89	73.42	67.89	53.88	52.86	51.05	50.40	50.40	50.67	51.09	51.28	51.72	52.75	54.32	56.18	58.14	60.10	62.12	64.21	66.36	68.44
2002	31.40	34.66	36.87	39.89	44.24	55.20	61.57	63.58	68.47	69.26	65.59	55.47	54.01	51.45	50.20	49.79	49.76	49.70	49.35	49.30	50.00	51.23	52.86	54.70	56.60	58.58	60.67	62.82	64.98	67.03
2003	38.36	37.49	38.35	41.84	52.21	57.88	59.74	63.87	63.19	61.14	57.92	56.78	53.44	51.21	50.01	49.66	49.39	48.59	47.79	47.75	48.37	49.34	50.85	52.54	54.38	56.35	58.46	60.61	62.82	64.79
2004	40.85	39.22	41.30	49.70	57.08	60.86	63.72	65.80	63.75	61.50	60.66	57.08	54.48	52.88	52.04	51.57	50.63	49.53	48.92	49.01	49.54	50.56	51.92	53.50	55.28	57.19	59.22	61.36	63.32	65.20
2005	38.43	42.40	50.82	58.37	61.81	65.82	67.26	65.56	66.56	65.80	62.39	59.73	57.90	56.62	55.57	54.30	52.89	51.74	51.14	51.04	51.34	51.99	53.09	54.51	56.13	57.86	59.77	61.54	63.37	65.13
2006	39.83	51.02	60.02	64.10	68.03	69.96	68.67	69.25	68.77	65.68	63.08	61.31	59.95	58.67	57.05	55.42	54.02	52.87	52.06	51.74	51.82	52.33	53.36	54.72	56.24	57.95	59.58	61.32	63.11	64.88
2007	54.00	58.86	63.33	68.57	70.72	69.72	68.90	68.25	65.63	63.38	61.68	60.35	59.11	57.52	55.75	54.25	52.99	51.82	50.90	50.44	50.48	51.11	52.18	53.53	55.08	56.60	58.25	59.96	61.77	63.57
2008	58.15	59.06	64.47	66.58	63.82	61.96	60.77	58.02	55.84	54.17	52.96	51.78	50.24	48.48	46.85	45.49	44.31	43.42	43.07	43.35	44.12	45.29	46.82	48.57	50.29	52.15	54.09	56.03	57.99	59.98
2009	53.33	60.40	59.79	56.67	50.74	49.14	45.83	43.59	42.19	41.33	40.42	39.06	37.40	35.83	34.66	34.06	34.23	35.00	36.14	37.67	39.51	41.50	43.57	45.54	47.55	49.56	51.53	53.57	55.67	57.75
2010	58.99	54.79	50.61	45.39	43.69	40.50	38.59	37.46	36.74	35.82	34.43	32.81	31.40	30.54	30.29	30.85	31.90	33.25	34.92	36.79	38.84	40.96	42.95	44.98	46.99	49.00	51.07	53.17	55.26	57.22
2011	52.26	44.69	36.49	35.10	32.38	30.82	29.84	29.18	28.29	27.03	25.84	25.21	25.19	25.62	26.67	28.20	29.93	31.78	33.74	35.86	37.99	39.97	41.99	44.01	46.03	48.09	50.19	52.27	54.27	56.33
2012	30.52	34.84	33.02	30.27	29.04	28.28	27.72	26.83	25.58	24.33	23.53	23.26	23.43	24.31	25.65	27.43	29.41	31.37	33.44	35.52	37.49	39.53	41.56	43.59	45.65	47.74	49.82	51.82	53.90	55.94
2013	37.97	35.44	32.95	31.86	31.24	30.76	29.91	28.55	26.97	25.50	24.41	23.77	23.78	24.34	25.50	27.13	29.05	31.09	33.13	35.06	37.04	39.06	41.08	43.14	45.23	47.30	49.28	51.36	53.40	55.39
2014	37.37	35.36	33.78	32.82	32.25	31.41	30.09	28.43	26.84	25.40	24.12	23.44	23.36	23.97	25.15	26.75	28.79	30.79	32.69	34.67	36.65	38.65	40.72	42.79	44.87	46.85	48.92	50.97	53.02	55.44
2015	38.80	37.57	36.22	35.04	33.85	32.44	30.86	29.27	27.71	26.20	24.89	24.12	23.89	24.41	25.53	27.15	29.12	30.95	32.88	34.85	36.83	38.87	40.95	43.03	45.01	47.08	49.11	51.16	53.59	57.17
2016	39.54	38.55	37.24	35.65	33.81	32.06	30.54	29.04	27.43	25.94	24.72	24.05	23.96	24.58	25.75	27.43	29.24	31.11	33.04	35.00	37.03	39.10	41.17	43.15	45.22	47.25	49.30	51.73	55.31	57.34
2017	39.74	38.71	37.03	34.84	32.76	31.15	29.71	28.16	26.58	25.05	24.03	23.56	23.65	24.48	25.83	27.42	29.28	31.15	33.04	35.02	37.08	39.14	41.11	43.18	45.22	47.26	49.67	53.26	55.30	57.32
2018	39.58	38.17	35.94	33.46	31.57	30.11	28.64	27.13	25.53	24.12	23.39	23.15	23.52	24.48	25.77	27.41	29.29	31.15	33.05	35.07	37.13	39.09	41.16	43.19	45.23	47.65	51.23	53.27	55.30	57.32
2019	39.15	37.20	34.61	32.29	30.63	29.19	27.77	26.24	24.68	23.58	22.98	23.00	23.56	24.44	25.75	27.41	29.27	31.12	33.08	35.13	37.09	39.14	41.18	43.21	45.63	49.21	51.24	53.27	55.30	57.32
2020	38.56	36.30	33.75	31.62	30.06	28.71	27.28	25.78	24.39	23.45	23.05	23.14	23.57	24.44	25.75	27.41	29.26	31.14	33.14	35.09	37.13	39.15	41.19	43.61	47.19	49.22	51.24	53.26	55.29	57.32

Federal Housing Administration  
Mutual Mortgage Insurance Fund

57. All Mortgages - PFS Loss Rates<sup>a</sup>

Book/Policy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1983	55.12	85.54	82.45	77.90	95.52	93.75	96.69	88.98	78.13	63.97	47.02	41.02	45.27	64.47	31.61	80.84	0.00	0.00	0.00	0.00	0.00	12.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	86.59	90.01	101.22	106.67	105.86	101.56	92.12	83.94	71.71	53.87	65.39	38.72	39.35	46.51	48.71	0.00	46.72	27.73	53.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.98	
1985	106.84	89.31	96.13	91.63	93.91	85.17	77.34	55.15	45.30	51.31	37.73	45.90	28.52	33.74	30.31	62.40	0.00	0.00	0.00	26.79	0.00	0.00	0.00	26.39	0.00	0.00	0.00	64.80	65.57		
1986	77.27	84.70	88.02	83.24	73.02	64.49	56.84	43.33	38.44	42.79	30.70	29.65	35.28	20.76	23.12	25.44	30.21	0.00	33.33	0.00	32.92	0.00	59.29	31.05	59.90	0.00	47.66	61.15	62.98	64.52	
1987	90.64	88.97	81.60	75.00	71.19	55.20	44.65	39.70	37.95	27.58	39.16	24.30	22.93	19.23	21.92	28.73	18.35	27.08	41.01	17.71	0.00	0.00	4.11	84.84	50.95	29.14	61.13	62.25	63.41	64.56	
1988	107.79	89.46	86.06	72.28	68.03	53.37	49.12	45.12	32.34	35.71	30.85	21.83	26.48	17.55	21.31	42.65	24.33	39.62	26.61	44.29	0.00	0.00	30.65	0.00	43.73	60.08	61.28	62.64	63.85	65.23	
1989	88.41	89.07	80.21	69.11	57.98	49.59	38.74	35.29	31.94	27.79	14.55	26.20	20.03	16.19	19.86	25.46	17.17	0.00	17.67	0.00	21.43	83.66	50.84	97.43	58.47	60.62	61.83	62.74	63.91	65.15	
1990	114.15	86.92	75.48	58.02	49.40	39.74	32.01	30.33	27.85	25.36	22.67	19.48	24.89	19.84	0.00	38.68	56.48	38.14	45.15	55.72	46.16	0.00	32.57	57.47	58.95	60.10	61.20	62.55	63.98	65.67	
1991	80.68	68.37	54.67	47.99	35.89	35.59	30.39	27.31	27.94	22.09	19.46	25.54	31.71	25.32	23.80	35.80	19.55	33.21	43.53	43.82	62.54	20.84	53.49	54.90	55.99	57.13	58.52	59.99	61.74	63.43	
1992	63.33	54.37	39.85	33.43	31.07	30.70	27.80	26.18	26.75	18.58	28.69	19.09	16.27	41.85	27.95	29.89	0.00	0.00	59.22	55.66	53.08	50.01	50.42	51.64	53.16	54.82	56.52	58.31	60.12	61.86	
1993	54.84	36.98	29.82	29.12	29.64	26.03	24.27	22.66	17.06	22.77	16.07	15.94	28.98	35.72	26.31	0.00	57.84	26.55	38.64	31.63	49.15	49.76	50.76	52.07	53.65	55.27	57.10	58.92	60.71	62.45	
1994	35.79	32.85	28.68	27.48	25.03	21.69	21.76	19.74	21.93	27.00	21.90	23.21	12.94	30.78	24.28	27.63	39.06	44.42	38.84	46.83	47.73	48.78	50.01	51.49	53.01	54.70	56.43	58.13	59.84	61.58	
1995	43.21	27.38	24.04	22.88	21.49	23.13	26.09	26.27	20.63	19.11	25.85	20.97	18.02	0.00	38.42	48.97	55.49	52.73	43.64	44.43	45.82	47.39	49.07	50.81	52.58	54.37	56.16	57.96	59.72	61.42	
1996	20.12	21.05	21.29	20.49	21.25	20.63	21.35	22.43	21.33	30.67	30.51	41.57	25.72	24.25	41.24	44.49	41.57	42.57	43.42	44.52	45.83	47.36	48.98	50.72	52.50	54.28	56.06	57.85	59.64	61.37	
1997	20.21	19.43	19.17	19.44	21.09	22.82	22.65	26.39	24.49	25.20	26.25	23.59	32.96	58.72	42.07	51.29	41.00	41.54	42.47	43.68	45.15	46.72	48.40	50.12	51.88	53.65	55.42	57.21	58.99	60.71	
1998	18.78	18.13	19.54	19.15	18.62	21.63	20.72	25.31	23.15	24.81	27.07	32.60	47.94	41.17	51.55	39.80	40.49	41.22	42.30	43.68	45.21	46.83	48.50	50.20	51.96	53.72	55.48	57.26	59.03	60.76	
1999	15.63	16.83	18.63	18.58	19.95	23.99	22.73	24.20	23.79	25.37	35.84	47.60	49.97	48.00	38.58	39.09	39.65	40.58	41.88	43.35	44.96	46.52	48.10	49.78	51.54	53.29	55.05	56.82	58.58	60.24	
2000	13.80	17.34	19.15	21.35	24.54	26.31	28.76	25.76	26.32	42.35	52.49	52.66	59.98	37.67	38.26	38.43	39.02	40.06	41.31	42.79	44.26	45.71	47.28	48.98	50.73	52.49	54.26	56.03	57.80	59.48	
2001	15.84	17.37	20.06	23.22	23.91	24.34	25.77	27.75	37.22	47.59	52.89	53.45	38.93	39.01	38.65	38.94	39.79	40.82	42.03	43.25	44.50	45.87	47.42	49.10	50.83	52.57	54.33	56.11	57.88	59.61	
2002	16.52	19.93	22.53	23.38	23.69	23.35	26.58	36.91	43.90	48.82	51.16	39.49	39.41	38.55	38.44	39.02	39.87	40.84	41.78	42.75	43.95	45.36	46.96	48.64	50.37	52.10	53.86	55.62	57.38	59.14	
2003	18.95	22.19	22.00	22.83	23.71	25.60	34.90	40.70	46.42	46.94	41.36	41.67	40.28	39.46	39.65	40.29	41.13	41.86	42.49	43.34	44.49	45.79	47.28	48.90	50.58	52.28	53.99	55.75	57.49	59.12	
2004	18.22	21.22	22.16	23.52	25.45	34.21	40.14	44.96	47.66	43.35	43.94	42.02	40.59	40.28	40.56	41.25	41.86	42.32	42.86	43.69	44.73	45.95	47.35	48.86	50.43	52.03	53.68	55.38	57.04	58.49	
2005	18.92	21.63	23.02	26.00	35.61	43.31	48.55	48.96	47.27	47.87	45.77	43.86	43.02	42.78	43.01	43.38	43.66	43.90	44.36	45.08	45.92	46.92	48.11	49.41	50.79	52.21	53.70	55.26	56.80	58.25	
2006	19.60	23.72	26.59	36.51	46.05	51.28	53.62	49.00	50.01	47.80	45.55	44.48	43.98	43.94	44.00	44.13	44.30	44.55	44.98	45.57	46.32	47.22	48.25	49.41	50.67	52.01	53.43	54.91	56.42	57.92	
2007	22.52	27.87	37.94	47.48	53.27	56.60	49.41	50.43	48.44	46.29	45.13	44.54	44.46	44.47	44.48	44.58	44.76	45.05	45.37	45.89	46.58	47.41	48.41	49.58	50.83	52.19	53.61	55.09	56.62	58.14	
2008	27.82	35.86	43.20	49.75	51.87	43.66	44.32	42.56	40.85	39.81	39.35	39.41	39.57	39.61	39.64	39.78	40.05	40.38	40.97	41.79	42.79	43.95	45.31	46.78	48.34	49.95	51.61	53.30	55.00	56.70	
2009	30.75	37.52	40.96	42.18	35.81	35.78	34.05	32.89	32.47	32.61	33.16	33.66	33.94	34.15	34.46	35.03	35.89	37.04	38.37	39.85	41.45	43.10	44.80	46.53	48.26	49.99	51.73	53.49	55.27	57.04	
2010	35.01	36.16	36.14	30.83	30.58	29.13	28.52	28.53	28.95	29.61	30.17	30.52	30.83	31.27	31.95	32.97	34.27	35.69	37.23	38.84	40.53	42.26	44.01	45.76	47.51	49.27	51.05	52.84	54.62	56.36	
2011	33.10	34.00	25.33	25.28	24.49	24.37	24.66	25.23	25.97	26.60	27.12	27.70	28.49	29.50	30.77	32.30	33.90	35.52	37.19	38.91	40.66	42.41	44.16	45.93	47.70	49.49	51.27	53.05	54.84	56.60	
2012	34.73	23.16	23.26	22.86	23.13	23.64	24.35	25.11	25.78	26.29	26.81	27.50	28.39	29.56	31.01	32.66	34.37	36.03	37.72	39.44	41.18	42.96	44.74	46.52	48.30	50.09	51.86	53.64	55.43	57.21	
2013	26.34	26.69	25.58	25.29	25.60	26.23	26.95	27.53	27.91	28.24	28.60	29.09	29.75	30.70	31.97	33.49	35.14	36.81	38.50	40.22	41.96	43.72	45.50	47.28	49.06	50.83	52.60	54.38	56.16	57.89	
2014	27.19	25.66	24.84	24.74	25.23	25.90	26.45	26.80	27.11	27.40	27.69	28.10	28.79	29.80	31.09	32.58	34.27	35.94	37.65	39.39	41.13	42.90	44.69	46.47	48.25	50.02	51.79	53.57	55.35	57.12	
2015	27.39	26.59	26.00	25.87	26.13	26.49	26.79	27.07	27.35	27.59	27.80	28.23	28.87	29.86	31.13	32.61	34.28	35.95	37.66	39.39	41.15	42.92	44.70	46.48	48.26	50.03	51.80	53.58	55.36	57.14	
2016	27.51	26.92	26.62	26.49	26.37	26.37	26.62	26.90	27.12	27.31	27.60	28.06	28.77	29.81	31.08	32.60	34.27	35.95	37.65	39.40	41.16	42.94	44.71	46.49	48.27	50.05	51.81	53.59	55.37	57.16	
2017	27.49	27.25	26.94	26.45	26.04	26.05	26.31	26.55	26.72	26.93	27.29	27.82	28.59	29.70	31.05	32.60	34.29	35.96	37.66	39.39	41.16	42.93	44.71	46.49	48.27	50.05	51.81	53.59	55.38	57.15	
2018	27.55	27.21	26.59	25.76	25.39	25.53	25.78	25.98	26.18	26.43	26.89	27.52	28.43	29.62	31.03	32.59	34.28	35.96	37.65	39.39	41.17	42.94	44.72	46.50	48.28	50.05	51.82	53.60	55.38	57.16	
2019	27.47	26.81	25.81	24.97	24.79	25.01	25.23	25.46	25.66	26.02	26.54	27.29	28.33	29.57	30.99	32.57	34.26	35.92	37.63	39.40	41.18	42.95	44.73	46.51	48.28	50.06	51.83	53.61	55.39	57.16	
2020	27.31	26.29	25.16	24.44	24.41	24.63	24.89	25.11	25.37	25.81	26.42	27.24	28.31	29.53	30.96	32.55	34.23	35.89	37.63	39.40	41.18	42.95	44.73	46.50	48.29	50.07	51.83	53.61	55.38	57.16	

<sup>a</sup>Severity is expressed as a percent of