Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund HECM Loans For Fiscal Year 2015

November 16, 2015

Prepared for

U.S. Department of Housing and Urban Development

By

Integrated Financial Engineering, Inc.

Integrated Financial Engineering

IFE Group, 51 Monroe Street, Suite 1100, Rockville, MD 20850, U.S.A

Phone: (301) 309-6560
Fax: (301) 309-6562
info@ifegroup.com

November 16, 2015

The Honorable Golding, Edward
Principal Deputy 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 Dr. Golding:

IFE Group has completed and, along with this letter, is submitting the fiscal year 2015 Actuarial Review of the Mutual Mortgage Insurance Fund Home Equity Conversion Mortgages (the HECM Fund).

We estimate that the HECM Fund's economic value as of the end of fiscal year 2015 was *positive* $6,778 million and the insurance in force was $105.23 billion. We project that at the end of fiscal year 2022 the HECM Fund's economic value will be $13,665 million and the insurance in force will be $184.49 billion.

The financial estimates presented in this Review require projections of events as long as 74 years into the future. These projections are dependent upon the validity and robustness of the underlying model and assumptions about the future economic environment and loan characteristics. These assumptions include economic forecasted by Moody's Analytics and the assumptions concerning compositions of future endorsements projected by FHA. To the extent that actual events deviate from these or other assumptions, the actual results may differ, perhaps significantly, from our current projections. The models used for this Review are, by nature, large and complex. We applied an extensive validation process to assure that the results reported in this Review are accurate and reliable.

The full actuarial report explains these projections and the reasons for the changes since last year's actuarial review.

Very truly yours,

Tyler T. Yang, Ph.D.
Chairman and CEO
Integrated Financial Engineering, Inc.

Actuarial Review of the
Federal Housing Administration
Mutual Mortgage Insurance Fund
HECM Loans
for Fiscal Year 2015

I have reviewed the "Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund, HECM Loans, for Fiscal Year 2015". The purpose of my review was to determine the soundness of the methodology used, the appropriateness of the underlying assumptions applied, and the reasonableness of the resulting estimates derived in the Review

The Review was based upon data and information prepared by the Federal Housing Administration (FHA). I have relied upon the FHA for the accuracy and completeness of this data. In addition, I also relied upon the reasonableness of the assumptions used in the economic projections prepared by Moody's Analytics, from which the base case used in the Review was derived.

It is my opinion that on an overall basis the methodology and underlying assumptions used in the Review are reasonable and appropriate in the circumstances. In my opinion the estimates in the Review lie within a reasonable range of probable values as of this time although the actual experience in the future will not unfold as projected.

Phelim Boyle, Ph.D., FIA, FCIA
Fellow of the Institute of Actuaries (UK)
Fellow of the Canadian Institute of Actuaries
November 16, 2015

Table of Contents

Executive Summary

The U.S. Department of Housing and Urban Development (HUD), Federal Housing Administration (FHA), provides reverse mortgage insurance through the Home Equity Conversion Mortgage (HECM) program. HECMs enable senior homeowners to obtain additional income by accessing the equity in their homes. The program began as a pilot program in 1989 and became permanent in 1998. Between 2003 and 2008, the number of HECM endorsements grew because of increasingly widespread product knowledge, lower interest rates, higher home values, and higher FHA loan limits. Prior to fiscal year (FY) 2009, the HECM program was part of the General Insurance (GI) Fund. The Federal Housing Administration Modernization Act within the Housing and Economic Recovery Act of 2008 (HERA)[1] moved all new HECM program endorsements into the Mutual Mortgage Insurance (MMI) Fund effective in FY 2009. At the beginning of 2014, the HECM Standard and HECM Saver programs were replaced with HECMs that reduced the initial and total allowable drawdowns in order to strengthen the financial condition of the program.[2] Also in 2014, FHA allowed a Non-Borrowing Spouse to be younger than 62[3] and implemented more conservative principal limit factors.[4] Then, in 2015, FHA introduced the Life Expectancy Set-Aside Growth Rate and related requirements to address tax and insurance defaults; additional guidance on HECM "Due and Payable" policies and timing requirements; and permissible loss mitigation options when property charges are not paid.

The National Housing Act requires an independent annual actuarial study of FHA's MMI Fund.[5] Accordingly, an actuarial review must be conducted on HECM loans within the MMI Fund. This document reports the estimated economic values of the FY 2015 through FY 2022 MMI HECM portfolios. A fiscal year's MMI HECM portfolio is defined as the loans that survive to the end of the fiscal year and were endorsed in FY 2009 or later. In addition to the initial capital reserve, the economic value of the portfolio depends on the net present value of the future cash flows from the surviving portfolio of loans existing at the start of the valuation forecast (the end of the fiscal year under review). Our projections indicate that, as of the end of FY 2015, the HECM portion of the MMI fund has an economic value of *positive* $6,778 million. The primary source of this increase from last year's estimate of negative $1,166 million was the change in the discount factors defined by the Office of Management and Budget (OMB) and the more favorable economic forecast by Moody's. These two changes contributed an increase of $9,223 million to the economic value of the MMI HECM Fund.

[1] HERA was passed by the United States Congress on July 24, 2008 and signed by President George W. Bush on July 30, 2008.
[2] Mortgagee Letter 2013-27, September 3, 2013: Changes to the Home Equity Conversion Mortgage Program Requirements.
[3] Mortgage Letter 2014-07, April 25th, 2014: Home Equity Conversion Mortgage (HECM) Program: Non-Borrowing Spouse.
[4] Principal Limit Factors following Mortgagee Letter 2014-12 provided PLFs for non-borrowing spouse and also revised PLFs for borrowers 62 and above.
[5] HERA moved the requirement from the 1990 National Affordable Housing Act (NAHA) to the Federal Housing Administration operations within the National Housing Act, 12 USC 1708(a)(4).

A. Status of the MMI HECM Portfolio

In order to assess the adequacy of the current and future capital resources to meet estimated future net liabilities, we analyzed all HECM historical terminations and associated recoveries using loan-level HECM performance data maintained by FHA through March 31, 2015. We developed loan-level termination and recovery models using various economic and loan-specific factors. We then estimated the future loan performance of the FY 2015 through FY 2022 MMI HECM portfolios using various assumptions, including macroeconomic forecasts that distinguish 100 possible future scenarios and the expected HECM portfolio characteristics provided by FHA.

Based on our evaluation of the HECM loans in the FY 2015 portfolio, we estimated the economic value of the HECM Fund to be *positive* $6,778 million. We also estimated that the economic value of the HECM portfolio will subsequently improve over time. Policy changes and more favorable future economic forecasts are predicted to increase the financial strength of future endorsements as well as the existing books of business.[6] The economic value of the HECM Fund as of the end of FY 2022 is estimated to be $13,665 million.

The maximum claim amount (MCA) of a HECM loan serves as the cap on the amount of insurance claims that FHA will pay the lender. The MCA is defined as the minimum of the appraised value and FHA's HECM loan limit at the time of origination. The insurance-in-force (IIF) is expressed as the sum of the MCAs of the active portfolio. As new endorsements are added to the portfolio, projected HECM IIF increases from $105,234 million in FY 2015 to $184,492 million in FY 2022. Exhibit ES-1 provides the baseline economic values of the HECM portfolio, IIF and new endorsements for FY 2015 through FY 2022.

[6] Details of the policy changes are provided in Section I of this Review.

Exhibit ES-1. Baseline Economic Value, Insurance-in-Force, and Endorsements for FY 2015-FY 2022 ($ Million)

Fiscal Year*	Economic Value	Insurance in Force**	Volume of New Endorsements***	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	6,778	105,234	15,763	302	
2016	7,429	109,334	15,073	575	76
2017	8,222	120,424	17,035	636	157
2018	9,135	132,573	18,340	692	221
2019	10,133	145,236	19,548	716	282
2020	11,213	158,091	20,866	738	342
2021	12,395	171,103	22,283	788	394
2022	13,665	184,492	23,715	823	447

*All values are expressed as of the end of the fiscal year.
**Insurance-in-force is estimated as the sum of the MCAs of the remaining insured loans.
*** Projections are based on the HECM demand model in Appendix E times the average MCA. The volume number in FY 2015 reflects the outstanding loans at the end of the fiscal year, and excludes loans endorsed and terminated in the same fiscal year.

B. Sources of Change in the Status of the Fund

The economic value of the HECM Fund increased by $7,944 million from the estimated FY 2014 economic value of *negative* $1,166 million as estimated in the FY 2014 Review. This change was driven primarily by four main factors:

- Actual data performance and portfolio status update reduces the FY 2015 economic value by $345 million.
- The 2015 model update and policy change lowers the FY 2015 economic value by $1,089 million.
- Updating the economic scenario forecast increases the FY 2015 economic value by $4,763 million.
- The discount factor update increase the FY 2015 economic value by $4,460 million.

C. Impact of Economic and Loan Factors

The projected economic value of the HECM Fund depends on various economic and loan-specific factors. These include the following:

- House Price Appreciation: HPA rates impact the recovery FHA receives upon loan terminations and the rate at which borrowers will refinance or move out of their property.

HPA rates are generated in our stochastic simulation of economic variables. These rates for the Monte Carlo simulation are centered on Moody's July 2015 forecast.

- One-year and ten-year Treasury interest rates and one-year LIBOR rate: Interest rates impact the growth rate of loan balances and the amount of equity available to borrowers at origination. Interest rate projections used in the stochastic simulation are also centered on the Moody's July 2015 forecast.
- Mortality Rates: Mortality rates are either directly obtained or derived from the U.S. Decennial Life Table for 1990-1991, 1999-2001 and 2009 populations, published by the Center for Disease Control and Prevention (CDC). Refer to Appendix A for the details of the calculation of mortality rates.
- Cash Drawdown Rates: These represent the speed at which borrowers access the equity in their homes over time, which impacts the growth of the loan balance. Borrower cash draw rates are derived from past HECM program experience with adjustments to account for the expected borrower characteristics of future books-of-business and the tighter drawdown limits starting in FY 2015.

The realized economic value will vary from the Review's estimate if the actual drivers of loan performance deviate from the baseline projections. Exhibit ES-2 presents the baseline economic value from the average of the Monte Carlo simulations, six alternative scenarios from our simulated paths, and two additional scenarios from Moody's Analytics. The baseline case of the Review is the mean of the economic values of the MMI HECM portfolio over the 100 simulated paths. Each alternative scenario estimates the performance of the Fund under the specific future interest rate and house price appreciation rates simulated for each path. Interpreting these results, there is approximately a 50 percent chance that the economic value would fall in the range of *negative* $104 million to positive $14,887 million, and an 80 percent chance to be within the range of *negative* $6,451 million to positive $19,072 million. Under the worst simulated scenario, the economic value could be *negative* $33,442 million. Based on our model and our assumptions, we estimate that this represents a 99.5 percent stress test for the HECM Fund.

Exhibit ES-2. Economic Values of the HECM Fund under Different Economic Scenarios ($ Millions)

Fiscal Year	Mean Stochastic Simulation	10th Best Path in Simulation	25th Best Path in Simulation	25th Worst Path in Simulation	10th Worst Path in Simulation	The Worst Path in Simulation	Moody's Baseline Path	Moody's Protracted Slump Path
2015	6,778	$19,072	$14,887	-104	-6,451	-33,442	8,189	-6,776
2022	13,665	37,727	31,052	5,423	-7,154	-56,410	19,029	-4,593

*All values are expressed as of the end of the fiscal year.

We also applied two of Moody's alternative scenarios in this Review. Moody's baseline scenario as a deterministic path produces an economic value about $1.41 billion higher than the baseline Monte Carlo result, due to the asymmetric distribution of stochastic simulation results. Under the

most stressful scenario projected by Moody's, the protracted slump scenario, the FY 2015 economic value of the Fund is *negative* $6,776 million. This is similar to the 9th worst path in our simulation. Thus, it is equivalent to about a 91st percentile stress test based on our simulation model and assumptions.

Note that the 10th or the 25th best and worst paths presented in Exhibit ES-2 may not correspond to the same paths that generate the 10th or the 25th best and worst economic values in the case of the forward loans in the MMI Fund. This is due to the substantial different risk drivers in the HECM loans causing differences in the sensitivity of the cash flows to economic conditions under the two programs as well as differences in the timing of these cash flows. As a result, the 25th worst scenario of the combined HECM and forward portfolios will not equal to the sum of the 25th worst HECM portfolio economic value and the 25th worst forward portfolio economic value that is reported in the separate Actuarial Review of the forward portfolio.

This Page Left Blank Intentionally

Section I. Introduction

A. Actuarial Reviews of the FHA Mutual Mortgage Insurance Fund

The National Housing Act requires an annual independent actuarial review of the Federal Housing Administration's (FHA) Mutual Mortgage Insurance (MMI) Fund.[7] FHA has conducted annual actuarial reviews of the MMI Fund since 1990.

The FHA Modernization Act within the Housing and Economic Recovery Act of 2008 (HERA)[8] moved all new endorsements for FHA's Home Equity Conversion Mortgage (HECM) program from the General Insurance Fund to the MMI Fund starting in fiscal year (FY) 2009. Therefore, an actuarial review must also be conducted on the HECM portfolio within the MMI Fund. This document reports the estimated economic value of the HECM MMI portfolios in FY 2015 and as projected through FY 2022. This review also provides the HECM portion of the insurance-in-force (IIF) used to compute the overall MMI Fund capital ratio.

B. HECM Program Overview

The U.S. Department of Housing and Urban Development (HUD), Federal Housing Administration (FHA), insures reverse mortgage insurance through the HECM program, which enables senior homeowners to obtain additional funds by borrowing against the equity in their homes. Since the inception of the HECM program in 1989, FHA has insured more than 932,633 reverse mortgages. To be eligible for a HECM (a) at least one of the homeowners must be 62 years of age or older, (b) if they have a mortgage, the outstanding balance must be paid off with the HECM proceeds and (c) they must have received FHA-approved reverse mortgage counseling to learn about the program. HECM loans are available from FHA-approved lending institutions. These approved institutions provide homeowners with cash payments or credit lines secured by the underlying homes, and there is no required repayment as long as the borrowers continue to live in the home and meet HUD guidelines on meeting requirements for property taxes, homeowners insurance and property maintenance. Borrowers use reverse mortgages to access cash for various reasons, including home improvements, medical bills, paying off balances on existing traditional mortgages or for everyday living. A HECM terminates for reasons described in Section V. However, the existence of negative equity does not require borrowers to pay off the loan and it does not limit the borrowers from receiving additional cash draws if allowed as per their HECM contract.

The reverse mortgage insurance provided by FHA through the HECM program protects lenders from losses due to non-repayment of the loans. When a loan terminates and the loan balance is

[7] HERA moved the requirement from the 1990 National Affordable Housing Act (NAHA) to the Federal Housing Administration operations within the National Housing Act, 12 USC 1708(a)(4).
[8] HERA was passed by the United States Congress on July 24, 2008 and signed by President George W. Bush on July 30, 2008.

greater than the net sale price of the home, the lender can file a claim for the amount of loss up to the maximum claim amount (MCA). The MCA is defined as the minimum of the home's appraised value and the FHA HECM loan limit, both measured at origination. A lender can and usually does assign the mortgage note to FHA when the loan balance reaches 98 percent of the MCA and is reimbursed for the balance of the loan. When note assignment occurs, FHA switches from being the insurer to the holder of the note and continues servicing the loan until termination. At loan termination (post-assignment), FHA attempts to recover the loan balance including any expenses, accrued interest, property taxes and insurance premiums.

In 2010, FHA introduced the "Saver" alternative to the Standard HECM product. The HECM Saver program charged a lower upfront mortgage insurance premium (MIP) but also reduced the amount of housing equity a borrower can access. Thus, the Saver's upfront mortgage insurance premium of one basis point attracted borrowers who can accept less funds in order to pay a lower mortgage insurance premium than the two percent upfront premium charged by the Standard HECM program.

Starting at the beginning of FY 2014, the Standard and Saver programs were replaced by a more conservative program to improve the financial viability of the HECM program. The program had lower principal limit factors than the Standard program, and also had initial disbursement limitations. Furthermore, the initial MIP was based on the mortgagor's initial disbursement.

Starting from August 4, 2014, the HECM program was modified to allow non-borrowing spouses younger than 62 years of age, and Special Principal Limit Factors were promulgated to deal with the longevity risk. Also, more conservative PLFs were also imposed for borrowers of age 62 and above. Note that the younger non-borrowing spouse gets the benefit of staying in the house until deceased, but the Special Principal Limit Factors of the HECM is based on the age of the younger spouse, whether or not he/she is a borrower, so the risk of longevity is addressed programmatically, especially given the newly applicable Special PLFs. Also note that our models also capture the longevity risk in our mortality variable and FHA's projections of the composition of future HECMs include spouses as young as 38 (see Appendix A). Appendix E incorporates the impact of this new product on HECM demand.

Starting from April 27, 2015, HUD introduced the requirements of Life Expectancy Set-Aside (LESA) for HECM loans, attached with the HECM Financial Assessment and Property Charge Guide. LESA is set aside at the origination of HECM loans and is to be used for the payment of property taxes, and hazard and flood insurance premiums.

The following are definitions of common HECM terms.

1. Maximum Claim Amount (MCA)

The MCA is the minimum of the appraised value of the home and the FHA loan limit at the time of origination. It is the maximum HECM insurance claim a lender can receive. The MCA is also

used together with the Principal Limit Factor (explained next) to calculate the maximum amount of initial equity available to the borrower. The MCA is determined at origination and does not change over the life of the loan. However, if the house value appreciates over time, borrowers may access additional equity by refinancing. In the event of termination, the entire net sales proceeds[9] can be used to pay off the outstanding loan balance, regardless of whether the size of the MCA was capped by the FHA loan limit at origination.

2. Principal Limits (PLs) and Principal Limit Factors (PLFs)

FHA manages its insurance risk by limiting the percentage of the initial available equity that a HECM borrower can draw by use of a Principal Limit Factor (PLF). Conceptually, the PLF is similar to the loan-to-value ratio applied to a traditional mortgage. Exhibit I-1 presents a selected number of PLFs published in October 2010 and also from the new program started in FY 2014 (FY 2014 Program) which replaced the Saver and Standard program.[10] From August 4, 2014, another program allowed a younger non-borrowing spouse; these are the Special PLFs to address the longevity risk of these younger spouses. This Current Program superseded the FY 2014 Program. It further restricted the PLFs for the borrowers.

For a given HECM applicant, the MCA is multiplied by the PLF, which is determined according to the HECM program features and the borrower's age and gender. The result is the maximum HECM principal limit available to be drawn by the applicant. The PLF increases with the borrower's age at HECM origination[11] and decreases with the expected mortgage interest rate (with a floor of 3.0 percent).[12] The PLFs for the Saver program were lower than the Standard program, offering borrowers a tradeoff between the amount of accessible home equity and the rate of the upfront mortgage insurance premium. The PLFs for the FY 2014 program was 85 percent of those in comparable Standard program PLFs. Over the course of the loan, the principal limit grows at a rate equal to the sum of the mortgage interest rate, the mortgage insurance premium and the servicing fees. Borrowers can continue to draw cash as long as the loan balance is below the current principal limit (except for the tenure plan, which acts as an annuity). As mentioned above, the Current program further restricted PLFs, as shown in the exhibit.

[9] Net sales proceeds are the proceeds from selling the home minus transaction costs.
[10] Mortgagee Letter 2013-27, September 3, 2013: Changes to the Home Equity Conversion Mortgage Program Requirements.
[11] For couples, the age of the younger one is used to determine the corresponding PLF.
[12] For adjustable rate mortgages, "expected" interest rates are calculated by the lender as the sum of an index rate and the lender's index margin. The index margin is what will actually be charged on the loan as a mark-up over the index rate used for the loan (LIBOR or Constant-Maturity Treasury, either 1-month or 1-year). For fixed-rate loans, the "expected" rate is the note rate on the mortgage.

Exhibit I-1. Selected Principal Limit Factors[13]

Expected Mortgage Interest Rate	Borrower Age at Origination*							
	25	35	45	55	65			
	Special PLFs				Standard	Saver	Expired FY 2014 Program	Current Program
5.50%	0.302	0.341	0.381	0.419	0.569	0.468	0.483	0.478
7.00%	0.146	0.187	0.228	0.270	0.428	0.316	0.363	0.332
8.50%	0.042	0.087	0.133	0.171	0.326	0.192	0.277	0.227
Expected Mortgage Interest Rate	**75**				**85**			
	Standard	**Saver**	**Expired FY 2014 Program**	**Current Program**	**Standard**	**Saver**	**Expired FY 2014 Program**	**Current Program**
5.50%	0.636	0.508	0.540	0.553	0.703	0.554	0.597	0.644
7.00%	0.516	0.376	0.438	0.410	0.606	0.443	0.515	0.513
8.50%	0.425	0.264	0.361	0.304	0.531	0.341	0.451	0.414

* The age of the younger borrower or spouse.

3. Payment Plans

HECM borrowers access the equity available to them according to the payment plan they select. Borrowers can change their payment plan at any time during the course of the loan as long as they have not exhausted their principal limit. The payment plans are:

- Tenure plan: a fixed monthly cash payment as long as the borrowers stay in their home;
- Term plan: a fixed monthly cash payment over a specified number of years;
- Line of credit: the ability to draw on allowable funds at any time and
- Combinations of all of the above.

For the currently effective program, the initial disbursement period limitation is applicable to all payment plans and subsequent payment plan changes that occur during the initial disbursement period.

4. Unpaid Principal Balance (UPB) and Loan Costs

HECMs differ from forward mortgage products as they require no repayment as long as the borrowers continue to reside in their home and follow FHA guidelines on property maintenance,

[13] The PLFs shown here are based on the 8/19/2014 values provided at: http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/hecm/hecmhomelenders

real estate taxes and insurance. In general, the loan balance continues to grow with borrower cash draws, and accruals of interest, premiums and servicing fees until the loan terminates.[14] HECMs can have fixed or adjustable interest rates and the adjustable rate can be adjusted annually or monthly.

The initial cost of a HECM can be financed by adding it to the loan balance instead of paying cash. Adding it to the loan reduces the remaining principal available to the borrower. These costs include origination fees, closing costs, upfront mortgage insurance premiums and pre-charged annual servicing fees. For all loans endorsed prior to October 4, 2010, the insurance premiums comprised an upfront premium of 2 percent of the MCA and an annual premium of 0.5 percent of the unpaid principal balance. After October 4, 2010, the upfront premium remained at 2 percent for the Standard program but was set as 1 basis point of the MCA for the Saver program. The annual insurance premium increased from 0.5 to 1.25 percent of the unpaid principal balance for both the Standard and Saver programs.

Starting from FY 2014,[15] under the new policy the annual MIP rate of 1.25 percent remained the same, but the upfront MIP was determined based on the amount of the initial cash drawn at loan closing. An initial MIP of 0.50 percent of the MCA was charged if the initial draw amount is less than or equal to 60 percent of the available principal limit and 2.50 percent if the initial draw amount exceeds 60 percent of the available principal limit.

5. Loan Terminations

HECM loans typically terminate when borrowers die, move out of their home, refinance the HECM or sell the house. Loans can also terminate under foreclosure if borrowers fail to pay property taxes or homeowner's insurance. Appendix D describes how we modeled the tax and insurance defaults.

When a HECM loan terminates, the current loan balance becomes due. If the net sales proceeds from the home sale exceed the loan balance, the borrower or the estate is entitled to the difference. If the net proceeds from the home sale are insufficient to pay off the full outstanding loan balance and the lender has not assigned the note, the lender can file a claim for the shortfall, up to the amount of the MCA. HECM loans are non-recourse, so the property is the only collateral for the loan; no other assets or the income of the borrowers can be accessed to cover any shortfall.

6. Assignments and Recoveries

The assignment option is a unique feature of the HECM program. When the balance of a HECM reaches 98 percent of the MCA, the lender can choose to terminate the FHA insurance by

[14] The loan balance can also decrease or stay the same since borrowers have the option to make a partial or full repayment at any time.

[15] Mortgagee Letter 2013-27, September 3, 2013: Changes to the Home Equity Conversion Mortgage Program Requirements.

redeeming the mortgage note with HUD at face value, a transaction referred to as loan assignment. HUD will pay an assignment claim in the full amount of the loan balance (up to the MCA) and will continue to hold the note until termination. During the note holding period, the loan balance will continue to grow by accruing interest, additional draws, premium, unpaid taxes and servicing fees. Borrowers can continue to draw cash as long as the loan balance is below the current principal limit. The only exception is that borrowers on the tenure plan are not constrained by the principal limit. At loan termination, the borrowers or their estates are required to repay HUD the minimum of the loan balance and the net sales proceeds of the home. These repayments are referred to as post-assignment recoveries.

C. FHA Policy Changes

FHA periodically implements policy changes to the HECM program, including changes in insurance premiums, principal limit factors, FHA loan limits for HECMs and related program features. These changes generally do not affect outstanding HECM contracts. FHA publishes the policy changes in Mortgagee Letters with several examples listed in the references at the end of this report and in footnotes.

Exhibit I-2 indicates that the principal limit factors have become more conservative since FY 2009. The percentage decrease in the PLFs since 2009 varies based on the borrower's age at origination and the expected interest rate. This reduction in PLFs reduces the amount of equity available to borrowers. This policy lowers the likelihood and size of claims and reduces FHA's financial risk accordingly, because it reduces the likelihood that the unpaid principal balance will exceed the net proceeds from the house sale. Exhibit I-2 also indicates that the FY 2014 program was more conservative than the previous Standard program, because the principal limit factors for the new program equaled 85 percent of the Standard program. The most recent policy change[16] effective on August 14, 2014 further reduces the principal limit factors and applies Special PLFs for spouses less than 62 years of age.

[16] Mortgagee Letter 2014-12, June 27, 2014: Home Equity Conversion Mortgage (HECM) Program: New Principal Limit Factors.

Exhibit I-2. Selected Principal Limit Factors Changes for Standard HECMs, the Expired FY 2014 Program, and the Current Program

Borrower Age* at Origination	Expected Mortgage Interest Rate	PLFs for Standard Program			PLFs for Expired FY 2014 Program	PLFs for Current Program
		FY 2009 and Prior	FY 2010	FY 2011 to FY2013	9/30/2013 - 8/3/2014	8/4/2014 and onward
35	5.50%					0.341
35	7.00%					0.187
35	8.50%					0.087
45	5.50%					0.381
45	7.00%					0.228
45	8.50%					0.133
55	5.50%					0.419
55	7.00%					0.270
55	8.50%					0.171
65	5.50%	0.649	0.584	0.569	0.483	0.478
65	7.00%	0.489	0.44	0.428	0.363	0.332
65	8.50%	0.369	0.332	0.326	0.277	0.227
75	5.50%	0.732	0.659	0.636	0.54	0.553
75	7.00%	0.609	0.548	0.516	0.438	0.410
75	8.50%	0.503	0.453	0.425	0.361	0.304
85	5.50%	0.819	0.737	0.703	0.597	0.644
85	7.00%	0.738	0.664	0.606	0.515	0.513
85	8.50%	0.66	0.594	0.531	0.451	0.414

* The age of the younger borrower or spouse.

In early 2009, the U.S. Congress passed the American Recovery and Reinvestment Act of 2009 (ARRA) [17] which mandated a temporary increase in the HECM loan limit to $625,500 nationwide, effective February 17, 2009 through December 31, 2009. The temporary loan limit increase was later extended to December 31, 2010 in the Department of the Interior, Environment, and Related Agencies Appropriations Act 2010.[18] Mortgagee Letters 2011-29 and 2011-39 further extended the $625,500 loan limit through December 31, 2012. Mortgage Letters 2012-26, 2013-43, and 2014-25 again extended the same loan limit to December 31, 2013, December 31, 2014, and December 31, 2015, respectively.

[17] ARRA was passed by the U.S. Congress on February 13, 2009 and signed by President Barack Obama on February 17, 2009.
[18] Department of the Interior, Environment, and Related Agencies Appropriations Act (H.R. 2996) was passed by the U.S. Congress on October 29, 2009 and signed by President Barrack Obama on October 30, 2009.

D. Current and Future Market Environment

This section discusses the recent and projected market environment and the implications for the HECM program. In our projections of the cash flows associated with FHA insurance under the HECM program, we used a set of 100 possible future economic scenarios, which were generated by our Monte Carlo simulation model. Each path produces a possible future scenario for house prices and unemployment and interest rates. This distribution is centered on Moody's July 2015 baseline forecasts in the sense that our projected values are just as likely to be above Moody's forecast values as below them.

1. House Price Growth Rate

The house price growth rate trend forecasts for the nation, states and MSAs were obtained from Moody's July 2015 forecast of the FHFA Purchase-Only (PO) repeat-sales House Price Index (HPI). The Purchase-Only Index is based on repeat sales at actual transaction prices and does not involve any appraised values. As such it provides a more direct and accurate measure of housing market conditions. Moody's state and MSA house price forecasts take into consideration local area economic conditions including unemployment rates. Moody's July 2015 forecast provides estimates from 2015Q3 to the end of 2045. We derive the House Price Appreciation (HPA) rates from the local HPI, and extended the HPA forecasts during 2045 to years beyond 2045.

Exhibit I-3a presents a brief summary of the July 2015 Moody's baseline national HPA forecast as compared to the one used in the 2014 Review. According to this year's forecast, the annual national house price growth rate is 5.71 percent through the fourth quarter of FY 2015. Then the rate declines to positive 1.72 percent per annum by the fourth quarter of FY 2017, representing a temporarily slowdown in house value growth rate. After that, the house price growth rate gradually rises to a long-run average annual rate of around 3.80 percent.

Exhibit I-3b presents the HPI comparison between the July 2015 Moody's baseline national HPI forecast and that of the July 2014. The updated forecast of HPI level grows faster during the first three forecasting years, and then remains higher than the 2014 forecast in all future years.

Exhibit I-3a. House Price Appreciation Rates: Actual and Forecast from Year 2007 to 2044

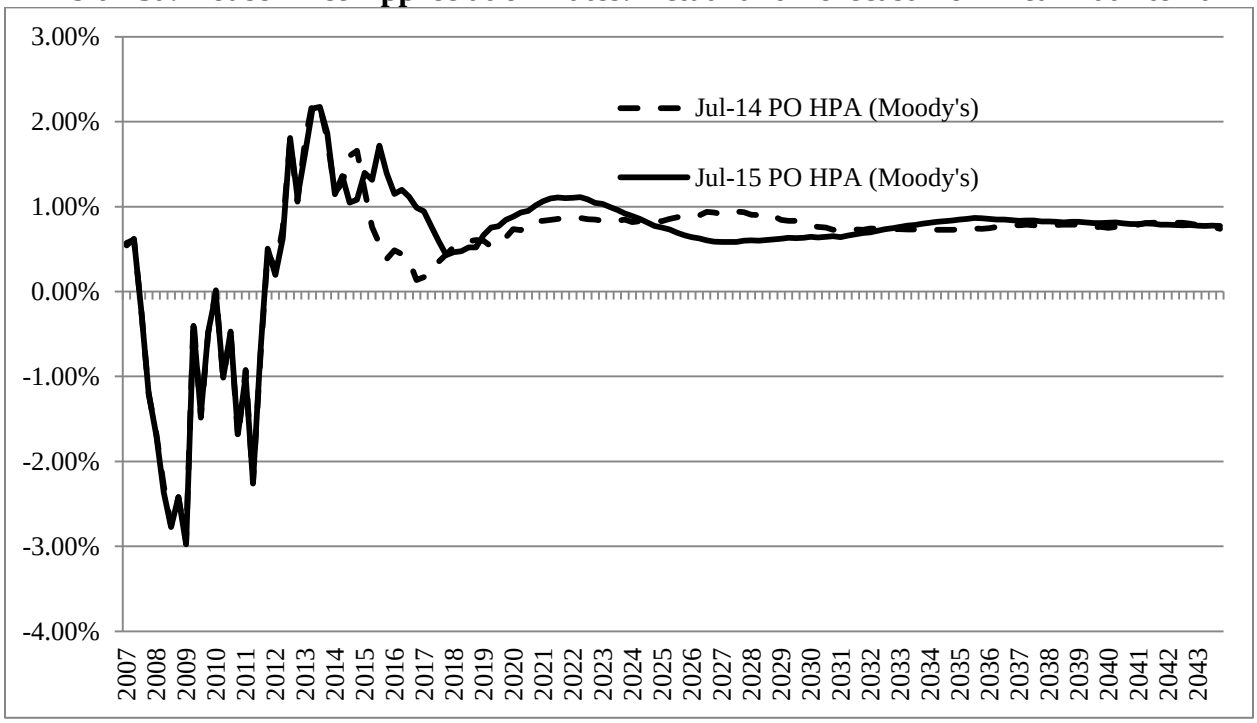
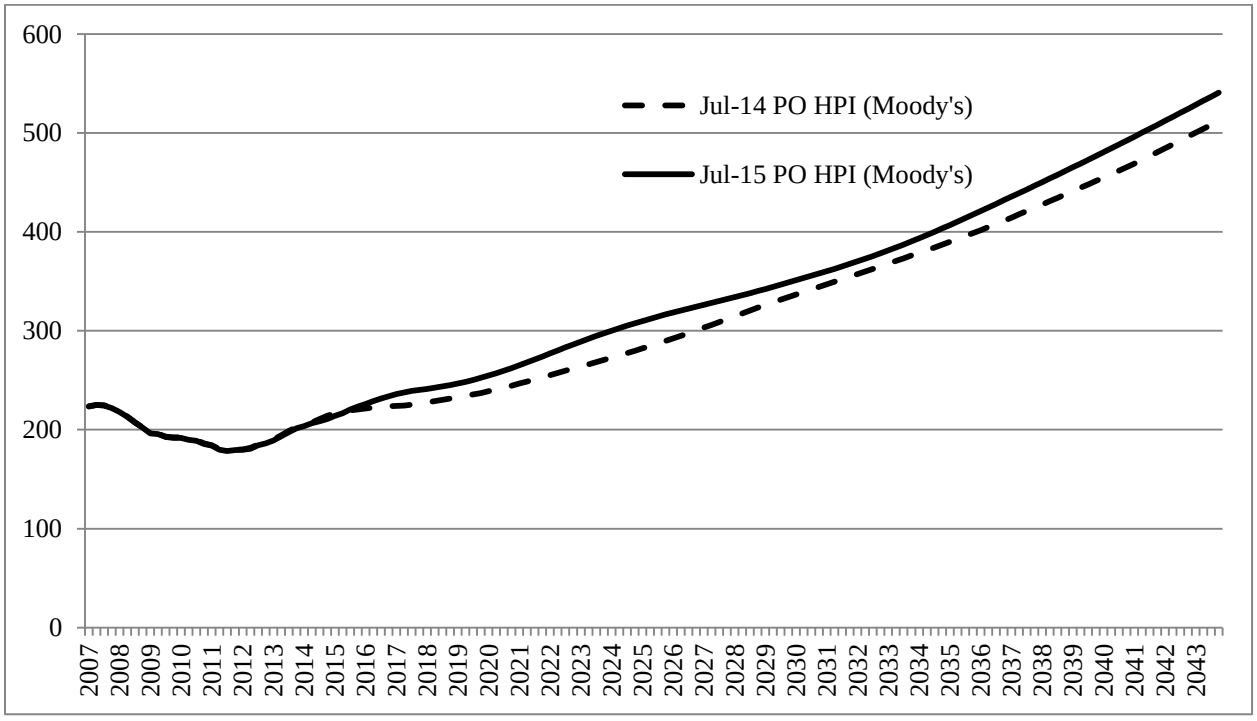


Exhibit I-3b. House Price Indices: Actual and Forecast from Year 2007 to 2044



The house price projections for individual states generally differ from the overall national level. The HECM portfolio active at the end of FY 2015 is concentrated in California, Florida, New York and Texas. Near-term strong growth rates were forecasted for California and Texas, while moderate increases were forecasted for Florida and New York. The long-term trends of house price growth for California and Florida are predicted to be higher than last year's Moody's forecast, while those for Texas and New York are predicted to be slightly lower. The differences compared to last year's Review are shown below in Exhibit I-3c for these large states and the national average.

Exhibit I-3c. Comparison of House Price Forecasts in Four States

State	Percent of FY 2015 Portfolio	House Price Growth Forecast			
		Short-Term Trend [19]		Long-Term Trend	
		Forecast in FY 2015 Review	Forecast in FY 2014 Review	Forecast in FY 2015 Review	Forecast in FY 2014 Review
California	17.58%	9.11%	3.87%	4.55%	2.84%
Texas	10.34%	9.39%	5.94%	3.06%	3.16%
Florida	5.44%	4.61%	3.26%	3.47%	2.91%
New York	6.53%	6.12%	3.28%	2.22%	2.70%
National Average		5.99%	2.94%	3.20%	3.03%

The stronger growth rates in house price affects the HECM portfolio in two ways. First, we observe strong short-term recovery in states that suffered the most in the recent recession, such as California. The higher forecasted housing value leads to more refinancing and lower claim payments. The improved house price growth rates in FYs 2014-2018 also increase the recovery revenue of HECM loans. Consequently, we projected lower average future claim loss for the HECM portfolio.

Second, a near-term strong house price forecast and long-term positive growth rate increase the additional equity available to a borrower through refinancing. However, this benefit is offset by the lower principal limit factors imposed in the FY 2014 and the August 14, 2014 policy change allowing a younger non-borrowing spouse. The net benefit would be the combined effect of house price appreciation and a lower percentage of allowed cash draws. Appendix A provides a detailed analysis of HECM refinancing.

Compared with last year's baseline scenario, the house price growth forecast under this year's baseline scenario is more optimistic, which leads to larger recoveries at termination and slower assignments.

[19] Short-term trend means the growth rate over CY 2015Q3-CY 2016Q3. Long-term trend means the annualized growth rate from CY 2015 to CY 2045.

2. Interest Rates

According to Federal Reserve Board statistics, the one-year U. S. Treasury rate has stayed at a record low level over the past several years. In response to the Federal Reserve's second round of quantitative easing (QE2) in November 2010, and "Operation Twist" started in September 2011, the 10-year Treasury rate continued to drop since 2010 and reached its lowest point since the 1950s in 2012. Since then, it had risen slowly, and reached 2.77% in 2014Q1. After a temporarily drop to 1.97% in 2015 Q1, the rate has rallied and is predicted to continue increasing in the future. The one-year London Interbank Offered Rate (LIBOR) is forecasted to stay low in the near future, as shown in Exhibit I-4a.

Exhibit I-4a. Selected Historical Interest Rates

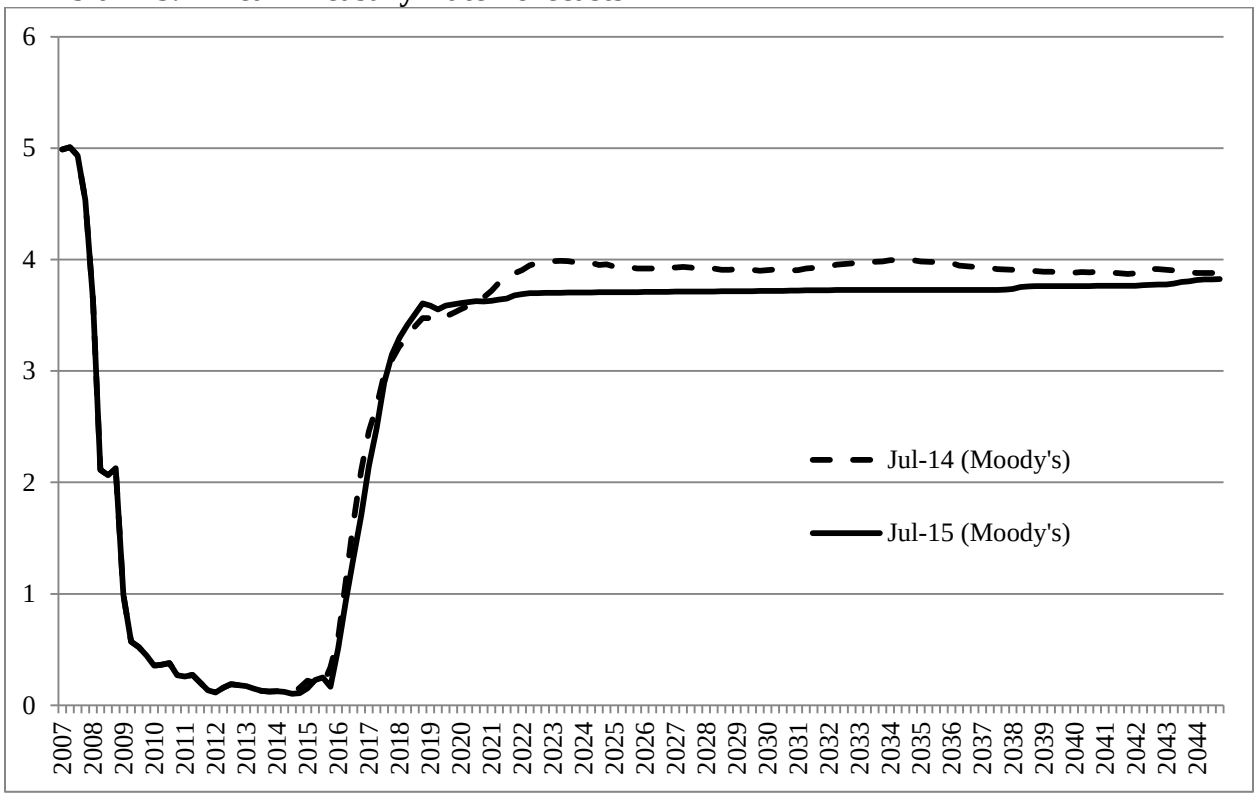
Rate type	Interest Rate		
	2013 Q3	2014 Q3	2015 Q3 (Forecast[20])
1yr CMT	0.12%	0.11%	0.17%
10yr CMT	2.71%	2.50%	2.52%
1yr LIBOR	0.67%	0.56%	0.65%

Approximately 83 percent of loans in the FY 2015 book of business are adjustable rate loans (see Section IV for a detailed breakdown). The mortgage interest rate for adjustable-rate HECMs is equal to the sum of the base rate and the lender's margin. The base rate can be one-year Treasury rate or one-year LIBOR rate. The expected HECM mortgage interest rate affects the amount of equity available to borrowers. The PLF increases as the expected rate declines for a given borrower age. Moody's has forecasted the one-year Treasury rate to rise steadily to 3.5 percent by FY 2018 and to stabilize to a long-run rate of around 3.8 percent. This forecast of one-year Treasury rate implies a continued low interest rate environment, which enables borrowers to access a large percentage of their home equity. However, even though one-year Treasury rates remain at a low level, average lender margins have increased from an average of 1.5 percent during 2008 and prior years to 2.5 percent from 2009 to 2011. In 2012, lender margins further increased to 3.0 percent. Among FY 2015 originations, the margin remained high, at 2.56 percent for adjustable rate loans.

Exhibit I-4b shows the comparison of the 1-year Treasury rate forecasts in the 2014 and 2015 Reviews. The realized 1-year Treasury rates in 2015 turned out to be close to what was forecasted by Moody's in July 2014. Also the forecast of the long-term level of the 1-year Treasury rate is adjusted downward this year, compared to Moody's July 2014 forecast.

[20] based on projection published by Moody's on July 2015.

Exhibit I-4b. 1-Year Treasury Rate Forecasts



3. HECM Demand

HECMs started as a pilot program in 1989 and became a permanent program in 1998. Between 2003 and 2008, the number of HECM loans grew steadily because of increased product awareness on the part of potential applicants, lower interest rates, higher home values and higher loan limits. Demand remained steady during the financial crisis with about 114,412 endorsements in FY 2009, similar to the level in FY 2008. The PLF reductions listed in Exhibit I-2 and house price depreciation have contributed to a decline in HECM demand since FY 2009. The initial disbursement limitation and reduction of PLFs in FY 2014 significantly decreased HECM demand compared with endorsement volume in 2013. Exhibit I-5 shows the actual numbers and dollars of endorsements in FY 2009 through FY 2014 as well as the estimated whole-year values for FY 2015 (based on data as of June 30, 2015). The exhibit also presents the volume projections for FY 2016 through FY 2022 based on our updated HECM demand model described in Appendix E. The projection has included possible non-borrowing spouses brought in by Mortgagee Letter 2014-12.

Exhibit I-5. Actual and Forecasted FY 2009 to FY 2022 Endorsements

Fiscal Year	Number of Endorsements	Average MCA per Endorsement	Total Endorsements ($millions)
2009	86,635	260,029	22,528
2010	61,922	261,554	16,196
2011	59,722	243,655	14,552
2012	46,262	235,036	10,873
2013	53,837	241,447	12,999
2014	47,646	258,656	12,324
2015	58,000	271,779	15,763
2016	55,000	274,052	15,073
2017	60,465	281,735	17,035
2018	64,174	285,789	18,340
2019	67,094	291,346	19,548
2020	69,751	299,151	20,866
2021	72,163	308,787	22,283
2022	74,336	319,021	23,715

HECM borrowers represent about 0.9 percent of all households with at least one member aged 62 years or older (according to AARP). If this ratio is maintained, the number of reverse mortgages will continue to increase with the expected growth of the senior population. In FY 2014, 18 percent of the population (approximately 57 million) was 62 or older. According to the U.S. Census Bureau's projection, 21 percent of the population (approximately 69 million) will be 62 or older in 2020 and this will grow to 24 percent of the population (approximately 86 million) by 2030. Furthermore, as longevity is expected to increase, more seniors may have insufficient savings to sustain their financial needs in retirement, potentially increasing the demand for HECMs.

4. HECM Secondary Market

The secondary market enhances HECM liquidity by providing capital market funding to primary market HECM lenders, broadening distribution channels for HECM loans and expanding the investor base for the HECM product. Fannie Mae had been the largest portfolio investor of HECM loans. However, new secondary market investors have emerged, replacing Fannie Mae as

the predominant outlet for this business. Fannie Mae's share of the reserve mortgage market dropped from over 90% in early 2009 to less than 1% in the third quarter of 2010.
Since December 2010, Fannie Mae ceased acquisitions of newly originated reverse mortgages, and continues to manage the existing HECM books of business[21]. As of December 31, 2014, Fannie Mae held for investment $48 billion in HECM.

Ginnie Mae implemented a HECM Mortgage Backed Security (HMBS) product in 2007. Under this program, Ginnie Mae approved issuers can pool and securitize newly originated HECMs. During FY 2010, Ginnie Mae had issued nearly $12 billion in HMBSs compared to $5.1 billion in FY 2009. The issuance[22] level dropped to $10.8 billion in FY2011, to $8.5 billion in FY 2012, to $9.2 billion in FY 2013, to $7.1 billion in FY 2014 and $6.7 billion in first three quarters of FY 2015.

The secondary market activities do not directly affect our actuarial projections, but a change in secondary market liquidity could potentially impact the volume of future endorsements.

E. Data Sources and Future Projections

This Review focuses on the economic value of HECM loans in the MMI Fund, which consists of the loans from FY 2009 through FY 2015 endorsement cohorts that were active at the end of FY 2015. All historical HECM data were used to analyze and better understand the performance of the loans within the program and to develop the termination model estimates. These data include loans that were endorsed under the General Insurance (GI) Fund over FY 1990 to FY 2008, as well as the loans endorsed under the MMI Fund beginning in FY 2009. Since the MMI fund was charged with covering the losses accruing in loans endorsed after FY 2008, the "MMI HECM portfolio" is defined to include only these more recent endorsements.

Borrower characteristics and loan features are based on loan-level data as of June 30, 2015. The actual endorsement volume is annualized for the remaining three months of the fiscal year. Historical data and forecasts of economic data were collected from Moody's Analytic economy.com website. These data include the one-year and ten-year Treasury rates, one-year LIBOR rates, the median house price, the unemployment rate and the Federal Housing Finance Agency (FHFA) purchase-only house price index appreciation rates. FHA provided estimates of the composition of borrower characteristics for future endorsements. We used an annual cash flow model by fiscal years to estimate the present value of the HECM future cash flows.

[21] Selling guide updates, Announcement SEL-2011-05, Fannie Mae , June 28,2011
[22] http://www.ginniemae.gov/media_center/Pages/monthly_issuance_reports.aspx

F. Structure of this Report

The remainder of this report consists of the following sections:

- Section II. Summary of Findings – presents the estimated economic value and insurance-in-force for the FY 2015 through FY 2022 MMI HECM portfolios. It also provides a step-by-step analysis of changes from last year's Review.
- Section III. Current Status of the HECM Program – analyzes the estimated economic values in further detail.
- Section IV. Characteristics of MMI HECMs – presents various characteristics of HECM endorsements for fiscal years 2009 through 2015.
- Section V. HECM Performance under Alternative Scenarios – presents the HECM portfolio economic values using alternative economic scenarios.
- Section VI. Summary of Methodology – presents the loan performance and cash flow models used to estimate the economic values in this report.
- Section VII. Qualifications and Limitations – describes the main assumptions and the limitations of the data and models relevant to the results presented in this Review.
- Appendix A. HECM Base Termination Model – provides a technical description of the loan performance model for the causes of loan termination excluding Tax and Insurance defaults (which is described separately in Appendix D).
- Appendix B. HECM Loan Performance Projections – provides a technical description of the loan termination projection methodology and the characteristics of the future endorsement cohorts modeled in this Review. It also gives an overview of Moody's economic forecasts for interest rates and home prices that produced the baseline Monte Carlo simulation as well as six selected alternative scenarios.
- Appendix C. HECM Cash Flow Analysis – provides a technical description of the cash flow model covering the various sources of cash inflows and cash outflows that HECM loans generate.
- Appendix D. Tax and Insurance Default Analysis – presents a technical description of the tax and insurance default model developed for this Review. It also explains how the tax and insurance default model is implemented in the cash flow projections.
- Appendix E. HECM Demand Model – presents a technical description of the HECM demand forecasting model and its implementation.
- Appendix F. Stochastic Forecast of Economic Variables – presents the time series econometric model estimates of the stochastic economic variables that drive future cash flows.

This Page Left Blank Intentionally

Section II. Summary of Findings

This section presents the projected economic values and insurance-in-force of the FY 2015 through the FY 2022 HECM MMI portfolios. An MMI-designated fiscal year's portfolio is defined as the set of loans that survive to the end of the fiscal year and were endorsed in FY 2009 or later, when the MMI fund was responsible for HECM losses. In addition to the capital resources as of the end of the fiscal year, the economic value of the HECM MMI portfolio depends on the discounted net present value of the future cash flows from the surviving portfolio of loans existing at the start of the valuation forecast (the end of the fiscal year under review). A fiscal year's economic value calculation does not include the effect of endorsements in future fiscal years.

A. The FY 2015 Actuarial Review

The FY 2015 Actuarial Review assessed the actuarial soundness of the HECM portfolio in the MMI Fund (the HECM Fund) as of the end of FY 2015 and projected the status of the portfolio through FY 2022. In this Review, we:

- Analyzed all HECM historical termination experience and the associated recoveries using loan-level HECM data maintained by FHA through June 2015.
- Developed loan termination models to estimate the relationship between loan termination cash flows and various economic, borrower and loan-specific factors.
- Constructed a stochastic simulation model for 100 possible economic scenarios of interest rates, unemployment rates and house price indices. These economic paths were calibrated to center around the baseline macroeconomic forecasts published by Moody's Analytics in July 2015.
- Estimated future cash flows associated with the projected FY 2015 to FY 2022 HECM MMI portfolios using various assumptions. These assumptions included simulated economic conditions from our Monte Carlo model, borrower characteristics of future endorsements and home-maintenance-risk adjustment factors.
- Estimated the economic value of the HECM MMI portfolio from FY 2015 through FY 2022, using expected cash flows from the Monte Carlo simulation and discount factors prescribed by the OMB.
- Investigated the sensitivity of the economic value of the Fund among seven future possible economic scenarios from our Monte Carlo simulation paths and Moody's alternative forecasts, as well as with respect to marginal changes in the major economic factors.

The following is a summary of the major findings in this Review, as shown in Exhibit II-1. These findings come from the stochastic simulation of 100 economic paths around Moody's baseline economic trend forecast. Our baseline estimate is the average of the economic values over these 100 paths.

- The economic value as of the end of FY 2015 was estimated to be *positive* $6,778 million.
- The economic value of the HECM MMI portfolio was projected to improve steadily over the next seven years and become $13,665 million by the end of FY 2022.
- The insurance-in-force (IIF) is expressed as the sum of the maximum claim amounts (MCAs) of all HECM loans remaining in the insurance portfolio (even though losses are not limited to the MCA). The estimated IIF reflects the combined, cumulative impacts of loan terminations and new endorsements. The IIF was estimated to be $105,234 million at the end of FY 2015 and was estimated to increase to $184,492 million by the end of FY 2022.

Exhibit II-1. Baseline Economic Value, Insurance-In-Force, and Endorsements for FY 2015 through FY 2022 ($ Millions)

Fiscal Year*	Economic Value	Insurance in Force**	Volume of New Endorsements***	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	6,778	105,234	15,763	302	
2016	7,429	109,334	15,073	575	76
2017	8,222	120,424	17,035	636	157
2018	9,135	132,573	18,340	692	221
2019	10,133	145,236	19,548	716	282
2020	11,213	158,091	20,866	738	342
2021	12,395	171,103	22,283	788	394
2022	13,665	184,492	23,715	823	447

* All values are as of the end of the fiscal year.
** Insurance in Force is estimated as the total of the MCAs of the remaining loans in the insurance portfolio.
*** Projections based on the HECM demand model in Appendix E multiplied by the average MCA. This volume number in FY 2015 reflects the outstanding loans at the end of the fiscal year, and excludes loans endorsed and terminated in the same fiscal year.

B. Changes in the Economic Value

The FY 2014 HECM Review estimated that the HECM portfolio had an economic value of *negative* $1,166 million at the end of FY 2014 compared to the estimate of this year's Review of *positive* $6,778 million at the end of FY 2015. Exhibit II-2 shows the capital resources as of the end of FY 2014 and by applying FY 2015 financial statements. The total HECM capital resources were reported to be $8,816 million at the end of FY 2014. Based on actual results through September 31, 2015, the HECM capital resources have increased to $9,632 million. We estimated the net present value of future cash flows for surviving loans at the end of FY 2015 to be *negative* $2,854 million. The economic value at the end of FY 2015 was therefore estimated to be *positive* $6,778 million.

Exhibit II-2. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2015 ($ Millions)

Item	End of FY2014[(1)]	End of FY2015
Total Capital Resources as of EOY	$8,816	**$9,632**
+ NPV of Future Cash Flows on Outstanding Business		(2,854)
Economic Value		**$6,778**
Insurance- In- Force		$105,234

(1) Source: Audited Financial Statements for FY 2014

C. Decomposition of the Differences in the FY 2015 Economic Value as Reported in the FY 2014 and FY 2015 Reviews

The economic value of the HECM portfolio in the MMI Fund changed from *negative* $1,166 million in FY 2014 as estimated in the FY 2014 Review to *positive* $6,778 million in FY 2015 as reported in this year's Review, as taken from the first and last lines of the second column of Exhibit II-3, representing an *increase* in value of $7,944 million. This increase in value results from the combination of updating realized actual performance of the Fund over the past two years, new economic forecasts and updated and enhanced model estimation.

Exhibit II-3 presents the step-by-step changes from the FY 2014 economic value to this year's estimate of the FY 2015 economic value. A similar analysis for FY 2021 is also included. Note that FY 2021 is the last projected fiscal year common to both Reviews. Also note that the order of the decomposition may affect the magnitude of the changes in value due to individual attributions.

The second row of Exhibit II-3 adjusts the estimated FY 2014 economic value by the estimated time value of cash flows from FY 2009 to FY 2014 books of business during FY 2015. The third row of Exhibit II-3 further includes the present value of the FY 2015 book. After these two adjustments, the economic value as of end of FY 2015 estimated in the FY 2014 Review is negative $1,071 million. The subsequent rows are identified by small-case letters; each row is discussed in detail below. The projected economic value of the Fund as of the end of both FYs 2015 and 2021 are reported.

Exhibit II-3. Sources of the Change in Economic Value for the HECM Portfolio in the MMI Fund between FY 2014 and FY 2015 ($ Millions)

Decomposition Steps	Change in FY 2015 Economic Value	FY 2015 Economic Value	Change in FY 2021 Economic Value	FY 2021 Economic Value
FY 2014 Economic Value Presented in FY 2014 Review		-1,166		
FY 2015 Economic Value Presented in the FY 2014 Review Excluding the FY 2015 Book-of-Business	-3	-1,169		
Plus: Forecasted Value of FY 2015 Book-of-Business Presented in the FY 2014 Review	98			
Equals: FY 2015 Economic Value Presented in the FY 2014 Review		**-1,071**		**1,036**
plus: a. Origination Volume Update for FY 2014 and Later Books	59	-1,012	29	1,065
plus: b. Update Performance and Future Book Compositions	-345	-1,356	-188	878
plus: c. 2015 Model Update and Adjustments for Policy Changes	-1,089	-2,445	-917	-39
plus: d. Economic Scenario Update	4,763	2,318	7,217	7,178
plus: e. Discount Factor Update	4,460	6,778	5,217	12,395
Equals: Estimate of Economic Value	**7,849**	**6,778**	**11,359**	**12,395**

a. Origination Volume Update for FY 2014 and Later Books

In the FY 2015 Review, the volume of endorsements occurring in FY 2014 was lower than the endorsement projection used in the 2014 Review, while the volume of endorsements occurring in FY 2015 was higher than the endorsement projection used in the 2014 Review. Since the economic value of the FY 2014 book was negative, while the economic value of the FY 2015 book was positive in the 2014 Review, both volume updates increase the economic value. They increase the economic value of the FY 2015 and FY 2021 portfolios by $59 million and $29 million, respectively.

b. Update Performance and Future Book Compositions

When we use FY 2015 actual data to replace estimated 2015 performance estimated in the FY 2014 Review, the change in the FY 2014 portfolio value in this step mainly consists of three

parts: (i) Update actual compositions for the FY 2014 and FY 2015 books, and the forecasted compositions for FY 2016 and later books; (ii) the books for FYs 2009-2014 are updated with actual termination and assignment data for the past year and (iii) the update of capital resources. The combined effect is a $345 million decrease in the economic value for FY 2015 and a decrease of $188 million for FY 2021.

c. 2015 Model Update and Adjustments for Policy Changes

In this 2015 Review, the major change in the termination models is the T&I default behavior. As described in Appendix D, HECM loans after assignment are assumed not to be foreclosed even if borrowers fail to pay taxes and insurance. FHA is assumed to pay taxes for those T&I default loans until their terminations. We assume that 25 percent of loans after assignment will go T&I default. This assumption leads to a cash outflow for the HECM portfolio going into the future and hence reduces the economic value. Combined with other model updates and the re-estimation of model coefficients using updated data, the FY 2015 model update reduces the FY 2015 economic value by $1,089 million and the FY 2021 economic value is reduced by $917 million.

d. Economic Scenario Update

From the FY 2014 to the FY 2015 Review, the macroeconomic forecast changes have a favorable impact on the forecasted FY 2015 economic value. First, the higher long-term HPI forecast would improve the sales revenue for conveyed properties and thus increase the recoveries. Second, the lower 1-year Treasury rate over the longer term will reduce the accrual rate for unpaid mortgage balances, resulting in lower claims and delays of assignments. As inferred from the sensitivity tests shown in Section V.C, the major impact comes from the former. After updating the market conditions, the economic value increased by $4,763 million for FY 2015 and by $7,217 million for FY 2021. This is the largest factor leading to the significant improvement in economic value this year compared to last year.

e. Discount Factor Update

This decomposition step shows the effect of switching to the FY 2016 discount factors. The latest OMB published discount factors are higher than the values of the FY 2015 factors used in last year's Review, as shown in Appendix C. The higher discount factors increase the magnitude of the present values of positive cash flows and the absolute size of the present value of negative cash flows. The HECM loans consist of recoveries with positive cash flow and claims with negative cash flow, which essentially offset each other. As recoveries occur at longer durations than claims, the updated higher discount factors have a larger impact on the cash inflows than on the cash outflows. As the result, the FY 2015 HECM economic value increased by $4,460 million and the FY 2021 HECM economic value increased by $5,217 million.

This Page Left Blank Intentionally

Section III. Current Status of HECMs in the MMI Fund

This section presents the components of the economic value for FY 2015 and also the projections through FY 2022. The HECM portion of the MMI Fund has an estimated economic value of *positive* $6,778 million at the end of FY 2015. The economic value and the insurance-in-force of the HECM program are both projected to increase over time under the baseline assumption.

A. Estimating the Current Economic Value and Insurance-in-Force of HECM in the MMI Fund

This section discusses the economic value and the insurance-in-force of the MMI Fund HECM portfolio.

1. Economic Value

According to NAHA, the economic value of the Fund is defined as the "cash available to the Fund, plus the net present value of all future cash inflows and outflows expected to result from the outstanding mortgages in the Fund." We estimated the current economic value for the HECM portfolio as the sum of the amount of capital resources and the net present value of all expected future cash flows from the estimated insurance-in-force as of the end of FY 2015. Exhibit III-1 presents the components of the economic value for FY 2015.[23] Data through June 2015 was annualized to estimate the total capital resources and the loan performance to the end of FY 2015. The total economic value consists of the following components:

- *Total Capital Resources* equals assets less liabilities in the Fund's balance sheet. The total capital resource is reported to be $9,632 million at the end of FY 2015 by the audited FHA MMI Fund financial statement.

- *Present Value of Future Cash Flows on Outstanding Business* consists of cash inflows and outflows. HECM cash inflows consist of premiums and recoveries. Cash outflows consist of claims and note-holding expenses. The cash flow model projects cash inflows and outflows using economic forecasts and loan performance projections. The present value of net future cash flows is estimated to be *negative* $2,854 million as of the end of FY 2015.

[23] Note that Exhibit III-1 is the same as Exhibit II-2, reproduced in this section for easy reading.

Exhibit III-1. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2015 ($ Millions)

Item	End of FY2014[(1)]	End of FY2015
Total Capital Resources as of EOY	$8,816	**$9,632**
+ NPV of Future Cash Flows on Outstanding Business		(2,854)
Economic Value		**$6,778**
Insurance- In- Force		$105,234

(1) Source: Audited Financial Statements for FY 2014

2. Insurance-in-Force

According to NAHA, the insurance-in-force (IIF) is defined as the "obligation on outstanding mortgages." We estimate the IIF as the total maximum claim amount (MCA) of all HECM loans remaining in the insurance portfolio as of the end of FY 2015. Another possible IIF measure is the outstanding loan balances, which tend to increase over time from interest accruals, premiums, service fees and borrower cash draws. As the main purpose of this review is to assess the long-term financial performance of the HECM portfolio, using the current loan balances to estimate the IIF could under-represent FHA's long-term insurance exposure depending on the distribution of loan ages in the HECM portfolio. In contrast, the aggregate MCAs for the portfolio will only depend on insurance termination and will be more stable over time. The MCA is the highest claim amount FHA may be required to pay out at insurance termination, although it does not cap the possible exposure.

Exhibit III-2 presents the estimated survival loan count and insurance-in-force for FY 2009 to FY 2015 endorsements at the end of FY 2015.

Exhibit III-2. Estimated Survival Loan Count and Insurance-in-Force

Endorsement Fiscal Year	Net Present Value of Future Cash Flows ($ Millions)	Survival Loan Count	Insurance-in-Force ($ Millions)
2009	-1,351	86,635	22,528
2010	-998	61,922	16,196
2011	-165	59,722	14,552
2012	-148	46,262	10,873
2013	-314	53,837	12,999
2014	43	47,646	12,324
2015	80	58,000	15,763

B. Projected Future Economic Values and Insurance-In-Force of HECMs in the MMI Fund

We present the forecasts of the future economic values and insurance-in-force projected for MMI HECMs. We estimated these future values by applying our termination, loss rate and cash-flow models to the endorsements, which were forecasted by the HECM demand model described in Appendix E. FHA's forecast of borrower characteristics determined the composition of loan-level characteristics of future endorsements.

Exhibit III-3 shows the estimated economic values of future MMI HECM books of business and the corresponding insurance-in-force.[24] All values in the exhibit are discounted to the end of each corresponding fiscal year.

Under the stochastic simulation approach, we estimated the economic value by taking the average over 100 simulated paths. On this basis, we project the economic value of the MMI HECM portfolio to gradually increase from $6,778 million in FY 2015 to $13,665 million in FY 2022, as shown in the first column of Exhibit III-3. This increase is primarily due to the projected positive economic value brought to the Fund by new endorsements. The initial disbursement limitations and the strong housing market recovery make these newer books profitable.

With the addition of new endorsements, the total insurance-in-force is estimated to increase from $105,234 million at the end of FY 2015 to $184,492 million in FY 2022. This represents an average net increase of $11,323 million per year.

[24] Note that Exhibit III-3 is the same as Exhibit II-1, reproduced in this section for convenience.

Exhibit III-3. Baseline Economic Value of the HECM Portfolio in the MMI Fund in Future Years ($ Millions)

Fiscal Year*	Economic Value	Insurance in Force**	Volume of New Endorsements***	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	6,778	105,234	15,763	302	
2016	7,429	109,334	15,073	575	76
2017	8,222	120,424	17,035	636	157
2018	9,135	132,573	18,340	692	221
2019	10,133	145,236	19,548	716	282
2020	11,213	158,091	20,866	738	342
2021	12,395	171,103	22,283	788	394
2022	13,665	184,492	23,715	823	447

* All values are expressed as of the end of the fiscal year.

** Insurance in force is estimated as the sum of the maximum claim amounts of the remaining insured loans.

*** Projections based on the HECM demand model in Appendix E multiplied by the average MCA. This volume number in FY 2015 reflects the outstanding loans at the end of the fiscal year, and excludes loans endorsed and terminated in the same fiscal year.

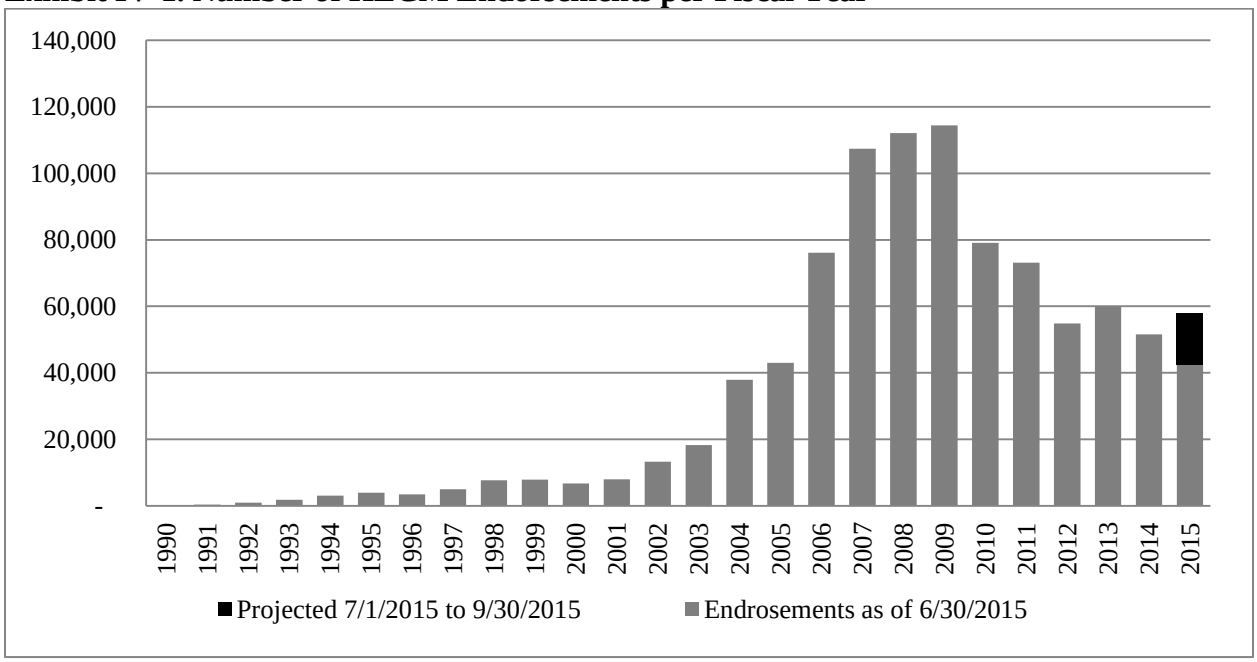
Section IV. Characteristics of the MMI HECM Books of Business

This section presents the characteristics of the HECM portfolio for the HECM loans endorsed from FY 2009 through FY 2015. HECM loans were first included in the MMI Fund in FY 2009. The loans from these books of business that have not terminated constitute the MMI HECM portfolio as of the end of FY 2015. A review of the characteristics of these books helps define the current risk profile of MMI HECMs, which includes these books and, going forward, all future HECM books. Some of the characteristics of previous books are shown as well, to indicate trends. All data used for this analysis were provided by FHA as of June 30, 2015.

A. Volume and Share of Mortgage Originations

FHA endorsed 42,531 HECM loans from October 1, 2014 to June 30, 2015, with a total dollar value, measured by the MCA, of $11.59 billion. FHA estimates that the total annual endorsements in FY 2015 will be about 58,000 loans and the corresponding dollar value will be about $15.90 billion. The total endorsement number of FYs 2009-2014 was 432,925. The corresponding dollar value was $110.72 billion. Since the inception of the HECM program, this program has been the largest reverse mortgage product in the U.S. market, representing the vast majority of reverse mortgages. Exhibit IV-1 presents the count of HECM endorsements by fiscal years.

Exhibit IV-1. Number of HECM Endorsements per Fiscal Year



B. Payment Types

HECM borrowers receive loan proceeds by selecting from various payment plans, *i.e*., term, line of credit, tenure and combinations. Exhibit IV-2 presents the distributions of HECM endorsements for FYs 2009 through 2015 by payment plan. As of June 30, 2015, the majority of HECM borrowers selected the line of credit option. This option accounted for 94 percent of the FY 2015 endorsements.

Exhibit IV-2. Distribution of FY 2009-FY 2015 HECM Loans by Payment Type

FY	Loan Type	Term	Line of Credit	Tenure	Term + Line of Credit	Tenure + Line of Credit	Total
2009	**Number of Loans**	993	104,689	1,927	4,284	2,515	114,408
	Percentage	0.87%	91.50%	1.68%	3.74%	2.20%	100.00%
2010	**Number of Loans**	411	74,364	782	2,180	1,317	79,054
	Percentage	0.52%	94.07%	0.99%	2.76%	1.67%	100.00%
2011	**Number of Loans**	312	68,924	717	2,014	1,141	73,108
	Percentage	0.43%	94.28%	0.98%	2.75%	1.56%	100.00%
2012	**Number of Loans**	189	51,826	538	1,426	839	54,818
	Percentage	0.34%	94.54%	0.98%	2.60%	1.53%	100.00%
2013	**Number of Loans**	327	56,697	668	1,374	857	59,923
	Percentage	0.55%	94.62%	1.11%	2.29%	1.43%	100.00%
2014	**Number of Loans**	460	47,930	891	1,422	911	51,614
	Percentage	0.89%	92.86%	1.73%	2.76%	1.77%	100.00%
2015	**Number of Loans**	463	39,821	672	883	692	42,531
	Percentage	1.09%	93.63%	1.58%	2.08%	1.63%	100.00%

C. Interest Rate Type

HECM borrowers can select fixed or adjustable rate mortgages. Exhibit IV-3 shows the distribution of HECM endorsements for FYs 2009 through 2015 by interest rate type. The majority of HECM borrowers selected monthly or annually adjustable rate mortgages in FY 2009. However, the percentage of fixed-rate endorsements increased sharply from 12 percent in FY 2009 to 69 percent in FY 2010 and maintained that level in FYs 2011 and 2012. Then fixed-rate loans climbed further to 72 percent of endorsements in the first three quarters of FY 2013. After that, fixed-rate HECM loans dropped sharply. In FY 2013 as a whole, it dropped to 61 percent, and by FY 2015, it had dropped down to 17 percent.

The LIBOR-indexed loans were in the 30 to 40 percent range over FYs 2009-2013. In FY 2014, they increased to 81 percent, as the fixed-rate option correspondingly declined in popularity. In FY 2015, they increased to an all-time high at 83 percent. Monthly adjustable LIBOR has been the dominant choice during the most recent 2 years, while the annual adjustable LIBOR option gained considerable popularity in FY 2015.

Exhibit IV-3. Distribution of FY 2009-FY 2015 HECM Loans by Interest Rate Type

FY	Index Type Rate Type	Libor Indexed		Treasury Indexed		Fixed	Total
		Annually Adjustable	Monthly Adjustable	Annually Adjustable	Monthly Adjustable		
2009	Number of Loans	23	39,574	696	60,805	13,310	114,408
	Percentage	0.02%	34.59%	0.61%	53.15%	11.63%	100.00%
2010	Number of Loans	7	24,174	9	396	54,468	79,054
	Percentage	0.01%	30.58%	0.01%	0.50%	68.90%	100%
2011	Number of Loans	8	23,317	2	44	49,737	73,108
	Percentage	0.01%	31.89%	0.00%	0.06%	68.03%	100.00%
2012	Number of Loans	1	16,688	4	77	38,048	54,818
	Percentage	0.00%	30.44%	0.01%	0.14%	69.41%	100.00%
2013	Number of Loans	2	23,572	0	14	36,335	59,923
	Percentage	0.00%	39.34%	0.00%	0.02%	60.64%	100.00%
2014	Number of Loans	1,234	40,735	2	3	9,640	51,614
	Percentage	2.39%	78.92%	0.00%	0.01%	18.68%	100.00%
2015	Number of Loans	15,481	19,971	12	8	7,059	42,531
	Percentage	36.40%	46.96%	0.03%	0.02%	16.60%	100.00%

D. Product Type

Almost all of the loans endorsed in FY 2009 through FY 2015 are "traditional" HECMs, where the borrowers had purchased their homes prior to taking out the reverse mortgage. A HECM-for-Purchase program was introduced in January 2009. This program allows seniors to purchase a new principal residence and obtain a reverse mortgage with a single transaction. However, these HECM-for-Purchase loans were never more than 4 percent of HECM endorsements for each subsequent year, as seen in Exhibit IV-4.

Exhibit IV-4. Distribution of FY 2009-FY 2015 HECM Loans by Product Type

FY	Product Type	Traditional HECMs	HECMs for Purchase		Total
			First Month Cash Draw >= 90% of Initial Principal Limit	First Month Cash Draw < 90% of Initial Principal Limit	
2009	Number of Loans	113,850	84	474	114,408
	Percentage	99.51%	0.07%	0.41%	100.00%
2010	Number of Loans	77,665	199	1,190	79,054
	Percentage	98.24%	0.25%	1.51%	100.00%
2011	Number of Loans	71,570	326	1,212	73,108
	Percentage	97.90%	0.45%	1.66%	100.00%
2012	Number of Loans	53,191	390	1,237	54,818
	Percentage	97.03%	0.71%	2.26%	100.00%
2013	Number of Loans	57,834	101	1,988	59,923
	Percentage	96.51%	0.17%	3.32%	100.00%
2014	Number of Loans	49,789	452	1,373	51,614
	Percentage	96.46%	0.88%	2.66%	100.00%
2015	Number of Loans	40,855	577	1,099	42,531
	Percentage	96.06%	1.36%	2.58%	100.00%

E. Endorsement Loan Counts by State

Among all endorsements in FY 2009 through FY 2015, approximately 37 percent were originated in California, Florida, Texas, and New York as measured by loan counts. California had the highest endorsement volume every year over this 6-year period at 13.7 percent, 14 percent, 13.5 percent, 12.7 percent, 14.1 percent, 17.5 percent, and 18.8 percent, respectively. While Florida had the second highest endorsement volume in both FY 2009 and 2010, the percentage in FY 2010 decreased by more than one-third, from 13.2 percent in the previous year to 9.0 percent. Its volume continued to drop to 6.8 percent in FY 2011. Since then, it stabilized in the range of 6 to 7 percent. In FY 2015, it rose back to the second highest at 8.3 percent. The endorsement volume in Texas increased steadily from FY 2009 to FY 2011 and has been the second highest state of endorsement volume for FYs 2011-2014. It dropped in recent years and was the third largest HECM state in FY 2015. The endorsement breakdown of these top four states is shown in Exhibit IV-5.

Exhibit IV-5. Percentage of Endorsements by State for FY 2009 - FY 2015 HECM Loans

FY	State	California	Florida	New York	Texas	Total
2009	**Number of Loans**	15,658	15,090	6,085	7,590	114,408
	Percentage	13.69%	13.19%	5.32%	6.63%	
2010	**Number of Loans**	11,059	7,109	4,624	6,307	79,054
	Percentage	13.99%	8.99%	5.85%	7.98%	
2011	**Number of Loans**	9,851	4,971	4,342	6,671	73,108
	Percentage	13.47%	6.80%	5.94%	9.12%	
2012	**Number of Loans**	6,961	3,369	3,943	4,900	54,818
	Percentage	12.70%	6.15%	7.19%	8.94%	
2013	**Number of Loans**	8,428	3,907	3,807	5,127	59,923
	Percentage	14.06%	6.52%	6.35%	8.56%	
2014	**Number of Loans**	9,047	3,583	3,028	3,845	51,614
	Percentage	17.53%	6.94%	5.87%	7.45%	
2015	**Number of Loans**	8,002	3,544	2,492	3,146	42,531
	Percentage	18.81%	8.33%	5.86%	7.40%	

F. Maximum Claim Amount Distribution

The MCA is the minimum of the FHA HECM loan limit and the appraised value (or if a HECM-for-purchase, the minimum of the purchase price or appraised value). It is used as the basis of the initial principal limit determination and as the cap on the potential insurance claim amount. Exhibit IV-6 shows the distribution of HECM endorsements over FYs 2009 through 2015 by the MCA level. Approximately 64 percent of loans endorsed in FY 2009 had an MCA less than $300,000 and this percentage was approximately 66 percent for FY 2010. The loans with MCA less than $300,000 increased to 70 percent in FY 2011, 72 percent in FY 2012, 71 percent in FY 2013, and then dropped to 67 percent in FY 2014. In FY 2015, this number dropped further to 65 percent.

The percentage of endorsements with an MCA between $300,000 and $417,000 dropped from 18 percent in 2009 and has been around 13 percent since then, but rose back to 15 percent in 2015. The percentage of endorsements with an MCA greater than $417,000 has been volatile.

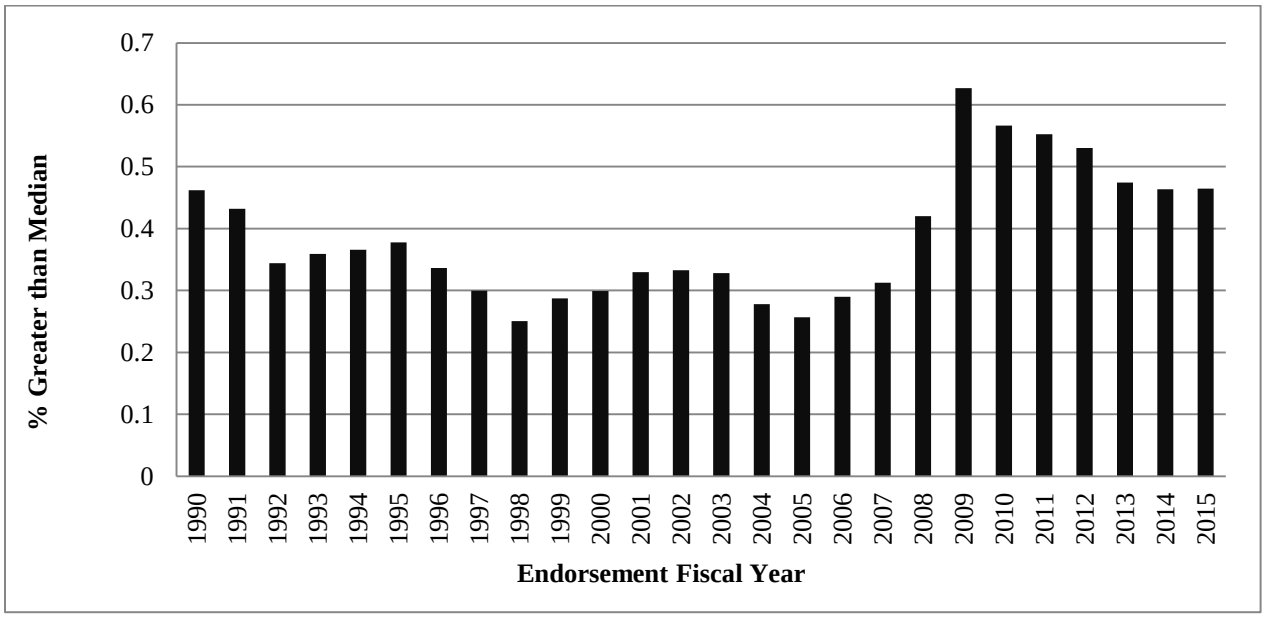
Exhibit IV-6. Distribution of FY 2009-FY 2015 HECM Loans by MCA Level

FY	Less Than $100k	$100k to $200k	$200k to $300k	$300k to $417k	Greater Than $417k	Total
2009	9.51%	31.91%	22.85%	17.60%	18.14%	100%
2010	12.14%	33.95%	19.97%	13.82%	20.13%	100%
2011	14.89%	35.69%	19.43%	12.91%	17.08%	100%
2012	16.11%	36.97%	18.75%	12.62%	15.55%	100%
2013	15.62%	36.29%	18.79%	13.08%	16.22%	100%
2014	13.00%	34.19%	19.74%	13.98%	19.10%	100%
2015	11.56%	32.33%	20.60%	14.87%	20.63%	100%

G. Appraised House Value

FHA research has found that loans associated with properties with an appraised value at origination greater than their area median tend to be maintained better than those with appraised value below the area median. Exhibit IV-7 shows the percentage of HECM loans with an appraised house value greater than the area median value. Starting with the FY 2005 book of business, there has been an upward trend in the ratio of appraised values to the area medians. The passage of the American Recovery & Reinvestment Act and HERA increased the HECM loan limit and further accelerated the upward trend as seen in FY 2009. In the FY 2009 endorsement book of business, 63 percent of the HECM properties were appraised at higher than the area median. Over FY 2011 to FY 2015, the ratio dropped and stabilized at around 46 percent.

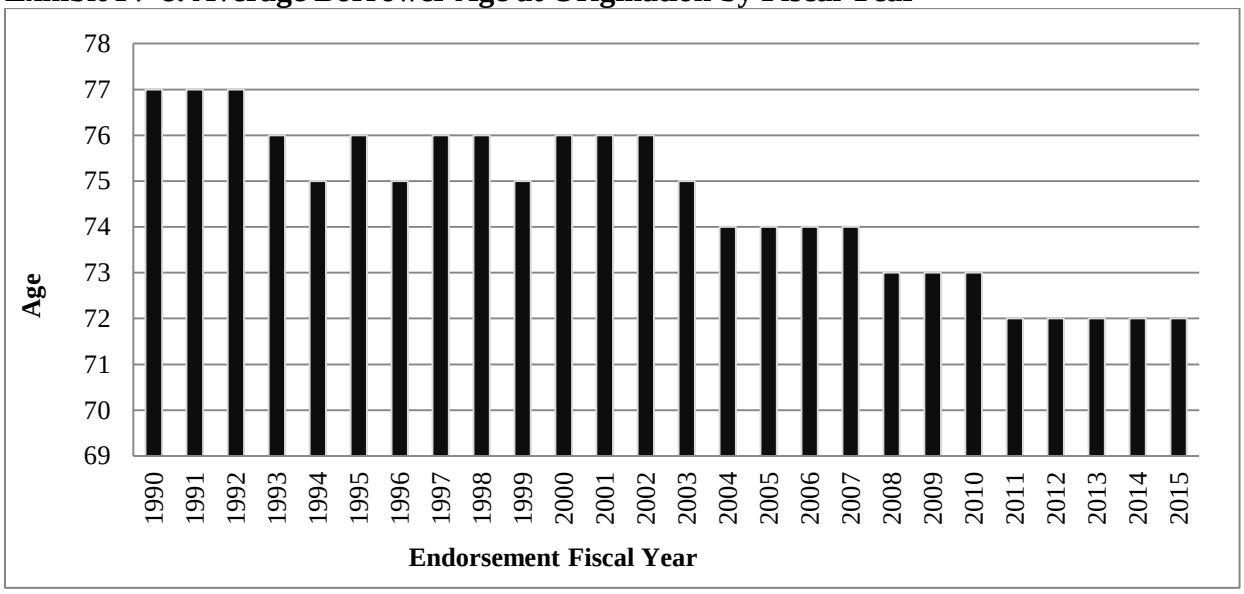
Exhibit IV-7. Percentage of Borrowers with Appraised House Value Greater than Area Median Value



H. Borrower Age Distribution

The borrower age profile of an endorsement year affects loan termination rates and the percentage of initial equity available to the borrower. Exhibit IV-8 presents the average borrower age at origination over FYs 1990-2015. The average borrower age has declined over time. Younger borrowers are associated with a higher financial risk exposure for FHA as they have a longer life expectancy. To manage this risk, the PLFs, which limit the percentage of initial equity available to the borrower, are lower for younger borrowers, limiting them to a smaller portion of the equity in the house. The average borrower age was about 73 years for FYs 2009-2010 endorsements, and 72 years for FYs 2011-2015 endorsements.

Exhibit IV-8. Average Borrower Age at Origination by Fiscal Year



I. Borrower Gender Distribution

Gender also affects termination behavior due to differences in mortality. The gender distribution of the HECM portfolio has remained steady over time. HECM loan behavior indicates that single males tend to terminate their loans the fastest, single females terminate the second fastest, and couples terminate the slowest. Exhibit IV-9 presents the gender distribution of HECM endorsements from FY 2009 through 2015. Single females comprise the largest gender cohort of the FY 2010 endorsements at 42 percent, followed by couples at 35 percent, and single males at 21 percent. A similar pattern is observed for FYs 2011 and 2012 endorsements. In FYs 2013-2015 endorsements, couples comprise 39 percent, surpassing single females to become the largest gender cohort. The single female share fell to around 38 percent while single males remain the lowest at 21 percent, about the same as in prior years.

Exhibit IV-9. Distribution of FY 2009-FY 2015 HECM Endorsements by Gender

Endorsement Fiscal Year	Male	Female	Couple	Missing
2009	21.70%	40.93%	36.76%	0.62%
2010	21.47%	41.88%	35.26%	1.39%
2011	20.86%	40.25%	37.08%	1.81%
2012	21.22%	39.16%	37.36%	2.27%
2013	21.15%	37.57%	38.96%	2.33%
2014	20.63%	38.75%	38.65%	1.97%
2015	21.84%	38.60%	38.79%	0.78%

J. Cash Draw Distribution

Data show that loans which have drawn a higher percentage of the initial amount of equity available tend to have a higher likelihood of refinancing. Exhibit IV-10 shows the distribution of the first-month cash draw as a percentage of the initial principal limit among different borrower age groups for HECM endorsements from FY 2009 through FY 2015.

Younger borrowers tend to draw a higher percentage of the initial amount of equity available than older borrowers. In FY 2009, 63 percent of the 62-65 age group drew over 80 percent of their initial principal limit, compared with 44 percent for the greater-than-85 years-old age group. The incidence of initial draws of above 80 percent of the principal limit rose sharply to above 70 percent over all age groups for FYs 2010-2013 endorsements. This was mainly driven by the disproportionally high initial draws incurred by most fixed-rate HECMs during that period. Such a requirement was subsequently prohibited by HUD in 2014. Note that the overall first-month draw over 80 percent fell from 74 percent in FY 2013 to 35 percent in FY 2015.

Although younger borrowers typically draw a higher percentage of the initial principal limit in the first month, the amount of cash drawn represents a smaller percentage of the MCA, because the PLF is lower for younger borrowers to account for the risk implied by their longer life expectancy.

Exhibit IV-10. First-Month Borrower Cash Draw of FY 2009-FY 2015 HECM Endorsements as a Percentage of the Initial Principal Limit

Endorsement Fiscal Year	Age Group	Number of Loans	Variable Rate Loans			Fixed Rate Loans	
			0-40%	40-80%	80-100%	0-80%	80-100%
2009	62-65	20,721	11.84%	24.15%	50.40%	0.48%	13.13%
	66-70	28,474	14.30%	24.72%	47.87%	0.35%	12.76%
	71-75	25,385	18.38%	24.98%	44.98%	0.27%	11.39%
	76-85	30,183	24.29%	24.44%	41.25%	0.28%	9.75%
	85+	9,645	34.71%	20.63%	36.65%	0.27%	7.74%
	Total	114,408	19.12%	24.26%	44.99%	0.33%	11.30%
2010	62-65	15761	7.38%	7.99%	4.21%	1.35%	79.08%
	66-70	18,813	8.92%	9.63%	4.99%	1.07%	75.40%
	71-75	16,996	12.86%	11.28%	5.74%	0.85%	69.28%
	76-85	20,323	19.43%	13.99%	6.58%	0.73%	59.26%
	85+	7,161	30.95%	14.65%	8.38%	0.78%	45.25%
	Total	79,054	14.16%	11.23%	5.71%	0.97%	67.94%

2011	62-65	17,003	8.29%	9.98%	5.02%	1.05%	75.67%
	66-70	18,139	10.58%	10.32%	4.76%	1.05%	73.30%
	71-75	15,171	14.63%	11.63%	4.88%	0.85%	68.01%
	76-85	16,788	21.84%	13.59%	5.16%	0.88%	58.54%
	85+	6,007	35.11%	13.17%	5.34%	0.60%	45.78%
	Total	73,108	15.49%	11.50%	4.98%	0.93%	67.10%
2012	62-65	13,712	8.58%	10.31%	5.53%	0.93%	74.66%
	66-70	13,782	10.55%	10.37%	4.52%	0.89%	73.68%
	71-75	10,897	13.91%	11.37%	4.37%	0.66%	69.69%
	76-85	11,922	20.26%	12.13%	4.80%	1.02%	61.79%
	85+	4,505	32.25%	12.72%	5.02%	1.13%	48.88%
	Total	54,818	14.62%	11.13%	4.84%	0.90%	68.51%
2013	62-65	14,927	7.93%	11.23%	15.34%	0.69%	64.82%
	66-70	15,879	9.79%	11.05%	15.06%	0.54%	63.58%
	71-75	12,101	13.27%	11.35%	14.07%	0.78%	60.54%
	76-85	12,656	19.00%	12.98%	13.27%	0.60%	54.15%
	85+	4,360	30.14%	12.27%	11.08%	0.87%	45.64%
	Total	59,923	13.45%	11.65%	14.26%	0.66%	59.98%
2014	62-65	12,031	12.19%	35.80%	29.35%	2.95%	19.71%
	66-70	13,890	14.77%	34.01%	29.91%	2.89%	18.42%
	71-75	10,650	19.03%	34.29%	28.22%	2.81%	15.65%
	76-85	11,061	24.24%	35.25%	26.07%	2.87%	11.58%
	85+	3,982	35.59%	33.43%	21.20%	2.96%	6.83%
	Total	51,614	18.69%	34.71%	27.93%	2.89%	15.79%
2015	62-65	9,393	12.75%	47.92%	19.56%	0.99%	18.78%
	66-70	11,014	14.83%	45.19%	20.53%	1.15%	18.30%
	71-75	8,952	18.07%	44.67%	20.20%	0.87%	16.19%
	76-85	9,627	23.03%	44.34%	19.59%	0.99%	12.05%
	85+	3,545	33.46%	43.41%	15.32%	1.47%	6.35%
	Total	42,531	18.46%	45.34%	19.60%	1.05%	15.55%

This Page Left Blank Intentionally

Section V. HECM Performance under Alternative Scenarios

The realized economic value of HECMs will vary from the Review's estimate if the drivers of loan performance deviate from the baseline projection. In this section, we present the baseline economic value from the Monte Carlo simulation and seven alternative scenarios. The baseline case in the Review is the mean of the economic values of the MMI HECM portfolio over the 100 equally likely simulated paths. Each alternative scenario estimates the performance of the Fund under the future interest rates, unemployment rates and house price appreciation rates specific to that scenario.

The first five alternative economic scenarios were based on our 100 simulated paths, corresponding to the paths that yielded the 10th best, 25th best, 25th worst, 10th worst and the worst projected economic values. The sixth alternative path is the most stressful scenario among Moody's Analytics alternative forecasts published in July 2015, and is called the Prolonged Slump. The seventh alternative path is Moody's July 2015 baseline forecast as a deterministic scenario. Here are the seven alternative scenarios: [25]

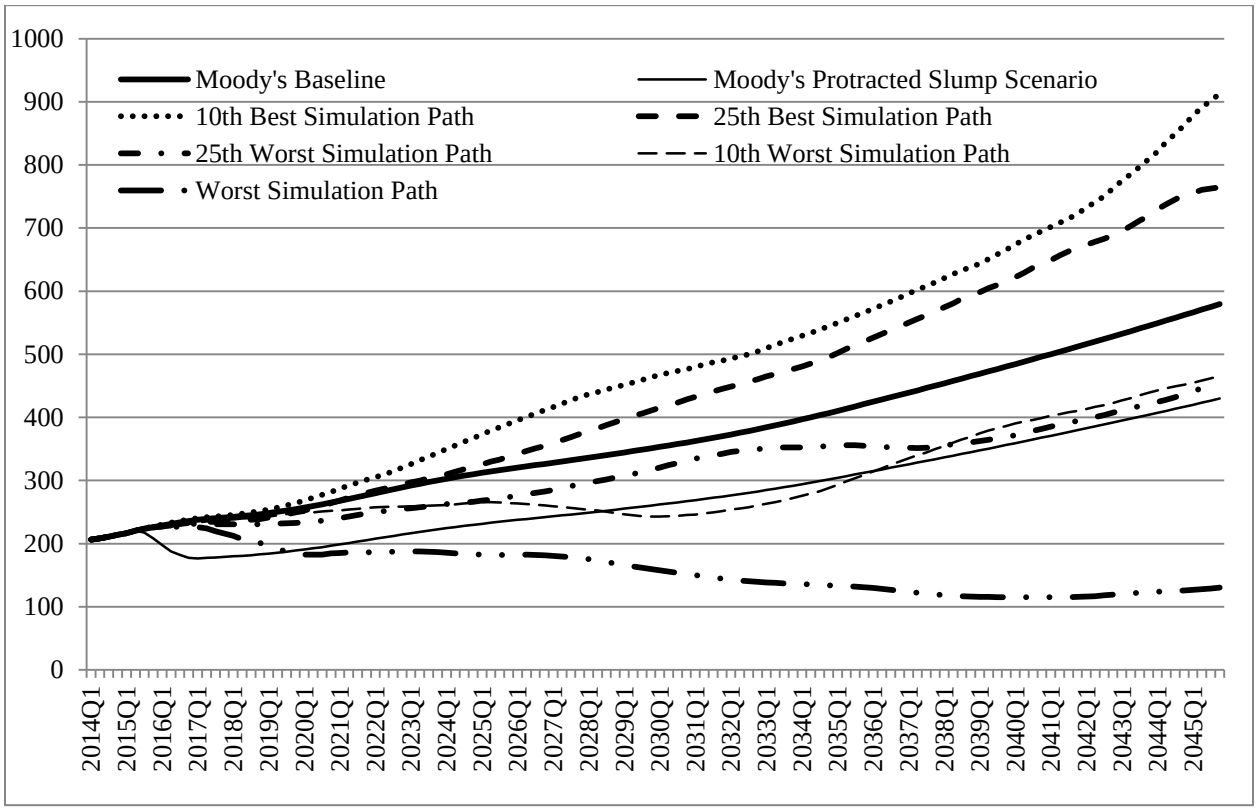
- 10th Best Path in Simulation, the path that resulted in the 10th highest economic value in the Monte Carlo simulation.
- 25th Best Path in Simulation, the path that resulted in the 25th highest economic value in the Monte Carlo simulation.
- 25th Worst Path in Simulation, the path that resulted in the 25th lowest economic value in the Monte Carlo simulation.
- 10th Worst Path in Simulation, the path that resulted in the 10th lowest economic value in the Monte Carlo simulation.
- The Worst Path in Simulation, the path that resulted in the lowest economic value in the Monte Carlo simulation.
- Moody's Protracted Slump Scenario, the most stressful alternative scenario forecasted by Moody's Analytics in July 2015.
- Moody's Baseline as a deterministic Scenario, as of July 2015.

Under Moody's protracted slump scenario, the levels of the house price indices converge to a long-term index level similar to its baseline forecast. As a result, this scenario shows low house price growth rates in the short-term, followed by higher than base case growth rates after it passes the lowest point. We applied an adjustment by assuming that the growth rates converge to long-run growth rates, instead of the Moody's methodology where the indices converge to their long-term levels. This adjustment avoids having the stress scenario show unusual growth after the initial stress period. As a result, the protracted slump scenario analyzed in this Review is more stressful than the original Moody's scenario. Appendix B provides more details about this adjustment.

[25] Detailed descriptions of these alternative scenarios is presented in Appendix B.

Exhibit V-1 shows the future movements of the national-level House Price Index under Moody's baseline and the six alternative economic scenarios used in our analysis. Starting with the 2013 Review, we have changed to the Purchase-Only HPI instead of the all-transaction HPI which was used in previous Reviews.

Exhibit V-1. Future National Purchase-Only House Price Indexes for Different Economic Scenarios



The macroeconomic factors that serve as inputs to the HECM model include the FHFA national, state, and MSA house price indices, the national unemployment rate, one-year and ten-year Treasury rates and the one-year LIBOR rate. Moody's house price forecasts are part of its macroeconomic model which considers local area economic environments including unemployment rates. The mortality rates were estimated based on CDC 1989-1991, 1999-2001, and 2009 U.S. Decennial Life Tables published by the Center for Disease Control. The detailed methodology is described in Appendix A. Borrower cash-draw assumptions were based on past program experience, with adjustments to account for different borrower composition provided by FHA.

Exhibit V-2 reproduces the projected expected economic values from FY 2015 through FY 2022 from our Monte Carlo simulation. This is our baseline stochastic case. Recall that this involves

taking the average of 100 randomly simulated paths.[26] The estimated economic value of the HECM portfolio in the MMI Fund at the end of FY 2015 is $6,778 million, and its economic value is projected to grow steadily to $13,665 million by the end of FY 2022.

Exhibit V-2. Fund Performance: Baseline Monte Carlo Simulation ($ Millions)

Fiscal Year*	Economic Value	Insurance in Force**	Volume of New Endorsements***	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	6,778	105,234	15,763	302	
2016	7,429	109,334	15,073	575	76
2017	8,222	120,424	17,035	636	157
2018	9,135	132,573	18,340	692	221
2019	10,133	145,236	19,548	716	282
2020	11,213	158,091	20,866	738	342
2021	12,395	171,103	22,283	788	394
2022	13,665	184,492	23,715	823	447

* All values are expressed as of the end of the fiscal year.
** Insurance-in-force is estimated as the MCAs of the remaining insured loans.
*** Projections are based on the HECM demand model in Appendix E times the average MCA. This volume number in FY 2015 reflects the outstanding loans at the end of the fiscal year, and excludes loans endorsed and terminated in the same fiscal year.

The results of each of the alternative scenarios on the performance of the HECM portion of the MMI Fund are now presented.

A. Selected Scenarios from Monte Carlo Simulation

The Monte Carlo simulation approach provides additional information about the probability distribution of the economic value of the HECM Fund with respect to different possible future economic conditions and the corresponding prepayments and claims. In addition to the estimation of the "expected" economic value of the HECM portfolio, the simulation also provides the economic value associated with each one of the 100 possible future economic paths. The distribution of economic values based on these scenarios allows us to gain insights into the sensitivity of the Fund's economic value to different economic conditions. Ordering the 100 economic values from low to high represents the percentiles from the worst to the best.

Exhibit V-3 presents the projected economic values for FY 2015 through FY 2022 under five different simulated future economic paths, and two additional Moody's scenarios. The 10th best economic value as of the end of FY 2015 is estimated to be $19,072 million. Compared with the baseline result (the mean across the 100 paths), the estimated economic value is $12,294 million

[26] Note that Exhibit V-2 is the same as Exhibit II-1, reproduced in this section for convenience.

higher in this scenario. There is approximately a 10 percent chance the economic conditions can be even more favorable and yield a higher economic value than $19,072 million.

The projected economic value for FY 2015 under the 10th worst simulated path is *negative* $6,451 million, which is $13,229 million lower than the baseline result. There is approximately a 10 percent probability that the actual realized economic value would be even more stressful than this path, resulting in an economic value worse than *negative* $6,451 million.

These two alternative scenarios suggest that there is an 80 percent chance that the economic value of the HECM portfolio would be between *negative* $6,451 and positive $19,072 million in FY 2015.

Under the 25th best scenario, the HECM economic value is projected to be positive $14,887 million in FY 2015, whereas the economic value under the 25th worst scenario is projected to be *negative* $104 million. These two alternative scenarios suggest that there is a 50 percent chance that the economic value of the HECM portfolio would be between *negative* $104 million and positive $14,887 million in FY 2015.

Under the worst scenario, the economic value is *negative* $33,442 million in FY 2015.

Exhibit V-3. HECM Economic Values under Different Scenarios ($ Millions)

Fiscal Year	Mean Stochastic Simulation	10th Best Path in Simulation	25th Best Path in Simulation	25th Worst Path in Simulation	10th Worst Path in Simulation	The Worst Path in Simulation	Moody's Baseline	Moody's Protracted Slump
2015	6,778	$19,072	$14,887	-104	-6,451	-33,442	8,189	-6,776
2016	7,429	20,468	16,332	218	-7,490	-35,894	9,174	-7,296
2017	8,222	21,999	17,796	737	-8,639	-38,767	10,418	-7,447
2018	9,135	24,222	19,659	1,581	-9,045	-41,869	11,818	-7,200
2019	10,133	27,159	22,134	2,542	-8,645	-45,098	13,373	-6,783
2020	11,213	30,449	24,824	3,565	-8,071	-48,431	15,106	-6,178
2021	12,395	34,168	27,953	4,273	-7,693	-52,234	17,002	-5,435
2022	13,665	37,727	31,052	5,423	-7,154	-56,410	19,029	-4,593

The detailed results of each of the simulated scenarios on the performance of the HECM portion of the MMI Fund are presented in Exhibits V-4 to V-10.

Exhibit V-4 presents the projected economic values for FY 2015 through FY 2022 under the 10th best simulated path. This scenario results in the highest economic value among all alternative paths presented in this section. The economic values at the end of FY 2015 and FY 2022 are estimated to be positive $19,072 million and positive $37,727 million, respectively. The high economic value in this alternative path is generated by a stable and faster house price

appreciation rate than Moody's baseline after FY 2016. This creates low Type I claim losses and high Type II claim recoveries. As a result, it led to the highest economic value among the eight presented scenarios through FY 2022.

Exhibit V-4. HECM Economic Value: 10th Best Simulation Path ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	19,072	98,979	13,807	1,708	
2016	20,468	103,062	14,032	1,184	212
2017	21,999	113,182	15,938	1,099	432
2018	24,222	124,472	17,242	1,631	593
2019	27,159	135,297	18,583	2,190	747
2020	30,449	146,287	20,261	2,372	917
2021	34,168	158,088	22,125	2,649	1,071
2022	37,727	170,559	23,822	2,327	1,232

Exhibit V-5 presents the projected economic values for FY 2015 through FY 2022 under the 25th best simulated path. The economic values at the end of FY 2015 and at the end of FY 2022 are estimated to be positive $14,887 million and positive $31,052 million, respectively. The FY 2015 economic value under this scenario is $4,185 million less than the FY 2015 economic value under the 10th best scenario. This path also has a faster house price appreciation rate than Moody's baseline after FY 2016, which results in higher-than-average FY 2015 economic value.

Exhibit V-5. HECM Economic Value: 25th Best Simulation Path ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	14,887	108,446	15,799	1,437	
2016	16,332	112,479	15,511	1,280	166
2017	17,796	123,931	17,326	1,119	345
2018	19,659	136,404	18,547	1,384	479
2019	22,134	148,675	19,808	1,869	606
2020	24,824	161,672	21,497	1,942	747
2021	27,953	174,284	23,441	2,256	873
2022	31,052	187,605	25,173	2,092	1,008

Exhibit V-6 presents the projected economic values for FY 2015 through FY 2022 under the 25th worst simulated path. Under this path, house prices in general appreciate at a slower rate than the baseline. Consequently, this path projects a relatively low economic value through FY 2022. The economic values at the end of FY 2015 and at the end of FY 2022 are estimated to be *negative* $104 million and *positive* $5,423 million, respectively.

Exhibit V-6. HECM Economic Value: 25th Worst Simulation Path ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	-104	106,397	15,997	-378	
2016	218	112,110	16,055	323	-1
2017	737	124,168	17,749	515	5
2018	1,581	137,217	18,685	824	20
2019	2,542	150,382	19,521	913	49
2020	3,565	163,633	20,450	937	86
2021	4,273	176,942	21,714	583	125
2022	5,423	189,953	23,102	996	154

Exhibit V-7 presents the projected economic values for FY 2015 through FY 2022 under the 10th worst simulated path. Under this path, house prices are at a low level and they depreciate a bit between FY 2020 and 2030, before it rebounds moderately until 2037. As a result, the economic value under the 10th worst path projects a low economic value through FY 2022. The economic values at the end of FY 2015 and FY 2022 are estimated to be *negative* $6,451 million and *negative* $7,154 million, respectively.

Exhibit V-7. HECM Economic Value: 10th Worst Simulation Path ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	-6,451	105,814	15,723	-1,616	
2016	-7,490	110,145	15,060	-967	-72
2017	-8,639	121,328	17,024	-991	-158
2018	-9,045	133,537	18,437	-173	-233
2019	-8,645	146,851	19,572	679	-279
2020	-8,071	160,744	20,628	866	-292
2021	-7,693	174,845	21,431	662	-284
2022	-7,154	188,566	22,202	816	-277

Exhibit V-8 presents the projected economic values for FY 2015 through FY 2022 under the worst simulated path. This stress path has a long protracted house price decrease until FY 2040, and stays stagnant until FY 2044. This creates a severe claim loss frequency and very low recoveries. As a result, it led to the lowest economic value by far among the 100 simulated scenarios for the whole HECM portfolio. The economic values at the end of FY 2015 and FY 2022 are estimated to be *negative* $33,442 million and *negative* $56,410 million, respectively. This result reflects approximately one out of a hundred economic outcomes.

Exhibit V-8. HECM Economic Value: Worst Simulation Path ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	-33,442	104,481	15,866	-5,411	
2016	-35,894	108,719	14,092	-2,079	-373
2017	-38,767	119,295	15,143	-2,116	-758
2018	-41,869	129,723	14,769	-2,057	-1,044
2019	-45,098	139,082	13,855	-1,938	-1,291
2020	-48,431	147,135	13,302	-1,811	-1,523
2021	-52,234	154,573	14,135	-2,099	-1,704
2022	-56,410	159,547	14,844	-2,293	-1,883

B. Moody's Alternative Scenarios

Exhibit V-9 presents the estimated economic value of the HECM Fund based on Moody's protracted slump economic scenario. This scenario provides a reasonableness check of the range

of results obtained from the Monte Carlo simulation. The economic value at the end of FY 2015 decreases from the base case of *positive* $6,778 million to *negative* $6,776 million under this alternative scenario. This is primarily due to high near-term house price depreciation, which reduces the amount of recovery at termination. The FY 2022 value is about $18,258 million lower than in the baseline Monte Carlo result. The protracted slump scenario projects an economic value that corresponds approximately to the 9th worst economic value in our simulation.

Exhibit V-9. HECM Economic Value: Protracted Slump Scenario ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	-6,776	105,234	15,763	-928	
2016	-7,296	107,992	12,349	-444	-75
2017	-7,447	114,975	11,759	3	-154
2018	-7,200	122,552	12,997	447	-201
2019	-6,783	131,087	14,326	639	-222
2020	-6,178	140,570	15,694	834	-229
2021	-5,435	150,819	17,115	960	-217
2022	-4,593	161,675	18,544	1,038	-196

Exhibit V-10 presents the estimated economic value of the HECM Fund based on Moody's baseline as a deterministic scenario. The result is very close to the median of the Monte Carlo simulation results, as the stochastic paths are constructed by centering on the Moody's baseline scenario.

Exhibit V-10. HECM Economic Value: Moody's Baseline Scenario ($ Millions)

Fiscal Year	Economic Value	Insurance in Force	Volume of New Endorsements	Economic Value of Each New Book of Business	Investment Earnings on Fund Balance
2015	8,189	105,234	15,763	644	
2016	9,174	109,304	15,069	893	91
2017	10,418	120,417	17,043	1,051	194
2018	11,818	132,617	18,395	1,119	281
2019	13,373	145,161	19,633	1,191	364
2020	15,106	157,922	20,971	1,282	452
2021	17,002	170,969	22,387	1,364	531
2022	19,029	184,294	23,804	1,414	613

C. Sensitivity Tests for Economic Variables

The above scenario analyses were conducted to examine the distribution of the economic value of the Fund with different possible combinations of interest rates, unemployment rates and house price movements in the future. It is also useful to understand the marginal impact of each of the major economic factors on the economic value. Below, we show the sensitivity of the FY 2015 deterministic base-scenario economic value of the Fund with respect to changes in each of the following three sets of economic variables:

- National House Price Index (HPI)
- Present value conversion factors
- Interest rates:
    - Ten-year constant maturity Treasury rate
    - One-year constant maturity Treasury rate
    - One-year LIBOR rate
    - Mortgage rate

Exhibit V-11 reports in graphic form the sensitivity of the economic value with respect to changes in HPI forecasts, future interest rates and OMB discount rates, respectively. The marginal impact is measured by the change of the economic value from the deterministic base scenario result as of the end of FY 2015. Each of these three sets of variables was separately shifted up and down to draw this graph, holding all other parameters constant. The present value factors and the interest rates were constrained to be non-negative.

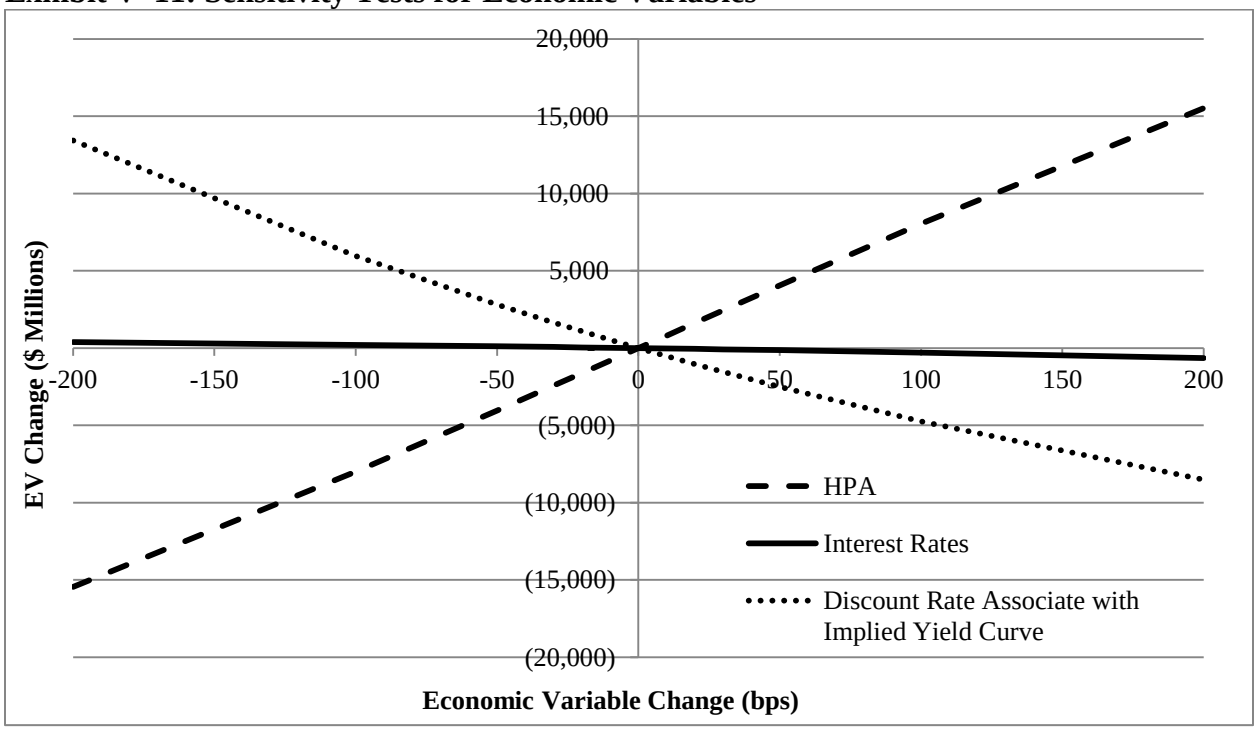
The sensitivity to shifts in the annualized house price appreciation rates (HPAs) from the base scenario has a positive slope and a nearly linear shape, indicating a nearly symmetric effect from increases and decreases with respect to HPAs. The results show that the adverse house price shifts reduce the economic value of the fund almost as much as the favorable house price shifts increase the economic value of the fund. This is the case as long as the loan balance accrues faster than house price appreciation. Under such a condition, the eventual recovery amount is almost linearly related to the HPA and the economic value will be approximately linearly related to the future HPA. A negative 100 basis points parallel shift in HPA will decrease economic value by $8,000 million, and a positive 100 basis points parallel shift in HPA will increase economic value by $8,055 million.

We applied positive/upward and negative/downward parallel shifts to the implied yield curve in the deterministic base scenario to compute the corresponding shifts in the discount factors. Negative (positive) shifts in the implied yield curve produce higher (lower) discount factors. The increase in discount factors, shown as negative shifts in the implied yield curve in Exhibit V-11, contribute to increases in the economic value of the Fund. This is because the major positive cash flows, the recoveries, are received further out in time than the major negative cash flows, the Type I and Type II claim payments. A downward 100 basis points parallel shift in the

implied yield curve will increase economic value by $5,954 million, whereas the upward shift of the same magnitude in implied yield curve will reduce the economic value by $4,741 million. This shows a convexity of the economic value with respect to the discount rate similar to most fixed income securities.

We applied parallel shifts to 1-year Treasury rates, 10-year Treasury rates, 1- year Libor rates and mortgage rates. The economic value curve has a very flat slope. A negative 100 basis points parallel shift in interest rates will increase economic value by $211 million, and a positive 100 basis points parallel shift in interest rates decrease economic value by $295 million. Compared to the shifts in house prices and discount rates, the impact of shifting interest rates is quite small. Changes in market interest rates (excluding discount factor impact) have relatively small effects on the two major cash flows of HECM loans, i.e., assignments and recoveries.

Exhibit V–11: Sensitivity Tests for Economic Variables



Section VI. Summary of Methodology

This section summarizes the analytical approach implemented in this Review. Detailed descriptions of the component models for HECMs are provided in Appendices A-F. The following sections summarize each of these appendices.

A. HECM Base Termination Model (Appendix A)

No repayment of principal is required on a HECM loan when the loan is active. Termination of a HECM loan typically occurs due to death, moving out, or voluntary termination via refinance or payoff. The termination model estimates the probabilities of the three mutually exclusive HECM termination events denoted as mortality, mobility and refinance. A multinomial logistic regression modeling approach is adopted to capture the competing-risk nature of the different termination events.

The termination model incorporates four main categories of explanatory variables:

- Fixed initial borrower characteristics: borrower age at origination and gender.
- Fixed initial loan characteristics: loan interest rate, origination year and quarter the first month cash draw percentage, the estimated ratio of property value to the local area's median home values at time of origination, and the estimated ratio of the local area's median home value to the national loan limit at the time of origination.
- Dynamic variables based on loan/borrower characteristics: loan age and updated borrower's age.
- Dynamic variables derived by combining loan characteristics with external macroeconomic data: interest rates, house price indices (which determine the cumulative house price growth), the amount of additional equity available to the borrower through refinancing and the updated loan-to-value ratio.

For each termination event type, a separate binomial logistic model is estimated based on loan-level historical HECM performance data and economic factors. The three logistic models are then aggregated to estimate the overall termination probabilities for the HECM program, following the approach developed in Begg and Gray (1984). The logistic model for each termination event is unique, including only the variables that impact the occurrence of that particular event. For example, the mobility model includes an estimate of the updated loan-to-value ratio over time to model the impact of potential gains from resale upon contemplation of moving out. The refinance model includes a refinance incentive variable. The mortality model includes the attained age of the borrower over the life of the loan and the borrower's gender for the impact of age and gender on the probability of death.

B. Loan Performance Projections (Appendix B)

The estimated HECM future termination rates are based on the characteristics of the surviving portfolio. To estimate the economic value of the current book of business, we project termination rates for the outstanding endorsement portfolio beyond the end of FY 2015. For future books' economic values, we also project the composition and volume of future endorsements. Each loan creates annual observations from its origin to the policy year when the loan reaches a duration of up to 74 years, or the borrower reaches age 109, the maximum assumed duration of a HECM loan. Thus the projection period for future books last until FY 2095. The assumed characteristics of the future HECM endorsements for FY 2016 through FY 2022 are based on FHA's projections.

At the time of HECM loan termination, the borrower or the heir also has the option to convey the property to HUD or pay off the outstanding loan balance. The decision is highly dependent on the house price at the time of loan termination compared to the accrued loan balance. Thus both the house price appreciation and current loan-to-value ratio will determine the final outcome. The conveyance model is also presented in Appendix B.

C. HECM Cash Flow Analysis (Appendix C)

The cash flow model estimates the HECM economic values for the FY 2009 through FY 2022 books of business. For the books through the FY 2015 book, the economic values are computed on the projected cash flows from the end of FY 2015. The economic values are the net present value of future cash flows for these books of business plus capital resources. The HECM cash flow model consists of four components: upfront and annual HECM mortgage insurance premiums, lender insurance claims before and upon assignment, note holding expenses (post-assignment) and recoveries on assigned notes in inventory. The cash flows are discounted according to the most updated Federal credit subsidy present-value conversion factors published by OMB.

D. HECM Tax and Insurance Default Model (Appendix D)

HECM tax and insurance defaults are imposed by HUD when tax or insurance payments are in arrears. A binomial logistic model estimates the probability of borrower defaults on tax and insurance obligations as a function of various borrower, loan and economic characteristics. The model's implementation allows these defaults to happen before loan assignment. After loan assignment, this Review assumes a constant 25 percent of assigned loans would go T&I defaults. The HECM portfolio of active loans as of the end of FY 2015 has a base-case projected life time cumulative tax and insurance default rate of 19.66 percent.

E. HECM Demand Model (Appendix E)

We updated the HECM demand volume model for this year's Review. This is a quarterly time series econometric model built on data of HECM loan counts, house price growth rates at the national level and the national senior population. The model predicts the number of HECM loans to be endorsed in FY 2016 through FY 2022. Without adequate non-borrowing younger spouse data, the 2015 model made assumption that the couple percent will be 10% higher than our prediction in total endorsements in the future. Different economic scenarios for house prices and interest rates generate different predictions of the future HECM loan counts.

F. Economic Scenario Simulations (Appendix F)

To forecast the economic values of the MMI HECM portfolio, simulated economic scenarios were generated by a Monte Carlo stochastic model. The simulated economic scenarios were calibrated to center around Moody's economic forecasts released in July 2015. Deterministic sensitivity analyses were also conducted to provide insights into the sensitivity of the portfolio with respect to changes in future economic conditions. The assumption of these future interest and house price growth rates are the fundamental economic factors that drive future termination rates, HECM tax and insurance default rates and the HECM demand volume in each of the stochastic simulation paths and in the specified deterministic alternative scenarios.

This Page Left Blank Intentionally

Section VII. Qualifications and Limitations

The economic value estimates provided in this Review are based on the component models that were discussed in Section VI. The models make predictions about HECM-related variables and relevant market conditions that change over time in response to economic, institutional and policy changes.

A. Basic Data Limitations

The quality of any model built on historical data is constrained by the scope, availability and accuracy of the data. Key variables determining market behavior may not be observed or they may be observed with error. Moreover, the theoretical specification of a model may not adequately capture the economic phenomena it tries to represent.

As an example of data limitations, HECM has a relatively short program history. The pilot program began in FY 1989 and became permanent in FY 1998 after endorsing 20,000 loans. The endorsements exceeded 10,000 loans per year in FY 2002 and reached 100,000 per year in FY 2007. Unlike the MMI Single Family forward mortgage program, HECM has a limited number of loans that have remained in FHA's portfolio for more than seven years. The lack of long-run performance data potentially limits the robustness of the models' predictive capacity for later policy years.

B. Model Sensitivity to Economic Projections

The main purpose of this Review is to assess the long-term financial performance of the HECM Fund. Two of the critical economic variables used in making these projections are future house prices and interest rates. We use stochastic models to project the future distribution of house prices and interest rates and apply a Monte Carlo simulation technique. Our stochastic models are calibrated so that they are centered on Moody's July 2015 baseline economic forecast. Hence the estimated results captured the impact of future deviations from Moody's baseline projections.

The results of the alternative scenario analyses in Section V represent various selected outcomes in the projected distribution of house prices and interest rates. The estimated probabilities of economic values depend on the Monte Carlo simulation which was built on our stochastic models.

C. Changing Reverse Mortgage Market Landscape

Changes in financial markets and retirement needs will affect both the reasons why borrowers participate in the HECM program and the specifics of new product offerings. This will affect the loan characteristics and performance of future endorsements including cash draw patterns and repayment behavior. Borrower characteristics may vary with the changing demographics as the large baby boomer population transitions to retirement. Hence, the accuracy of the estimates on the performance of future books is sensitive to the borrower composition and termination behavioral assumptions.

At the start of FY 2014, the Standard and Saver products were eliminated and replaced by a single new program. The new program has a principal limit factor of 85 percent of the level of the prior Standard program. It reduced the allowable initial disbursement, where mortgagors are subject to an initial 12-month disbursement limitation of 60 percent of the initial principal limit or the sum of mandatory obligations that must be satisfied at closing plus an additional 10 percent of the initial principal limit, not to exceed the maximum principal limit. The existing annual MIP rate of 1.25 percent continued to be in effect. The initial MIP was changed, to be determined based on the amount of the mortgagor's initial draw at loan closing. The new origination requirements tended to defer cash outflows and increase cash inflows.

On August 4th, 2014, HUD adjusted the HECM program by allowing non-borrowing spouses younger than 62 years old. This adjustment further reduces the PLFs, while extending the eligibility of the HECM program to a larger clientele population. The effect on borrower reception and how they change their withdrawal behavior is still uncertain at this early stage. The newly announced LESA and the guideline and assumptions for handling T&I defaults introduced further uncertainty about the future policy effectiveness.

In this Review, we have explicitly modeled the longevity improvement of HECM borrowers with endorsements between FY 1989 to 2013. However, future HECM borrowers may experience mortality uncertainty unobserved at the current time. This remains another area that could be investigated in the future.

Appendix A

HECM Base Termination Model

Appendix A: HECM Base Termination Model

This Appendix describes the methodology used to estimate the termination behavioral functions of HECM loans. In this 2015 Actuarial Review we refined the methodology and the model specification from the FY 2014 HECM Review. We re-estimated model parameters using the updated data.

HECM loans terminate due to borrower mortality (death), loan refinancing or borrower move-outs (mobility). A multinomial logistic model is specified and estimated to capture the loan termination behavior. Pursuant to Mortgagee Letter 2011-01, HECM loans can be terminated under foreclosure when borrowers fail to pay their real estate taxes and/or property insurance premiums as required by the HECM contract. Building upon last year's econometric model of tax and insurance (T&I) defaults, we refined the specification of T&I defaults (discussed in Appendix D). When necessary, we distinguish the "base" termination model discussed in this Appendix from the T&I default termination model described in Appendix D. To clarify another possible confusion, a HECM insurance terminates at mortgage note assignment (because then HUD owns the loan), but the HECM loan itself does not terminate at this time as the borrower continues to live in the home. Hence, note assignments are not modeled as HECM loan terminations. Starting from this 2015 Review, the T&I defaults after mortgage note assignments are not modeled as loan terminations (discussed in Appendix D). Also note that the HECM model is an annual model, whereas the models we use for FHA forward mortgages are quarterly.

The available FHA historical HECM termination data were used to estimate the base termination model. These data include loans that were endorsed under the General Insurance (GI) Fund between FY 1990 and FY 2008, and loans endorsed under the Mutual Mortgage Insurance (MMI) Fund in FY 2009 through the end of March of 2015. Only the loans endorsed under the MMI Fund, however, are included to determine the economic value of the MMI Fund in this Review.

A1. The Multinomial Logistic Model

Similar to Szymanoski, DiVenti, and Chow (2000), Yuen-Reed and Szymanoski (2007) and last year's Actuarial Review of HECM loans (IFE Group 2014), a competing-risk multinomial logistic model is used to estimate the probabilities of HECM loan termination events excluding T&I default terminations.

Given survival to the beginning of time period *t*, the conditional probabilities that a loan will terminate due to mortality ($P_D(t)$), refinance ($P_R(t)$) or mobility ($P_M(t)$) are given by:

$$P_D(t) = \frac{e^{\alpha_D + X_D(t)\beta_D}}{1 + e^{\alpha_M + X_M(t)\beta_M} + e^{\alpha_R + X_R(t)\beta_R} + e^{\alpha_D + X_D(t)\beta_D}} \quad (1)$$

$$P_R(t) = \frac{e^{\alpha_R + X_R(t)\beta_R}}{1 + e^{\alpha_M + X_M(t)\beta_M} + e^{\alpha_R + X_R(t)\beta_R} + e^{\alpha_D + X_D(t)\beta_D}} \quad (2)$$

$$P_M(t) = \frac{e^{\alpha_M + X_M(t)\beta_M}}{1 + e^{\alpha_M + X_M(t)\beta_M} + e^{\alpha_R + X_R(t)\beta_R} + e^{\alpha_D + X_D(t)\beta_D}} \quad (3)$$

The probability of remaining active during the period is simply one minus the sum of these three probabilities. The constant terms α_D, α_R and α_M and the coefficient vectors β_D, β_R and β_M are parameters estimated by the multinomial logistic model. The subscripts D, R and M denote death, refinance and mobility, respectively. The vectors of dependent variables for predicting the conditional probability of termination due to mortality, refinance and mobility are represented by $X_D(t)$, $X_R(t)$ and $X_M(t)$, respectively. Loan and borrower characteristics as well as economic variables are included in each vector to predict HECM terminations. Some of these variables are constant over the life of the loan while others vary over time.

To classify observed terminations among the three possible outcomes, terminations that resulted from refinancing were based on FHA's endorsement records. That is, these refinancing terminations would lead to FHA endorsement of new HECM loans. The remaining terminations were cross-referenced with the Social Security Administration's mortality data provided by FHA. If a loan terminated within one year prior to and two years after the borrower's recorded death date,[27] the loan was considered to have terminated due to death. The remaining terminations are classified as mobility terminations.

The estimation technique for the multinomial logistic equation system follows Begg and Gray (1984), who showed that it is statistically equivalent to model a multinomial logistic regression model as a special aggregation of individually estimated binomial logistic regression models. For more details, see the FY 2015 Actuarial Review (IFE Group 2015, Appendix A) for forward mortgages. The next subsections describe the three binomial logistic sub-models.

A1.1. Mortality Model

The mortality model estimates the probability that a HECM loan terminates due to the death of the borrower. Social Security Administration mortality data obtained by FHA indicates the date of death of HECM borrowers. The IFE Group received updated mortality data up to March of 2015. Death dates were aligned with a two-year shift after and one-year shift before termination dates to determine which loans terminated due to death, in order to account for possible time lag between the dates of the recorded termination and the actual death.

[27] For loans with multiple borrowers, the date of death of the last surviving borrower is used. The same holds for spouses even if one of them is not a borrower.

We used four variables to forecast death terminations: rates from actuarial mortality tables, gender, policy year and percent of the available cash draw taken in the first month.

The *Mortality* variable accounts for expected mortality rates. It is based on the gender- and age-specific mortality rates $m_g(t)$ from the U.S. Life Table from the Center for Disease Control and Prevention (CDC). For loans with co-borrowers or couples, we created a joint mortality table, and calculated the likelihood of both borrowers or spouses not surviving to the end of a period. Equation 4 below depicts the *Mortality* [*M(t)*] calculation.

$$M(t)\begin{cases} m_g(t) & if\ single \\ m_b(t)|\, D_{co}(t-1)S_b(t-1) + m_{co}(t)|\, D_b(t-1)S_{co}(t-1) + m_b(t) * m_{co}(t)\,|S(t-1) & if\ couple \end{cases} \quad (4)$$

where *M(t)* represents the mortality rate at *t* ;
$m_g(t)$ represents the conditional mortality rate (gender and age specific) for a borrower dying at time *t* based on the U.S. Census Decennial Life Table;
$m_i(t)|\, D_j(t-1)S_i(t-1)$ represents the mortality rate of borrower *i* at time *t* conditional on that borrower *j* died before time *t-1* and borrower *i* survived up to time *t-1*. The notation here is that *i= b (borrower), j=co (co-borrower),* or *i=co, j=b*; and
$m_b(t) * m_{co}(t)\,|S(t-1)$ represents the probability that both borrower and co-borrower die at time t conditional that both survived to *t-1*.

Next, equation (5) transforms *M(t)* into *xbetaM(t)* as the input explanatory variable for the regression:

$$xbetaM(t) = ln(\frac{M(t)}{1-M(t)}) \quad (5)$$

This variable is called the transformed mortality rate. A piece-wise linear spline function was used to capture possible non-linearity of the mortality rate with respect to the age of the borrower.

The HECM program now has more than 25 years of history since its inception in 1989. Mortality rates across gender and age groups have decreased during this time period. In order to capture this trend, we used various life tables from the Census to calculate the corresponding mortality rate. The life tables we used include the CDC 1989-1991,[28] 1999-2001, and 2009[29] mortality rates. We used the mortality rate for these years, and performed interpolations for the years in between. We also extrapolated the mortality rate from 2009 to 2013 which covers our estimation

[28] U.S. Decennial Life Tables for 1989-91, From the Centers for Disease Control And Prevention/National Center for Health Statistics.
[29] Revised United States Life Tables, 2001-2009, the Centers For Disease Control And Prevention, http://www.cdc.gov/nchs/nvss/mortality/lewk3.htm

data. For forecasts after 2014, we keep mortality rates constant at the 2013 level for each given age.

Even though the second part of equation 4 accounts for when the last survivor dies, historical evidence shows that mortality-related HECM termination rates for couples tend to be lower than the joint mortality rate estimated in Equation 4. The dummy variable *Gender(Couple)*, which equals 1 if a couple and 0 otherwise, is designed to account for this experience.

Prior HECM experience also indicates that the likelihood of death terminations increases with policy year, even after controlling for borrower age-induced mortality increases. A piece-wise linear spline function of the time-dependent variable *PolicyYear* was used to capture variations in the trend (see the details in the next section). HECM loans have been endorsed over the past 25 years, but most of the loans were endorsed in the last 11 years. Due to the limited number of loan observations in late policy years, we restricted our sample to observations that are shorter than policy year 12.

Historical HECM experience also suggests that borrowers who experience heavier mortality than the baseline actuarial table seem to have a propensity to have a higher first month draw-down of their total eligible draw amount. Therefore, the variable *CashDraw* captures this self-selection of borrowers within the HECM program. Similar to the FY2014 model, we include two dummy variables: one for Term product and the other for Term product with Line of Credit feature, in order to reflect additional self-selection effects.

A1.2. Refinance Model

Termination occurs if the loan is refinanced. The refinance model consists of three types of explanatory variables: loan age, borrower-related characteristics, and economic variables. We use loan observations with less than or equal to 18 policy years due to the limited number of observations beyond 18 years.

A1.2.1. Loan Age Variables for the Refinance Model

Prior HECM experience shows that the majority of refinances occur after the first few years of the loan. To capture this experience, the same *PolicyYear* variable as defined in the mortality model is included. The series of piece-wise linear spline functions for loan age are defined as follows[30]:

$$Pol\_yr1 = \begin{cases} loan\ age & if\ loan\ age \le k_1 \\ k_1 & if\ loan\ age > k_1 \end{cases}$$

[30] All piece-wise linear functions for other variables are defined in a similar way. The boundary values or knot points are specified in the exhibits for each estimated model.

$$Pol\_yr2 = \begin{cases} 0 & if\ loan\ age \leq k_1 \\ loan\ age - k_1 & if\ k_1 < loan\ age \leq k_2 \\ k_2 - k_1 & if\ loan\ age > k_2 \end{cases}$$

$$Pol\_yr3 = \begin{cases} 0 & if\ loan\ age \leq k_2 \\ loan\ age - k_2 & if\ loan\ age > k_2 \end{cases}$$

where $k_1 = 3$, $k_2 = 6$ and $k_3 = 11$.

Coefficient estimates for each variable are the slopes of the line segments between individual knot points. The overall generic *PolicyYear* function for the three *Pol_yr* segment is given by:

$$PolicyYear \text{ function} = \beta_1 * Pol\_yr1 + \beta_2 * Pol\_yr2 + \beta_3 * Pol\_yr3$$

A1.2.2. Borrower-Related Variables for the Refinance Model

The variables *borrower's age at origination*, *Mortality Rate*, and *Gender* are borrower characteristics in the refinance model. Historical experience suggests that older borrowers are less likely to refinance, but this propensity decreases at a decreasing rate. Similarly, borrowers of different genders also refinance at differing rates. *Gender* refers to categorical variables representing female, male, couple and missing; with female as the baseline in this model (so it is not included in the equation). Historical experience suggests that couples and males are more likely to refinance than females, holding everything else constant.

The likelihood of refinancing is also affected by the cash draw utilization of the borrower. An analysis of the data suggests that the first-month cash draw (*CashDraw1-CashDraw2*) was a positive predictor of the likelihood of future refinances. We used piece-wise linear functions for the variable percentage initial cash draw.

The ratio of local area median house price to national loan limit at HECM origination is used to capture how expensive a house is compared to the national average. A high ratio indicates a larger dollar amount of benefits if the borrower choses to refinance, thus implying a higher probability of refinance.

Similar to last year, the FY 2015 model included two house value related variables: the 2-year HPI change that captures the short term housing price change and the current LTV that captures both HPI and UPB changes since origination.

A1.2.3. Economic Variables for the Refinance Model

The refinance incentive variable was designed to model HECM borrowers' potential benefit of refinancing a loan. The refinance incentive variable represents the net increase in the principal limit for a borrower upon refinancing relative to the refinancing costs. Equation 6 is the refinance incentive measure we used:

$$rfi_t\_new = \frac{\min\left(MCA_0 \times \Delta H, LoanLimit_t\right) \times PLF_t - C - PL_t}{C} \quad (6)$$

where MCA_0 = Original maximum claim amount for loan at time 0

$\Delta H = \frac{HPI_t}{HPI_0}$, HPI is the FHFA house price index per MSA (or state if loans are located outside of an MSA)

$LoanLimit_t$ = FHA loan limit for time t

PLF_t = New principal limit factor for the borrower's age and the current interest rate at time t

C = Transaction cost to originate the refinanced loan

PL_t = Gross principal limit on the original HECM loan at time t

At loan origination, the relative value of the property affects the future house price appreciation. Properties with higher values tend to have a larger appreciation amount in the HECM program and therefore lead to a higher probability of refinance. We used Home Value above Area Median as an indicator to measure relative house price compared with the local area median house price. The local median house price data was obtained from the Census at the MSA and state levels, with the most granular level available being used for each property.

A1.3. Mobility Model

The mobility model estimates the probability that a HECM loan terminates due to the borrower moving out of the HECM property. Factors representing borrower characteristics, economic conditions, and loan-specific variables were used as explanatory variables. For the same reason as the refinance model, we limit our sample to loans aged less than or equal to 18 years.

A1.3.1. Loan Age Variables for the Mobility Model

As before, the *PolicyYear* is a series of piece-wise linear functions for loan age, but with different knot points in this mobility model, to make the model better fit updated data.

A1.3.2. Borrower-Related Variables for the Mobility Model

Borrower-specific characteristics are also key drivers of the likelihood of moving out. Historical experience suggests that compared with younger borrowers, older borrowers are more likely to

move out, such as moving to a nursing home. We include *orig_age* and *pol_yr* to capture the borrowers' age in the ongoing years.

The *Gender_Couple*, *gender_male* and *gender_missing* refer to couple borrowers, single male borrowers and borrowers without gender information, respectively. Results show that couples are more likely to move out compared with single borrowers.

The Mortality *xbetaM(t)* of Equation 5 is used as a piece-wise gender-specific transformed mortality function that captures the borrower's mobility based on age-related issues, including health reasons, moving to a nursing home or to an assisted-living facility, or to live with their children.

We included two loan-type dummy variables: Term HECM and loans with Term and Line of Credit (LOC). The pure Term loans seem to have mobility rates greater than for the Term loans with LOC, which indicates a self-selection effect for borrowers with different mobility preferences.

A1.3.3. Economic Variables for the Mobility Model

In order to capture HECM program changes, we added *pre2004* to indicate whether the HECM loan was originated before CY 2004. Results show that HECM borrowers are less likely to move out if a loan is originated after year 2004.

The *Home Value vs. Area Median* variable estimates the ratio of appraised property value at origination to median value in the local (MSA or state) area. This variable reflects the higher propensity to move for borrowers whose houses have higher values.

We used updated loan-to-value ratio and house price volatility. Historical experience indicated that HECM borrowers with lower updated loan-to-value ratios are more likely move out of their homes than borrowers with higher loan-to-value ratios. The economic incentive may come from the fact that with little equity in the house, the incentive to spend to maintain the property is low, so their effective rental rate is low; this is not easy to give up by moving. The house price dispersion parameter estimated by FHFA was used to capture the variability among local house price appreciation rates. The 2015 model also included the 2-year HPI change to capture the short-term effect caused by house price changes.

A1.4. Combining the Three Risks

The joint termination hazard rate can be defined as

$$P(t) = \sum_{j=1}^{3} P_j(t) \qquad (7)$$

where P_j is defined in Equations 1, 2, and 3; which are estimated from the binomial logistic models and transferred to the competing risk probabilities using the Begg and Gray (1984) methodology. *P(t)* is an augmented joint conditional probability that a HECM loan will terminate due to any one of the three competing risks. These *P(t)* probabilities are calculated at the loan level and used to estimate future cash flows.

The majority of HECM loans have been endorsed in the past nine years, which limits the number of loans that have remained in FHA's portfolio for a significant amount of time. As a result of this limited seasoning experience, the accuracy of the model to predict terminations for later policy years is limited. Experience with HECMs has shown that as the borrower ages, the mortality rate increases at an increasing rate and becomes the single dominant termination reason among the three possible causes.

A2. Model Estimation Results

Exhibits A-1, A-2, and A-3 present the coefficient estimates for the parameters and the goodness-of-fit statistics for the binomial logistic regression models.

Exhibit A-1. Mortality Termination Model Estimation Results

Analysis of Maximum Likelihood Estimates						
Description	**Parameter**	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	**Intercept**		-3.1820	0.0422	5697.4925	<.0001
Policy Year	**pol_yr_d1**	**[1,2]**	1.4016	0.0207	4587.5790	<.0001
	pol_yr_d2	**(2,3]**	0.1219	0.0118	106.4741	<.0001
	pol_yr_d3	**(3, 8]**	-0.1201	0.00292	1696.1616	<.0001
	pol_yr_d4	**(8,74]**	0.1048	0.00889	139.0066	<.0001
If Borrower is Couple	**Gender_Couple**		-0.3571	0.0127	794.5296	<.0001
Transformed Mortality Rate	**mortality_d1**	**(-∞,-2]**	0.8883	0.00576	23766.4999	<.0001
	mortality_d2	**(-2, ∞)**	1.0962	0.0176	3858.0499	<.0001
Cash Drawdown Percentage	**pct_cashdd**		-1.0409	0.0125	6884.5030	<.0001
Term Product	**TERM**		0.2538	0.0269	88.7440	<.0001
Term Product with Line of Credit	**TMLC**		0.1586	0.0137	134.2711	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	79.3	**Somers' D**	0.613
Percent Discordant	18.0	**Gamma**	0.630
Percent Tied	2.7	**Tau-a**	0.018
Pairs	306263194769	**c**	0.806

* Death date used in mortality calculation may be later than the actual up to two years.

Exhibit A-2. Refinance Termination Model Estimation Results

Analysis of Maximum Likelihood Estimates						
Description	**Parameter**	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	**Intercept**		-7.2271	0.1593	2058.0415	<.0001
Policy Year	**pol_yr_r1**	**[1,3]**	0.6919	0.00941	5410.4548	<.0001
	pol_yr_r2	**(3,6]**	-0.1945	0.00596	1067.1533	<.0001
	pol_yr_r3	**(6,11]**	-0.1447	0.00731	391.9643	<.0001
	pol_yr_r4	**(11,74]**	-0.3340	0.0248	180.9907	<.0001
Borrower Age at Origination	**Orig_Age**		-0.0107	0.00152	49.8497	<.0001
Home Value above Area Median	**hp_above_med**		0.2563	0.0105	595.8077	<.0001
Transformed Mortality rates	**mortality_r1**	**(-∞,-1.5]**	0.1595	0.0107	221.6141	<.0001
	mortality_r2	**(-1.5,+∞)**	0.2127	0.1748	1.4801	0.2238
Refinance Incentives	**RFI_new1**	**(-∞,0]**	0.0504	0.00196	663.4094	<.0001
	RFI_new2	**(0,+∞)**	0.2770	0.00332	6959.0396	<.0001
Cash Drawdown Percentage	**pct_cashdd_r1**	**(0,0.7]**	1.6838	0.0403	1745.5276	<.0001
	pct_cashdd_r2	**(0.7,1]**	1.6200	0.0623	676.6029	<.0001
One Year Change in 10-Year Treasury Rate	**int_change1**	**(-∞,0]**	0.1792	0.0132	184.5926	<.0001
	int_change2	**(0,+∞)**	-0.1482	0.0170	76.2928	<.0001
Area Median House Price to Origination Loan Limit	**limit1**	**[0,1]**	2.4271	0.0206	13913.2912	<.0001
	limit2	**(1,+∞)**	0	.	.	.
Borrower's Gender	**Gender_Couple**		0.1410	0.0182	59.8274	<.0001
	Gender_Male		0.0648	0.0144	20.1687	<.0001
	Gender_Missing		-0.2405	0.0854	7.9228	0.0049
Line of Credit	**LOC**		-0.0904	0.0159	32.3056	<.0001
2-Year HPI Change	**HPA_2Y_r**		-1.2465	0.0430	841.8718	<.0001
Current LTV	**CLTV1**	**[0,0.5]**	2.0619	0.0686	2058.0415	<.0001
	CLTV2	**(0.5,0.8]**	-5.6017	0.0695	5410.4548	<.0001
	CLTV3	**(0.8, +∞)**	-4.4766	0.1420	1067.1533	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	79.4	**Somers' D**	0.632
Percent Discordant	16.2	**Gamma**	0.661
Percent Tied	4.4	**Tau-a**	0.012
Pairs	209379835660	**c**	0.816

Exhibit A-3. Mobility Termination Model Estimation Results

Analysis of Maximum Likelihood Estimates						
Description	**Parameter**	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	**Intercept**		-9.4743	0.1360	4855.9736	<.0001
If One Year Change in 1-Year Treasury Rate Less than -10%	**OneYrCmt_bucket1**		-0.0927	0.00991	87.5353	<.0001
If One Year Change in 1-Year Treasury Rate More than 10%	**OneYrCmt_bucket3**		-0.0993	0.0115	75.1527	<.0001
Policy Year	**pol_yr_n1**	**[1,2]**	1.4217	0.0226	3960.0252	<.0001
	pol_yr_n2	**(2,3]**	0.3033	0.0127	572.0981	<.0001
	pol_yr_n3	**(3,74]**	0.0381	0.00339	126.4811	<.0001
Borrower's Gender	**Gender_Couple**		0.2881	0.0111	673.8539	<.0001
	Gender_Male		-0.0577	0.0104	30.7501	<.0001
	Gender_Missing		0.1301	0.0486	7.1772	0.0074
Transformed Mortality rates	**mortality_n1**	**(-∞,-6]**	-0.1277	0.0172	55.2425	<.0001
	mortality_n2	**(-6, -0.5)**	0.3783	0.01000	1431.3377	<.0001
	mortality_n3	**(-0.5,+∞)**	-1.2644	0.4109	9.4686	0.0021
Age at Origination	**Orig_Age**		0.0133	0.00125	114.2509	<.0001
If Origination Year is before 2004	**pre2004**		0.3515	0.00833	1781.6386	<.0001
Appraised Value to Area Median House Price	**rel_hp**		0.2383	0.00623	1463.9959	<.0001

Analysis of Maximum Likelihood Estimates						
Description	**Parameter**	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Current LTV	**CLTV1**	**[0,0.5]**	0.1570	0.0332	22.3720	<.0001
	CLTV2	**(0.5,1.0]**	-2.5555	0.0259	9706.3717	<.0001
	CLTV3	**(1.0,+∞)**	0	.	.	.
House Price Volatility	**Sigma**		-1.0484	0.1853	32.0195	<.0001
2-Year HPI Change	**hpa_2y_n1**	**(-∞,-0]**	3.4080	0.0829	1688.4319	<.0001
	hpa_2y_n2	**(0,+∞)**	2.4836	0.0384	4174.4933	<.0001
Term Product	**TERM**		0.1307	0.0230	32.3077	<.0001
Term Product with Line of Credit	**TMLC**		-0.0706	0.0131	28.9292	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	73.8	**Somers' D**	0.503
Percent Discordant	23.5	**Gamma**	0.516
Percent Tied	2.7	**Tau-a**	0.021
Pairs	445681905480	**c**	0.751

A3. Base Termination Model Implementation

Representing the combined hazard rate, Exhibit A-4 below shows the average conditional HECM termination rates projected by our simulation models by policy year (loan age) and the endorsement fiscal year. In Exhibit A-4, numbers above the shaded numbers are historically observed termination rates; the FY 2015 termination year (shaded) was estimated based on partial year actual data. Mortgage Letter 2014-12 allowed co-borrowers and spouses to be as young as 35. The composition of future books projected by FHA contains co-borrowers and spouses as young as age 38. Correspondingly, the future in A-4 extends to policy year 72.

Exhibit A-4. HECM Termination Rates Conditional on Surviving to the Beginning of the Policy Year

Policy Year	Endorsement Fiscal Year													
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	1.7%	0.9%	0.9%	1.0%	1.2%	1.3%	1.1%	1.2%	1.2%	1.1%	1.1%	1.1%	1.2%	1.1%
2	2.9%	3.4%	3.1%	4.4%	4.4%	6.5%	4.4%	3.8%	3.7%	3.9%	4.4%	4.2%	4.4%	4.2%
3	2.9%	3.4%	4.9%	5.7%	4.8%	5.7%	5.8%	5.2%	5.6%	6.5%	7.2%	6.6%	7.3%	6.7%
4	3.2%	4.4%	5.1%	5.4%	4.4%	5.1%	5.3%	4.9%	5.5%	6.4%	6.5%	6.7%	6.8%	6.8%
5	4.1%	4.5%	5.8%	4.5%	4.0%	4.6%	5.0%	4.8%	5.4%	6.0%	6.4%	6.2%	6.7%	6.1%
6	4.6%	7.0%	4.7%	4.1%	3.6%	4.4%	4.9%	4.8%	5.4%	6.0%	5.9%	6.0%	5.9%	5.5%
7	7.7%	4.5%	4.2%	3.7%	3.5%	4.3%	4.8%	4.8%	5.3%	5.7%	5.7%	5.6%	5.5%	5.5%
8	4.9%	4.1%	3.9%	3.6%	3.5%	4.3%	4.8%	4.7%	5.2%	5.5%	5.5%	5.3%	5.5%	5.4%
9	4.8%	4.1%	4.0%	3.9%	3.8%	4.6%	5.0%	4.9%	5.4%	5.6%	5.4%	5.5%	5.9%	5.8%
10	4.8%	4.3%	4.3%	4.2%	4.1%	4.8%	5.2%	5.1%	5.5%	5.6%	5.6%	5.7%	6.0%	6.2%
11	5.1%	4.8%	4.7%	4.6%	4.4%	5.0%	5.4%	5.3%	5.6%	5.9%	5.8%	5.9%	6.1%	6.2%
12	5.6%	5.2%	5.1%	4.9%	4.6%	5.3%	5.7%	5.4%	5.8%	6.0%	6.0%	5.9%	6.3%	6.1%
13	6.2%	5.8%	5.5%	5.3%	5.0%	5.7%	6.0%	5.7%	6.1%	6.3%	6.2%	6.3%	6.4%	6.4%
14	6.9%	6.3%	5.9%	5.7%	5.4%	6.1%	6.5%	6.1%	6.5%	6.6%	6.6%	6.7%	6.7%	6.9%
15	7.5%	6.8%	6.5%	6.2%	5.9%	6.6%	7.0%	6.6%	6.9%	7.0%	7.0%	7.2%	7.3%	7.4%
16	8.2%	7.5%	7.0%	6.8%	6.5%	7.3%	7.7%	7.1%	7.5%	7.6%	7.6%	7.7%	7.8%	7.8%
17	9.0%	8.2%	7.7%	7.5%	7.2%	8.0%	8.5%	7.8%	8.2%	8.3%	8.3%	8.4%	8.4%	8.4%
18	9.9%	9.0%	8.5%	8.3%	8.1%	8.9%	9.4%	8.6%	8.9%	9.0%	9.1%	9.1%	9.1%	9.2%
19	10.9%	10.0%	9.4%	9.2%	9.0%	9.9%	10.5%	9.5%	9.8%	9.9%	9.8%	9.9%	10.0%	10.0%
20	12.0%	11.1%	10.4%	10.2%	10.1%	11.1%	11.7%	10.5%	10.8%	10.8%	10.8%	11.0%	10.9%	10.9%
21	13.3%	12.3%	11.6%	11.4%	11.3%	12.4%	13.0%	11.6%	11.8%	11.8%	11.9%	12.0%	12.0%	12.0%
22	14.8%	13.7%	13.0%	12.8%	12.7%	13.8%	14.5%	12.8%	13.0%	13.1%	13.1%	13.2%	13.2%	13.2%
23	16.4%	15.2%	14.5%	14.3%	14.2%	15.4%	16.1%	14.2%	14.4%	14.4%	14.4%	14.5%	14.5%	14.5%
24	18.2%	17.0%	16.2%	16.0%	15.9%	17.1%	18.0%	15.7%	15.9%	15.8%	15.9%	16.0%	16.0%	15.9%
25	20.2%	18.9%	18.1%	17.9%	17.8%	19.1%	20.1%	17.4%	17.5%	17.5%	17.5%	17.6%	17.5%	17.5%
26	22.5%	21.0%	20.2%	20.0%	19.9%	21.4%	22.3%	19.1%	19.3%	19.4%	19.3%	19.3%	19.3%	19.3%
27	24.9%	23.3%	22.5%	22.3%	22.3%	23.8%	24.8%	21.1%	21.3%	21.3%	21.2%	21.2%	21.2%	21.2%
28	27.5%	25.9%	25.1%	25.0%	24.9%	26.5%	27.6%	23.3%	23.4%	23.3%	23.3%	23.3%	23.3%	23.3%
29	30.4%	28.8%	28.0%	27.8%	27.7%	29.5%	30.6%	25.6%	25.6%	25.5%	25.6%	25.6%	25.6%	25.6%
30	33.6%	31.9%	31.1%	30.9%	30.9%	32.7%	33.8%	27.9%	27.9%	27.9%	27.9%	27.9%	27.9%	28.0%
31	37.1%	35.3%	34.5%	34.4%	34.4%	36.2%	37.3%	30.3%	30.3%	30.3%	30.3%	30.4%	30.3%	30.4%
32	40.7%	38.9%	38.1%	38.1%	38.1%	39.8%	41.0%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%
33	44.6%	42.8%	42.0%	42.0%	42.0%	43.7%	44.8%	34.9%	34.9%	34.9%	34.9%	34.9%	34.9%	34.9%
34	48.6%	46.9%	46.1%	46.1%	46.1%	47.7%	48.8%	36.8%	36.8%	36.8%	36.8%	36.8%	36.7%	36.8%
35	52.7%	51.0%	50.3%	50.3%	50.3%	51.8%	52.8%	38.3%	38.2%	38.2%	38.1%	38.2%	38.1%	38.2%
36	56.9%	55.3%	54.6%	54.7%	54.6%	55.9%	56.9%	39.1%	38.9%	38.9%	38.9%	39.1%	39.0%	38.9%
37	61.0%	59.6%	58.9%	59.0%	59.0%	60.1%	61.0%	39.2%	39.0%	39.0%	39.0%	39.2%	39.1%	39.1%
38	65.1%	63.8%	63.2%	63.2%	63.2%	64.1%	65.0%	38.8%	38.6%	38.5%	38.6%	38.8%	38.7%	38.6%
39	69.0%	67.8%	67.3%	67.4%	67.3%	68.0%	68.8%	38.1%	37.9%	37.7%	37.9%	38.0%	37.9%	37.9%
40	72.7%	71.7%	71.2%	71.3%	71.2%	71.8%	72.4%	37.5%	37.2%	37.0%	37.2%	37.2%	37.2%	37.1%
41	76.2%	75.3%	74.9%	75.0%	74.9%	75.3%	75.9%	37.1%	36.8%	36.6%	36.7%	36.7%	36.7%	36.6%
42	79.4%	78.7%	78.3%	78.3%	78.3%	78.6%	79.1%	37.1%	36.9%	36.6%	36.7%	36.6%	36.6%	36.5%

Policy Year	Endorsement Fiscal Year													
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
43	82.4%	81.7%	81.4%	81.4%	81.3%	81.6%	82.0%	37.6%	37.5%	37.0%	37.2%	37.0%	37.0%	36.8%
44	85.0%	84.4%	84.1%	84.2%	84.1%	84.3%	84.6%	38.6%	38.5%	38.1%	38.1%	38.0%	38.0%	37.6%
45	87.3%	86.8%	86.6%	86.6%	86.5%	86.6%	86.9%	40.1%	40.2%	39.8%	39.7%	39.6%	39.5%	39.1%
46	89.3%	88.9%	88.7%	88.7%	88.7%	88.7%	89.0%	42.2%	42.5%	42.1%	41.9%	41.8%	41.7%	41.2%
47	90.9%	90.7%	90.5%	90.5%	90.4%	90.5%	90.7%	45.0%	45.3%	44.9%	44.7%	44.6%	44.6%	44.0%
48	92.3%	92.1%	91.9%	91.9%	91.8%	91.9%	92.0%	48.3%	48.6%	48.3%	48.1%	48.0%	48.0%	47.4%
49	.	.	.	.	.	.	.	51.9%	52.3%	52.1%	51.8%	51.8%	51.8%	51.2%
50	.	.	.	.	.	.	.	55.8%	56.2%	56.1%	55.9%	55.9%	55.9%	55.3%
51	.	.	.	.	.	.	.	59.9%	60.3%	60.3%	60.1%	60.1%	60.2%	59.6%
52	.	.	.	.	.	.	.	64.1%	64.5%	64.5%	64.3%	64.3%	64.4%	63.9%
53	.	.	.	.	.	.	.	68.2%	68.6%	68.6%	68.4%	68.4%	68.5%	68.1%
54	.	.	.	.	.	.	.	72.3%	72.6%	72.6%	72.5%	72.5%	72.6%	72.3%
55	.	.	.	.	.	.	.	76.2%	76.4%	76.4%	76.3%	76.3%	76.4%	76.2%
56	.	.	.	.	.	.	.	79.8%	79.9%	79.9%	79.9%	79.9%	79.9%	79.8%
57	.	.	.	.	.	.	.	83.0%	83.1%	83.1%	83.1%	83.0%	83.1%	83.0%
58	.	.	.	.	.	.	.	85.8%	85.9%	85.9%	85.8%	85.8%	85.9%	85.8%
59	.	.	.	.	.	.	.	88.2%	88.3%	88.3%	88.3%	88.3%	88.3%	88.2%
60	.	.	.	.	.	.	.	90.3%	90.3%	90.3%	90.3%	90.3%	90.3%	90.3%
61	.	.	.	.	.	.	.	92.1%	92.1%	92.1%	92.1%	92.1%	92.1%	92.1%
62	.	.	.	.	.	.	.	93.5%	93.5%	93.5%	93.5%	93.5%	93.5%	93.5%
63	.	.	.	.	.	.	.	94.7%	94.7%	94.7%	94.7%	94.7%	94.7%	94.7%
64	.	.	.	.	.	.	.	95.7%	95.7%	95.7%	95.7%	95.7%	95.7%	95.7%
65	.	.	.	.	.	.	.	96.5%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%
66	.	.	.	.	.	.	.	97.2%	97.2%	97.2%	97.2%	97.2%	97.2%	97.2%
67	.	.	.	.	.	.	.	97.8%	97.8%	97.8%	97.8%	97.8%	97.8%	97.8%
68	.	.	.	.	.	.	.	98.2%	98.2%	98.2%	98.2%	98.2%	98.2%	98.2%
69	.	.	.	.	.	.	.	98.6%	98.6%	98.6%	98.6%	98.6%	98.6%	98.6%
70	.	.	.	.	.	.	.	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%
71	.	.	.	.	.	.	.	99.1%	99.1%	99.1%	99.1%	99.1%	99.1%	99.1%
72	.	.	.	.	.	.	.	99.3%	99.3%	99.3%	99.3%	99.3%	99.3%	99.3%

Appendix B

HECM Loan Performance Projections

Appendix B: HECM Loan Performance Projections

This Appendix explains how the HECM termination model, described in Appendix A, was used to forecast future loan terminations. We briefly summarize the economic scenarios for interest rates and home prices that were used in our projections. The adjustments to home price to account for deferred maintenance are also presented below. Finally, this Appendix describes how assumptions about the future cohort characteristics along with the HECM loan volume forecasts generate new loan-level endorsements during the future fiscal years 2016-2022.

B1. General Approach to Loan Termination Projections

HECM loan termination rates are estimated for all future policy years for each surviving (active) loan. The policy year is the annual loan age and by assumption the maximum possible policy year is 74. To illustrate the initial conditions of the forecast, a loan endorsed in FY 2009 and still active in FY 2015 has its first full year termination rate estimated in policy year eight, because the first seven policy years have already elapsed by the end of FY 2015 (the starting date of the forecast). Active loans are distinguished by the fiscal year of endorsement from FY 2009 through FY 2015. Future endorsements are generated for FY 2015 Q4 through FY 2022 as described in Section B4 below.

The variables used in the analysis are derived from loan characteristics and economic forecasts. Moody's July 2015 forecasts of interest rates and house price indices are combined with the loan-level data to simulate the stochastic economic paths and create the necessary variables. MSA-level forecasts of house price indices apply to loans in metropolitan areas; otherwise loans inherit their state-level house price index forecasts. Moody's house price forecasts are generated simultaneously with various macroeconomic variables including the local unemployment rates.

For each loan during future policy years, the derived loan variables serve as inputs to the logistic termination models described in Appendix A. The termination projections by types of termination are combined to generate conditional termination rates per policy year, representing the probability of loan termination in a policy year by different modes of termination given that it survives to the end of the prior policy year. The HECM cash flow model uses these forecasted termination rates to project the cash flows associated with different termination events.

B2. Economic Scenarios

We used 100 simulated stochastic economic paths that are calibrated to center around Moody's baseline scenario as of July 2015 to generate our benchmark results. We also applied seven alternative economic scenarios for sensitivity analysis, including five economic paths from our stochastic simulation, the Moody's baseline as a deterministic scenario and the "Protracted

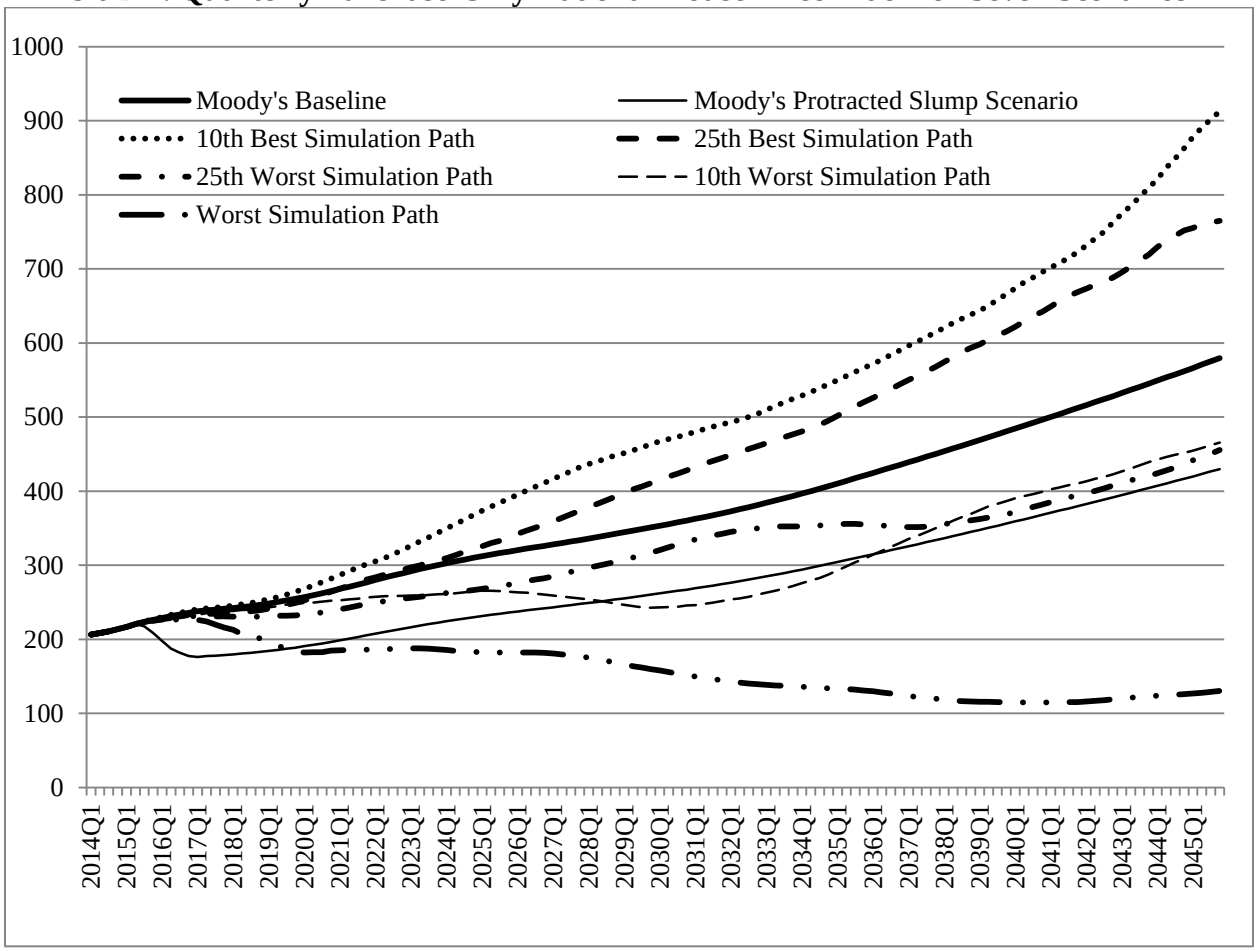
Slump Scenario" suggested by Moody's economy.com as of July 2015. The economic factors include the FHFA national, state and MSA purchase-only house price indices; the national unemployment rates; the 10-year Treasury rate, the 1-year Treasury rate and the 1-year LIBOR rate.

The seven alternative scenarios are:

- Moody's July 2015 baseline as a deterministic scenario;
- 10^{th} Best Path in the simulation, the path that resulted in the 10^{th} highest economic value in the Monte Carlo simulation;
- 25^{th} Best Path in the simulation;
- 25^{th} Worst Path in the simulation, the path that resulted in the 25^{th} lowest economic value in the Monte Carlo simulation;
- 10^{th} Worst Path in the simulation;
- The Worst Path in the simulation, the path that resulted in the lowest economic value in the Monte Carlo simulation and
- Moody's Protracted Slump Scenario.

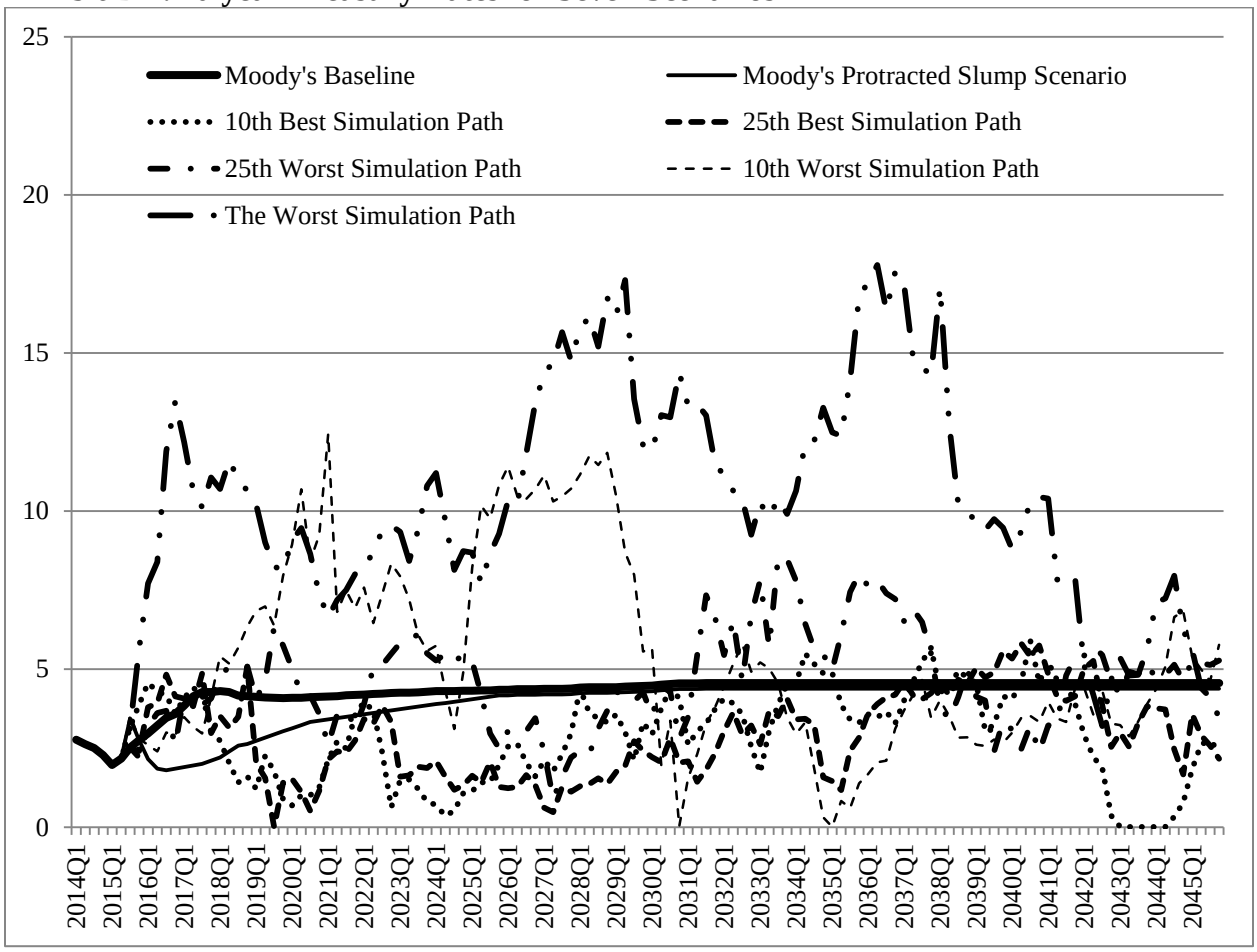
Under Moody's forecast methodology, the levels of the home price indices for any scenario converge to the base-case long-term index levels. As a result, the stress scenarios show faster house price growth after the index bottoms out. As in the corresponding Actuarial Review for forward mortgages, we made an adjustment to this methodology whereby the house price growth rates converge to the long-run growth rates instead of converging to the base-case levels of the indices. This adjustment eliminates the stress scenarios showing a faster growth after the index bottoms out. Based on quarterly data, the graph in Exhibit B-1 illustrates the historical quarterly national house price changes and those for each of the selected scenarios.

Exhibit B-1. Quarterly Purchase-Only National House Price Index for Seven Scenarios



A similar chart for the 10-year constant maturity Treasury (CMT) rates appears in Exhibit B-2 below. The Federal Reserve Board has kept interest rates low for the past few years, but public discussion focuses on when this will ease up. In Moody's alternative economic scenarios, the future paths of interest rates all rise rapidly in the near term. The one-year and ten-year LIBOR rates tend to reflect a small, positive and time-varying credit spreads over Treasury rates of the same duration. The LIBOR series is not shown for brevity.

Exhibit B-2. 10-year Treasury Rates for Seven Scenarios



B3. Maintenance-Risk Adjustments

Research[31] on the HECM portfolio indicates the need to account for the home maintenance risk posed by HECM borrowers. Maintenance risk refers to the moral hazard that HECM borrowers may underinvest in the maintenance on their homes, especially when their anticipated equity upon termination is low or negative. First we derive the cumulative house price discount factor by using the HECM property sales price data from CoreLogic. The formula for the discount is

$$House\ Price\ Discount\ Factor = 1 - \frac{HP_t}{HP_0 * \frac{HPI_t}{HPI_0}} \qquad (1)$$

[31] Capone, C. A., K. L. Chang and C. A. Cushman (2010). *Identification of Home Maintenance Risk in Reverse Mortgages: An Empirical Examination of Home Price Appreciation among HECM Borrowers.* American Real Estate and Urban Economics Association 2010 Mid-Year Conference: Washington, D.C

where HP_t is the sale price of the house underlying a HECM loan obtained from CoreLogic;

HP_0 is the appraised value of the same house at the time of HECM loan origination;

HPI_t is the local FHFA purchase-only house price index at time *t*.

We calculated the average housing price discount factor for terminated HECM loans regardless of termination type. Then, we used an exponential decay function of the policy year to fit the historical average discount factor, as shown in the formulas below. Similar to the Capone, et al. (2010) finding, HECM loans with prices lower than the local median price tend to be less carefully maintained than those with prices above the local median. We included an indicator *hp_above_med* (i.e., the appraisal value is above the local median house price) to capture this effect.

$$House\ price\ discount\ factor\ at\ loan\ age\ t$$

$$= \begin{cases} 0.2 - 0.3 * e^{-0.2*\min(age,6)} & if\ age < 10 \\ 0.25 - 0.9 * e^{-0.2*age} & if\ age \geq 10 \end{cases} \quad if\ hp\_above\_med = 0 \qquad (2)$$

$$House\ price\ discount\ factor\ at\ loan\ age\ t$$

$$= \begin{cases} 0.13 - 0.25 * e^{-0.35*\min(age,4)} & if\ age < 10 \\ 0.2 - 0.8 * e^{-0.2*age} & if\ age \geq 10 \end{cases} \quad if\ hp\_above\_med = 1 \qquad (3)$$

We used the above equations to project the maintenance-risk adjustment factors. The projected recovery from property disposition is computed as:

$$Estimated\ Property\ Sale\ Price$$
$$= HP_0 \times \frac{HPI_t}{HPI_0} \times (1 - House\ Price\ Adjustment\ Discount\ Factor) \qquad (4)$$

And the net sale price of the property is:

Net Property Sale Price = Estimated Property Sale Price × (1 – % sales expenses) (5)

The maintenance-risk adjustment factors apply only to property recovery revenue at the projected HECM loan termination date.

B4. Conveyance and Payoff Selection Model in Post-assignment

For terminated loan in Type 2 Claim, borrowers can pay off HECM loans and pack back HUD as minimal of 95% of UPB, or HUD can sell the conveyed property to recover their loss. In this year's Review, we used HECM loans terminated with payoff and conveyance types from FY 2005 through FY 2015 to analyze HECM's conveyance and payoff selection choice. There were 9,345 observations for the logistic model.

Most variables in the equation have the same specification in the termination model shown in Appendix A, with one additional variable included: the national relative unemployment rate *rel_ue_usa* which reflects macro-economic conditions that imply a higher probability of conveyance in a bad economy. The results also indicate that HECM borrowers in areas with higher house prices than the national average are more likely to pay off. For example, borrowers in California may have more incentive to keep their houses than borrowers in Kansas. Also, HECM borrowers with higher appreciated home value, with higher relative home price relative to local median price, or with lower loan-to-value ratio are less likely to convey because of the higher possibility of retaining some equity in the house after paying off the loan balance. Older borrowers or those with higher upfront cash draws are less likely to keep the house and thus are more likely to convey. Exhibit B-3 shows the estimation results.

Exhibit B-3. Conveyance and Payoff Selection Model Coefficients

Analysis of Maximum Likelihood Estimates					
Description	**Parameter**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
	Intercept	-13.4197	0.7782	297.3913	<.0001
loan age <=7	**pol_yr1**	0.8183	0.0684	143.3084	<.0001
loan age >7	**pol_yr2**	0.3288	0.0148	491.0251	<.0001
borrower's age at origination	**Orig_Age**	0.0850	0.00577	216.8439	<.0001
ratio of median local house price to national loan limit at origination <= 1	**limit1**	-3.2087	0.1317	593.6115	<.0001
ratio of unemployment rate to past 10y average at termination, at national level	**rel_ue_usa**	0.7780	0.0985	62.4451	<.0001
first month cash draw	**pct_cashdd**	0.6388	0.0943	45.9106	<.0001
relative house price	**rel_hp**	-1.2700	0.0898	199.8558	<.0001

Analysis of Maximum Likelihood Estimates					
Description	**Parameter**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Cumulative HPA between termination and origination	**Cumulative HPI_Change**	-0.0231	0.00116	397.2162	<.0001
updated loan to value ratio	**CLTV**	2.0236	0.1482	186.4899	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	88.9	**Somers' D**	0.778
Percent Discordant	11.0	**Gamma**	0.779
Percent Tied	0.1	**Tau-a**	0.383
Pairs	21476444	**c**	0.889

B5. Forecasted Endorsement Volume and Portfolio Composition

Based on HECM loan data observed through June 2015, the Moody's July 2015 baseline economic forecast, and the HECM total demand count model in Appendix E; Exhibit B-4 shows forecasted HECM endorsement volumes and MCAs for FY 2016 through FY 2022 books. The projected loan compositions of these future books were based on the projection by FHA, which included the newly allowed spouses younger than 62.

Starting in FY 2014, FHA canceled the Standard and Saver programs and introduced a new program which has an initial disbursement cap of 60 percent, and has the principal limit at 85 percent of the original Standard product. We assume that the maximum claim amount (MCA) of individual loans will grow by Moody's July 2015 forecast of national HPI from FY 2015 through FY 2022.

Exhibit B-4. HECM Volume and MCA Projections for Future Endorsements (allowing younger spouses)

FY	Average MCA	Total Count	Total Dollar Volume ($m)
2016	$274,052	55,000	$15,073
2017	$281,735	60,465	$17,035
2018	$285,789	64,174	$18,340
2019	$291,346	67,094	$19,548
2020	$299,151	69,751	$20,866
2021	$308,787	72,163	$22,283
2022	$319,021	74,336	$23,715

The assumptions on the age and gender distribution for FY 2016-2022 new programs were based on the distribution of the FY 2014 endorsements and are shown in Exhibit B-5.

Exhibit B-5. Future Endorsement Age and Gender Distribution

Current Program FYs 2016-2022 (Adjusted for Non-Borrowing Spouse)				
Age Group	Male	Female	Couple	Row Totals
< 62	0.0%	0.0%	100.0%	100.0%
62 to 65	13.9%	18.9%	67.2%	100.0%
66 to 70	13.0%	22.9%	64.1%	100.0%
71 to 75	14.6%	31.6%	53.8%	100.0%
76 to 85	15.9%	37.5%	46.6%	100.0%
85+	22.0%	60.8%	17.2%	100.0%
All Ages	**13.8%**	**27.0%**	**59.1%**	**100.0%**

Based on recent data and expected market changes, assumptions about the future market shares of loan interest rate types were projected by FHA as shown in Exhibit B-6.

Exhibit B-6. Future Distribution of Loan Amortization Types

FY	Fixed Rate Loan	Variable Rate Loan
2016-2022	20%	80%

Assumptions for each future cohort were projected by FHA as shown in Exhibit B-7. These buckets represent the cash draw preferences of future borrowers from the 3rd to the 74thpolicy years, without policy restrictions on upfront draw amounts. However, since predicted behavior is expected to change due to new policy mandates, borrowers are not allowed to draw more "single disbursement at origination equal to the greater of 60% of the Principal Limit, or the mandatory obligations plus 10% of the Principal Limit"[32] in the first policy year. The projected draw distribution was provided by FHA. Also, we assume that the first-month cash draw equals the first-year cash draw for future cohorts, for their termination and T&I projections.

Exhibit B-7. Future Distribution of Projected Cash Draws for FYs 2016 - 2022

Percentages	**Cash draw to initial principal limit (Cash Draw Down Bucket)**										
Age Group	**0%-10%**	**10%-20%**	**20%-30%**	**30%-40%**	**40%-50%**	**50%-60%**	**60%-70%**	**70%-80%**	**80%-90%**	**90%-100%**	**100%**
62 to 65	3.3%	1.9%	1.9%	2.1%	2.3%	2.4%	1.9%	1.9%	1.7%	3.0%	77.7%
66 to 70	4.2%	2.3%	2.4%	2.5%	2.4%	2.0%	2.0%	1.6%	1.5%	2.5%	76.5%
71 to 75	5.4%	3.4%	3.1%	2.7%	2.6%	2.7%	2.2%	1.7%	1.3%	2.7%	72.2%
76 to 85	7.9%	5.1%	4.3%	3.5%	3.1%	2.7%	2.5%	1.9%	1.3%	2.9%	64.7%
85+	12.4%	9.4%	6.4%	4.0%	3.3%	2.8%	2.0%	1.5%	1.6%	3.1%	53.5%
Weighted Column Totals	**5.4%**	**3.4%**	**3.0%**	**2.7%**	**2.6%**	**2.4%**	**2.1%**	**1.8%**	**1.5%**	**2.8%**	**72.2%**

The above assumptions form the basis for generating projected future HECM endorsements for FYs 2016 to 2022.

[32] Mortgagee-Letter 2013-27, Department of Housing and Urban Development, September 3, 2013.

This Page Left Blank Intentionally

Appendix C

HECM Cash Flow Analysis

Appendix C. HECM Cash Flow Analysis

This Appendix describes the calculation of the present value of future cash flows. Future cash flow calculations are based on forecasted variables, such as house price appreciation and interest rates, in addition to individual loan characteristics and borrower behavior assumptions. There are four major components of HECM cash flows: insurance premiums, claims, note holding expenses and recoveries on notes in inventory (after assignment). HECM cash flows are discounted according to the latest discount factors published by the Office of Management and Budget (OMB). These elements of cash flow and the present value calculations are described in this Appendix.

C1. Definitions

The following definitions will facilitate the discussion of HECM cash flows:

- **Maximum Claim Amount (MCA):** Maximum claim amounts are calculated as the minimum of three amounts: the HECM property's appraised value at the time of loan application, the purchase price of the property, and the national HECM FHA loan limit ($625,500 for FY 2015).

- **Insurance-In-Force (IIF):** Refers to the active loans in the FHA insurance portfolio (prior to loan assignment) and calculated as the total of their MCAs.

- **Conditional Claim Type 1 Rate (CC1R):** Among loans that terminated before note assignment, the percentage of such loans that had a shortfall. The shortfalls are labeled as claim type 1. The other terminations before assignment have zero claim amounts, corresponding to when the property value exceeds the outstanding loan balance by more than the sales transactions cost.

- **Claim Type 2 (Assignment):** When the cumulative UPB of an HECM reaches 98 percent of the MCA, the lender can assign the promissory note to FHA. FHA pays the UPB at the time of assignment to take the ownership of the note. The assignment events are labeled as claim type 2.

- **Note Holding Period:** The length of time from note assignment to loan termination. During this period, FHA takes possession of the loan, now called an assigned note, and services it until loan termination.

- **Recoveries**: The property recovery amount received by FHA at the time of note termination after assignment, expressed as the minimum of the loan balance and the predicted net sales proceeds at termination. The recovery amount for refinance termination is the loan balance.

C2. Cash Flow Components

HECM cash flows are comprised of premiums, claims, note expenses and recoveries. Premiums consist of upfront and annual mortgage insurance premiums, which are inflows to the HECM program. Recoveries after assignment, a cash inflow, represent cash recovered from the sale of the property once the loan terminates. Claim type 1 payments are cash outflows paid to the lender when the sale of a property is insufficient to cover the balance of the loan. Assignment claims and note holding payments are additional outflows. Exhibit C-1 summarizes the HECM inflows and outflows.

Exhibit C-1. HECM Cash Flows

Cash Flow Component	Inflow	Outflow
Upfront Premiums	X	
Annual Premiums	X	
Claim Type 1 Payments		X
Claim Type 2 (Assignment) Payments		X
Note Holding Expenses		X
Recoveries	X	

We next discuss the major components and calculations associated with these HECM cash flows.

C2.1. Loan Balance

The unpaid principal balance (UPB) is a key input to the cash flow calculations. The UPB at a given time *t* is calculated as follows:

$$UPB_t = UPB_{t-1} + Cash\ Draw_t + Accruals_t$$

The UPB for each period *t* consists of the previous loan balance plus any new borrower cash draws and accruals. The accruals include interest, annual mortgage insurance premiums, and servicing fees. Future borrower draws are estimated by assigning draw patterns to loans based upon the cash draws during the first two years. As noted in Appendix D, we assume that tax and insurance default terminations before assignments will accrue additional UPB at an annual rate of 2.5 percent of the estimated property value for the assumed one year between the default date and the property disposition date. And 25 percent of the loans without available cash draws after assignments are assumed to fail to pay taxes and insurance, thus these loans will accrue additional UPB at annual property tax rates on the estimated property value until their termination. State-level average property tax rates were used to estimate the after-assignment tax accrual amounts; unpaid hazard and flood insurance premiums after assignment are not accrued.

C2.2. Premiums

Upfront and annual mortgage insurance premiums are the primary sources of FHA revenue from the HECM program. Borrowers typically finance the upfront premium when taking out a HECM loan. Similarly, the recurring annual premiums are added to the balance of the loan.

C2.2.1. Upfront Premiums

The upfront premium is paid to FHA at the time of loan closing. It is equal to a stated percentage of the MCA. Since FY 2009, the upfront premium rate for the Standard HECM contract has been 2 percent of the MCA. This rate remained the same for the Standard program through FY 2013. For FY 2011 to 2013, the upfront premium rate for the Saver program was 0.01 percent (1 basis point) of the MCA. For the new program introduced in FY 2014, the upfront premium rate is 0.5 percent of the MCA if the first-year cash draw is less than or equal to 60 percent of the initial principal limit, and 2.5 percent of MCA if the first-year cash draw is more than 60 percent of the initial principal limit. Typically, the upfront premium is financed by the HECM lender. The amount is added to the loan balance and eventually repaid to the original lender. Thus, the upfront premium is paid in full to FHA at the loan closing, and is a positive cash flow.

C2.2.2. Annual Premiums

The annual premium is calculated as a percentage of the current loan balance. For the FY 2009 and FY 2010 books of business, the annual premium was 0.5 percent of the UPB. From FY 2011 onward, the annual premium was set to 1.25 percent of the UPB for all Standard, Saver, and the new program introduced in FY 2014. Before a loan is assigned, the annual premium is assumed to be advanced by the lender, paid to FHA, and added to the accruing loan balance.

C2.3. Claims

HECM claims consist of two types: claim type 1 and claim type 2.

C2.3.1. Claim Type 1 (Pre-assignment)

Claim type 1 enters the HECM cash flows as payments to the lender when a property is sold and the net proceeds from the sale are insufficient to cover the balance of the loan at termination. Since the inception of the HECM program in 1989, the occurrence of claim type 1 has been rare. The losses from claim type 1 can be expressed as:

Minimum of zero and the net sale proceeds at termination deducted from the unpaid loan balance, for a loan that terminates before the UPB reaches 98 percent of the MCA.

C2.3.2. Claim Type 2 (Assignment)

Lenders can assign a loan to FHA when the UPB reaches 98 percent of the MCA. FHA acquires the note resulting in a cash outflow, the acquisition cost, equal to the loan balance (up to the MCA). The majority of HECM lenders assign loans to FHA as soon as the UPB reaches 98 percent of the MCA. Thus, the HECM forecasting model assumes that the assignment occurs when the projected UPB reaches 98 percent of the MCA threshold. Based on the historical average, the cash outflow at assignment averaged approximately 99 percent of the MCA. The net losses from claim type 2 depend on two components, the note holding expenses after assignment and recoveries from assigned notes, now discussed.

C2.4. Note Holding Expenses after Assignment

In this FY 2015 model, we introduce one additional component to note holding expenses after assignment. The note holding cash outflows include both the additional cash draws by the borrower and property taxes FHA paid for those borrowers who default on their tax payments after assignment.

One component of note holding expenses after assignment is the additional cash draws by the borrowers that occur under the contract after FHA takes ownership of the note. This happens only if the total cash drawn by the borrower has not reached the maximum principal limit upon the assignment date.

For loans without additional cash draws available after assignment, this FY 2015 Review assumes that 25 percent of the borrowers of the assigned loans will fail to pay taxes (and insurance). As discussed in Appendix D, the T&I defaults after assignment will not result in loan terminations. FHA will pay the taxes for the borrowers and accrue the payments on the loan UPB. Thus, the note holding expenses will also include the tax payments of those 25 percent of loans, which equal annual tax rates by states multiplied by the estimated property values, until the loan terminates.

C2.5. Recoveries from Assigned Loans

At note termination for an assigned loan, the HECM loan is due and payable to FHA. The timing of loan terminations after assignment (when UPB reaches 98 percent of MCA) is projected with the termination model in Appendix A. The amount of recovery equals the minimum of the loan balance and the predicted net sales proceeds at termination, where net sales proceed equals the projected property value less selling expenses. For tax and insurance (T&I) defaults that occur after assignment, the dollar amount of tax payments are included in UPB amount and are counted as cash outflow in note holding expenses. Different from previous years, T&I defaults will not cause loan terminations after assignment. Therefore, for all loan terminations that occur after

assignment, the amount of recovery follows the same equation as terminations before assignment.

C3. Net Future Cash Flows

The portfolio cash flow for a HECM book of business can be computed by summing the individual components as they variously occur over time:

$$\begin{aligned} \textit{Net Cash Flow}_t = \quad & \textit{Upfront Premiums}_t + \textit{Annual Premiums}_t + \textit{Recoveries}_t \\ & - \textit{Claim Type 1s}_t - \textit{Claim Type 2s}_t - \textit{Note Holding Expenses}_t \end{aligned}$$

The discount factors applied in computing the present value of cash flows are the annual Federal credit subsidy present value conversion factors published by the Office of Management and Budget (OMB). The credit subsidy discount factors for the 2016 President's Budget reflect the most recent Treasury yield curve, which captures the Federal government's cost of capital in raising funds. These factors reflect the capital market's expectation of the consolidated interest rate risks of U.S. Treasury securities. The discount factors vary depending on how far into the future a cash flow will occur. The discount factors are shown in Exhibit C-2. As an example, a cash flow occurring at the end of FY 2016 is multiplied by 0.9890 to convert it into a present value for year-end FY 2015. The discount factors used in this Review are higher than the corresponding discount factors in last year's Review.

Exhibit C-2. OMB Discount Factors

Fiscal Year	Discount Factor
2016	0.9890
2017	0.9685
2018	0.9431
2019	0.9149
2020	0.8850
2021	0.8550
2022	0.8252
2023	0.7965
2024	0.7690
2025	0.7426
2026	0.7169
2027	0.6917
2028	0.6671
2029	0.6430
2030	0.6196
2031	0.5968
2032	0.5747
2033	0.5532
2034	0.5323

Fiscal Year	Discount Factor
2035	0.5121
2036	0.4925
2037	0.4735
2038	0.4551
2039	0.4374
2040	0.4202
2041	0.4036
2042	0.3876
2043	0.3721
2044	0.3572
2045	0.3428
2046	0.3290
2047	0.3158
2048	0.3030
2049	0.2908
2050	0.2791
2051	0.2678
2052	0.2571
2053	0.2467

Appendix D

HECM Tax and Insurance Default Model

Appendix D: HECM Tax and Insurance (T&I) Default Model

This Appendix presents the tax and insurance default model. In Section D1 we provide some background information. Section D2 describes the data and provides summary descriptive statistics. Section D3 introduces the model and provides parameter estimates and other statistics. Section D4 describes various aspects of model implementation. Section D5 reports the projected cumulative lifetime T&I default rates by endorsement year cohorts.

D1. Background

In Mortgagee Letter (ML) 2011-01, FHA announced that HECM loans with tax or insurance (T&I) delinquencies are considered due and payable, and therefore subject to foreclosure if they do not comply with repayment plans. Through impacts on termination speeds and recovery rates, this ruling has the potential to impact the economic value of the HECM program.

There are several major policy changes in FY 2015 that will affect the T&I default model. In Mortgagee Letter (ML) 2015-09, HUD introduced the requirement and calculation of Life Expectancy Set-Aside (LESA), which is used for the payment of property taxes and hazard and flood insurance premiums. The LESA guidelines became effective on 4/27/2015. With this set-aside, HECM loans with LESA will have fewer funds available for withdrawal, but there will be no T&I defaults before the life expectancy of the borrowers. However, FHA has indicated that there is little information available yet, including the percentage of HECMs with LESAs and the types of LESAs imposed. FHA did not indicate how mortgagees should determine which mortgagors should have LESAs, and who should have which type of LESA. Intuitively, the incentives of mortgagees are on the side of not imposing LESAs, so as to increase the demand for HECMs. Therefore, we assume zero effect of this LESA guideline due to limited information about how this is being implemented. Once more originations with LESAs become available, the potential impact of this policy needs to be reviewed and re-evaluated.

For HECM loans before assignment, HUD provided additional guidance on due and payable policies and the timing requirements in Mortgagee Letter 2015-10 and Mortgagee Letter 2015-11. For HECM loans after assignment, HUD currently does not foreclose on assigned loans that are in default on tax and/or insurance payments. In order to secure and maintain HUD's position on the lien of an assigned loan, HUD advances tax payments on behalf of the borrower. HUD first advances funds from the borrower's available HECM funds. If no funds are available, HUD advances the tax payment and adds the payment to the loan balance. These policies affect all existing books and future books.

For loans before assignment, based on the same methodology as in prior years, the T&I model is used to project their default behavior. If the loans go to default, we assume the foreclosure will be enforced within one year, and the costs of T&I default in that year will be accrued to the loan

UPB. The T&I model does not affect loans after assignment. We assume a constant percentage, 25%, of assigned loans go to tax default immediately after assignment. We use the property tax rates by state to calculate the taxes HUD will pay annually until the termination of those loans. The tax payments are treated as note holding expenses, a component of cash outflows as discussed in Appendix C, and added to the loan balance.

The remainder of this Appendix discusses the T&I default model. Notice that for this FY 2015 Review, the T&I default model is applicable only for the performance of HECM loans before assignment.

D2. Data

FHA's data bases identify which HECM loans have had episodes of T&I delinquency. Some of these loans may terminate through foreclosure pursuant to Mortgagee Letter 2011-01 or for other reasons, and some may have cured. For purposes of this analysis, "default" is defined as a T&I delinquent loan not making any T&I repayments over a consecutive 12-month period. Correspondingly, a loan stays in delinquency (but not default) as long as a partial repayment is made in any 12-month window. However, a T&I delinquent loan is cured only when the T&I debt is paid in full by the borrower. Under this definition of T&I default, a borrower who owes $1,000 T&I in month 1 will not be considered in default if this borrower makes a $10 repayment within the next 12 months. However, if this borrower makes a $10 repayment in month 5, but does not make any additional repayments until month 20, this loan will be considered in default at month 17, after 12 months of no repayments. T&I default is defined as the terminal status. A binomial logistic regression estimates the probability of a T&I default as a function of various explanatory variables.

We processed the HECM loan data provided by FHA to create a unique record for each loan/policy-year combination. In order to build the predictive model, we obtained the following static loan attributes for the entire active and terminate HECM loan universe as of March 31, 2015: loan type (line of credit or other), borrower age at origination, borrower gender, origination date, initial month cash drawdown as a percentage of the maximum allowable draw, whether the property is located in the two states with the highest HECM concentration (California and Texas), an indicator of whether the home value at origination was above or below the local area median value, loan age and current LTV.

The historical T&I default behavior varied throughout the years. In recent years, the HECM loans are less likely to experience a T&I default because the more effective enforcement of the foreclosure process. In this year's review, we use only the loan performances starting from FY 2011 to estimate our model, in order to base our predictions consistent with the recent policy change. In contrast to previous reviews, we also included the terminated loans in the estimation process, to capture the T&I performance from the whole HECM universe.

D2.1. Variable Definitions

We used the following variable specifications in our regression analysis:

timeDfltAny = 1 when the loan reaches a 12 months delinquency status during the year with no partial repayments; = 0 if not delinquent or fully cured, partially repaid delinquent, or delinquent less than 12 months during the year. (Dependent variable)

pct_cashdd = the percentage of cash drawdown to the maximum allowed amount in the first month of loan origination. The model uses a linear spline function, with a knot point of 90%. For the new program starting from FY 2014, we assumed the first-year cash draw percentage is the same as the first-month cash draw percentage.

Orig_Age = borrower age at origination.

LOC = 1 if product type is line of credit; 0 otherwise.

Single_Female = 1 if single female borrower; 0 otherwise

Single_Male = 1 if single male borrower; 0 otherwise

Gender_Missing = 1 if borrower's gender is missing; 0 otherwise

stateCA/stateTX = 1 if collateral property is in California/Texas; 0 otherwise.

Relative house price to median = home value to the local area median home value at origination.

PolicyYear = current loan age in years. A spline function is applied on this variable.

LTV_Current = current UPB divided by the estimated current property value, capped at 1.

D2.2. Descriptive Statistics

Exhibit D-1 shows selected statistics for the estimation sample dataset. Also, 15.3 percent of HECM loans have had a T&I delinquency history, among which 40 percent are currently in default.

Exhibit D-1. Descriptive Statistics of Active and Terminated Loans

Variable	Number of Observations	Mean	Standard Deviation
Ever in Default	113,031	0.401	0.490
Default Policy Year	45,381	4.557	2.026
Percent Cash Drawdown <= 90%	413,095	0.486	0.267
Percent Cash Drawdown > 90%	325,620	0.954	0.024
Original Age	738,715	72.098	7.284
LOC	738,715	0.903	0.296
Gender_Male	738,715	0.187	0.390
Gender_Female	738,715	0.406	0.491
Gender Missing	738,715	0.007	0.084
State CA	738,715	0.167	0.373
State TX	738,715	0.069	0.253
Relative house price to median	738,715	1.108	0.577

D3. T&I Default Model

The T&I default model was estimated based on the data extract from the FHA database as of the end of March 2015. All active and terminated loans endorsed in FY 2001 and later were included in the estimation sample. Endorsements prior to FY 2000 are excluded because of the new enforcement policy announced in Mortgagee Letter 2011-01. Loan performance begins in FY 2010. Regression results are presented below in Exhibits D-2.

Exhibit D-2. Maximum Likelihood Estimates of the T&I Default Model

Analysis of Maximum Likelihood Estimates					
Parameter	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		-9.9106	0.0892	12348.9402	<.0001
pct_cashdd1	**(0, 0.9]**	0.9724	0.0306	1010.8449	<.0001
pct_cashdd2	**(0.9,∞)**	-9.6899	0.2183	1970.0864	<.0001
Orig_Age		-0.0100	0.000731	187.2461	<.0001
LOC		0.9987	0.0370	728.2064	<.0001
Gender_Female		0.5215	0.0116	2010.7866	<.0001
Gender_Male		0.5872	0.0134	1933.1955	<.0001
gender_missing		0.4823	0.0621	60.2324	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	**Boundary Values**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
stateCA		-0.2393	0.0154	240.4293	<.0001
stateTX		0.5763	0.0168	1176.6510	<.0001
rel_hp		-0.1317	0.0101	170.9640	<.0001
pol_yr1	**[1,2]**	1.3842	0.0322	1847.4842	<.0001
pol_yr2	**(2,3]**	-0.1220	0.0162	56.9102	<.0001
pol_yr3	**(3,+∞)**	-0.2728	0.00343	6309.2481	<.0001
CLTV		3.8738	0.0408	9007.4690	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	73.8	**Somers' D**	0.503
Percent Discordant	23.6	**Gamma**	0.516
Percent Tied	2.6	**Tau-a**	0.019
Pairs	108310399184	**c**	0.751

Based on the regression results in Exhibit D-2, borrowers with a larger initial cash draw exhibit a higher default propensity than those with a lower initial cash draw. However, the default propensity is reduced if the initial cash draw is greater than 90 percent of the allowed draw, which were mostly among fixed-rate borrowers. Default risk is higher in Texas, and lower in California, other things equal. Default is a decreasing function of elapsed time from origination. Default propensity is lower among those with home prices above the area median. Single borrowers of either gender are more likely to default compared to the omitted category representing mainly couples.

D4. T&I Default Model Implementation

We forecast T&I default behavior using the T&I binomial logistic default model derived above. A T&I default can happen in a future year only if the loan survives to the end of that year and is not assigned in that year. Thus, the base termination model described in Appendix A takes sequential precedence over the T&I default termination model. We assume that T&I defaults will accrue UPB at 2.5 percent of the property value before assignment. We also assume a fixed one-year period will elapse between the T&I default event and the subsequent property disposition. After assignment, T&I default model is not effective, and we assume a 25 percent T&I default rate and that these T&I defaults will accrue UPB at the state-level tax rate times the property value.

D4.1. Treatment of HECM loans in T&I default at the start of the forecast

We assume that active HECM loans already meeting the default definition, i.e., at any point of time a loan has 12 or more months of delinquency history without any repayment, will be resolved through involuntary termination. There were 45,381 such loans as of March 31, 2015. In view of the one-year disposition time assumption, these defaulted loans were treated as if defaults occurred in FY 2015 and the dispositions are assumed to occur in FY 2016. Thus, during the simulation, the T&I default model was not further applied to these loans.

D4.2. Forecast implementation of T&I default model for the at-risk population

Delinquent loans meeting the cure definition, uncured delinquencies with less than one year of delinquency history, loans with no delinquency history and future endorsements are all treated as part of the "at risk" population for future T&I default. We start by applying the default model to determine the likelihood of default of each loan in each future fiscal year. Each loan is randomly assigned to either default or not default according to the computed probability of default. Once a loan is flagged as a default, we set the effective date of property disposition one year into the future.

D5. Summary Forecast Results

To quantify the implementation of the model, the annual T&I default probabilities were forecasted for all active loans at the end of June 30, 2015 for all remaining years of the 74-year limit assumed for every HECM loan. The resultant cumulative lifetime T&I default rates by historical fiscal years of endorsement starting from FY 2009 for the active loans appear in the Exhibit D-3 below. The results include loans meeting the default definition as of June 30, 2015, and the assumed 25% of tax default loans after assignment. The projected T&I default rate indicates a higher default rate than observed before the assignment, owing in part to the lack of incentive for borrowers to pay property tax after their HECM is assigned to HUD, assuming they receive advice that they will not be foreclosed on for not paying taxes and insurance.

Exhibit D-3. Lifetime T&I Default Rates for the Current Portfolio by Endorsement Year

Fiscal Year of Endorsements	HECM Loan Count	Lifetime T&I Default Rate
2009	86,633	17.74%
2010	61,919	19.46%
2011	59,722	19.80%
2012	46,262	20.52%
2013	53,837	21.94%
2014	47,646	20.03%
2015*	42,072	19.47%
Total	**398,091**	**19.66%**

*2015 endorsements through 6/30/2015

This Page Left Blank Intentionally

Appendix E
HECM Demand Model

Appendix E. HECM Demand Model

E1. Background

The Actuarial Review requires forecasting future demand of HECM loans for the FYs 2016 - 2022 in order to project future economic values of the MMI HECM portfolio. The HECM demand forecasting model was designed to respond to different future economic scenarios for house prices, and has a quarterly frequency. Since the HECM analysis uses an annual frequency, the quarterly projections are aggregated to an annual basis.

E2. Data

The HECM demand model predicts demand by loan counts, not dollar volumes. Quarterly forecasts of the FHFA purchase-only repeat-sales home price indices were based on Moody's Analytics July 2015 forecasts.

HECM demand depends on the number of eligible senior homeowners who might choose to borrow from the program. To proxy this demographic demand driver, historical estimates and future forecasts of the U.S. population aged 62 years and older were obtained from the U.S. Census Bureau's website.[33]

The most recent year for which this data is available is 2014. The census forecast of the future senior population had an annual instead of quarterly frequency. We applied linear interpolation to fill in quarterly observations. Although the HECM model is on an annual basis, we used quarterly data here in order to retain enough observation points to support the estimation of a time series model.

There were 49 (FY 2003 Q2 through FY 2015 Q2) quarterly observations used in the regression, reflecting data availability and taking into account the lags used in connection with the explanatory variables. The forecasted demand covers FYs 2015 Q3 through 2022 Q4. Forecasts for FYs 2015 Q3 and 2015 Q4 are needed to update the HECM insurance portfolio to end of FY 2015. Exhibit E-1 summarizes the input data of the demand model.

Since the FY 2014 Review, the newly eligible younger co-borrowers and non-borrowing spouses have introduced additional modelling issues. Because this policy was effective starting August 4, 2014, we have not observed enough historical data to properly analyze the potential impact of this new policy on HECM demand. From historical data, we estimated the couple's share in total HECM counts by a linear regression with no intercept. The coefficient of this simple regression indicated that couple borrowers account for about 37.5 percent of the total HECM loan counts.

[33] *http://www.census.gov/population/projections/data/national/2014.html.*

Following the FY 2014 Review, we assumed that the number of couple borrowers would increase 10 percent or 3.75 percentage points from the demand level not allowing younger co-borrowers and spouses. For the 2015 Review, we assumed that single-borrower counts will not change under the new policy.

Exhibit E-1. Input Data for the Demand Model

Period	HECM Loan Count	Couples	US. Pop>= 62 Years Old	HPI Index
2003Q1	3,704	1,356	42,543,076	166
2003Q2	5,043	1,935	42,828,724	169
2003Q3	5,881	2,225	43,006,256	171
2003Q4	7,145	2,639	43,184,524	175
2004Q1	9,917	3,558	43,338,700	179
2004Q2	9,844	3,524	43,444,736	183
2004Q3	10,979	4,000	43,599,840	187
2004Q4	9,430	3,477	43,755,500	192
2005Q1	11,784	4,439	43,923,080	197
2005Q2	9,129	3,553	44,115,412	202
2005Q3	12,707	4,862	44,284,368	207
2005Q4	14,731	5,803	44,453,972	212
2006Q1	18,336	7,216	44,628,464	217
2006Q2	22,435	8,749	44,813,524	220
2006Q3	20,598	7,841	44,989,424	222
2006Q4	23,967	9,001	45,166,016	222
2007Q1	29,006	10,614	45,491,776	224
2007Q2	27,328	10,382	46,125,232	225
2007Q3	27,111	9,974	46,457,912	224
2007Q4	24,647	9,087	46,792,992	222
2008Q1	30,481	11,083	47,113,548	218
2008Q2	28,663	10,188	47,406,636	213
2008Q3	28,256	9,530	47,731,396	207
2008Q4	27,557	9,566	48,058,380	202
2009Q1	30,073	13,005	48,355,036	196
2009Q2	28,617	10,880	48,591,744	195
2009Q3	28,161	10,408	48,891,692	193
2009Q4	24,773	8,995	49,193,492	192
2010Q1	20,437	6,955	49,480,656	192
2010Q2	15,348	5,445	49,739,692	190
2010Q3	18,497	6,826	50,030,044	189
2010Q4	18,384	7,234	50,322,088	186

Period	HECM Loan Count	Couples	US. Pop>= 62 Years Old	HPI Index
2011Q1	20,659	7,808	50,669,320	184
2011Q2	17,161	6,371	51,016,551	180
2011Q3	16,904	6,166	51,363,783	178
2011Q4	13,929	5,363	51,918,678	179
2012Q1	14,978	5,710	52,473,573	180
2012Q2	14,216	5,355	53,028,467	181
2012Q3	11,695	4,515	53,583,362	184
2012Q4	12,084	4,733	53,994,051	186
2013Q1	15,832	6,298	54,404,740	189
2013Q2	16,371	6,683	54,815,429	193
2013Q3	15,636	6,372	55,226,118	198
2013Q4	13,093	5,387	55,670,462	201
2014 Q1	14,825	5,900	56,114,805	204
2014 Q2	12,588	4,949	56,559,149	206
2014 Q3	11,107	4,241	57,003,492	209
2014 Q4	14,195	5,589	57,461,524	211
2015 Q1	14,059	5,394	57,919,556	214

E3. Quarterly Time Series Model of HECM Demand

The dependent variable is the natural log of the number of HECM loans endorsed in a quarter. The explanatory variables, also in log form, include the first and second lags of the dependent variable, the year-over-year change in home prices, and the senior population.

We used an Ordinary Least Squares (OLS) regression approach similar to previous years. The various explanatory variables, their coefficients and significance levels are shown in Exhibit E-2.

Exhibit E-2. OLS Regression of Log of HECM Loan Count

	Parameter Estimate	Standard Error	t-stat value	Pr > |t|
1-quarter lag of log of loan count	0.81431	0.14726	5.53	<.0001
2-quarter lag of log of loan count	0.07308	0.14349	0.51	0.6130
log (HPI at t / HPI at t - 4)	0.13335	0.53879	0.25	0.8056
log(Pop >= 62 yr at t)	0.06279	0.03457	1.82	0.0760
Adj R-Sq = 0.9997 Durbin-Watson = 1.996 Number of Observations = 49				

E4. Forecasts of HECM Loan Counts based on HECM Demand Model

The HECM demand model uses the following variables: forecasts of home prices and the senior population, as well as the lagged values of the dependent variable. A calibration factor is derived by dividing FHA's projected FY 2015 HECM volume by the model's projected volume. This calibration factor (0.7641) was applied to all future years among simulated future economic scenarios.

Exhibit E-3 presents the forecasts of future HECM endorsement counts based on alternative scenarios used in Section V.

Exhibit E-3. Forecasts of HECM Loan Counts for Simulated Economic Scenarios

Fiscal Year	Mean Stochastic Simulation	10th Best Path in Simulation	25th Best Path in Simulation	25th Worst Path in Simulation	10th Worst Path in Simulation	The Worst Path in Simulation	Moody's Baseline Path	Moody's Protracted Slump
2016	55,000	52,358	55,631	55,608	55,024	54,602	54,996	52,616
2017	60,465	57,657	60,934	60,739	60,464	59,165	60,469	54,807
2018	64,174	61,241	64,587	64,102	64,426	61,340	64,229	59,587
2019	67,094	64,195	67,620	66,769	67,315	62,466	67,171	64,002
2020	69,751	67,101	70,725	69,226	69,811	63,605	69,832	67,691
2021	72,163	69,852	73,723	71,704	71,663	66,662	72,230	70,795
2022	74,336	72,092	76,149	74,141	73,309	69,527	74,362	73,407

Appendix F

Stochastic Processes of Economic Variables

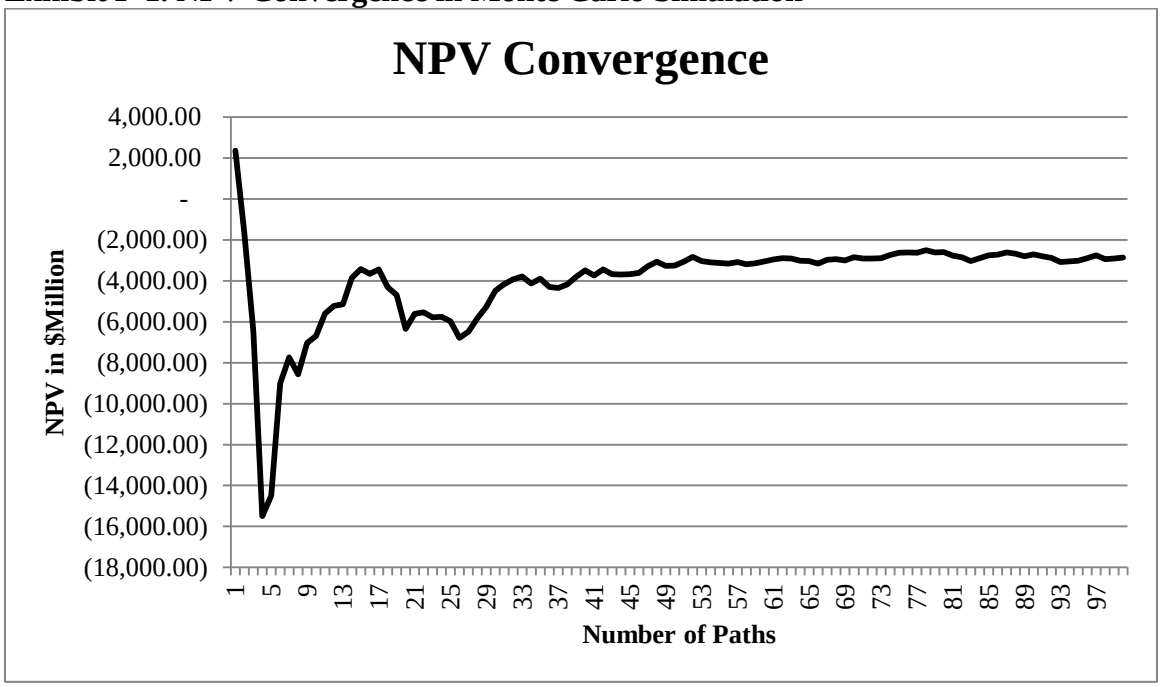
Appendix F: Stochastic Processes of Economic Variables

This Appendix describes the stochastic models used for generating the economic variables used in the Monte Carlo simulations of the 2015 HECM Actuarial Review. Starting from the 2012 Review, we computed the present value of expected cash flows among 100 possible paths of house price appreciation rates (HPAs) and interest rates and, since then, unemployment rates. This application is consistent with the industry best practice for pricing and measuring risks of mortgage portfolios.

The concept of Monte Carlo simulation approach that we use in this Review is to project a number of equally likely future paths of HPA, unemployment and interest rates, and compute the net present value (NPV) of the projected cash flows for each path. Since each path is equally likely to occur, the expected present value is computed as the mean of the NPVs among all simulated paths. By increasing the number of simulations, the average NPV among the paths will gradually converge to a constant level, which is the unbiased estimate of the expected present value of the MMI HECM Fund.

We simulated 100 paths of future economic variables to estimate the expected present value. Using more paths would require increasing computation time but with diminishing improvement in the estimation precision. Exhibit F-1 shows the convergence of the Monte Carlo simulation: after about the 50th path the average NPV of future cash flows has stabilized in a reasonably small range.

Exhibit F-1. NPV Convergence in Monte Carlo Simulation



The stochastic economic variables modeled herein for computing expected present value include:

- 1-year Treasury rates,
- 10-year Treasury rates,
- 1-year London interbank overnight rates (LIBOR),
- FHFA national Purchase-Only house price index (HPI) and
- Unemployment rates.

These stochastic variables have been modeled to project the "actuarial" or "real-world" measures and hence were estimated using historical data.[34] This approach is appropriate for the Actuarial Review because the simulated rates are designed to approximate the actual future distribution. Since all status transition probability models were estimated using the historically observed interest rates, unemployment rates and house price appreciation rates, using the interest rates and other economic variables in the actuarial measure, versus risk-neutral measures typically used for security trading purposes, makes the entire model internally consistent.

F1. Historical Data

F1.1. Interest Rates

With the high inflation rate caused by the global oil crisis in the late 1970's, interest rates rose to an historical high in early 1980's. Since then, the Federal government shifted its monetary policy from managing interest rates to managing the money supply. Since this policy shift, interest rates generally decreased but with higher volatility. Exhibit F-2 shows historical interest rates since 1970. The 1-year Treasury rate was around 5% in 1970 and increased steadily to its peak of 16.31% in 1981 Q3. After that, it followed a decreasing trend and reached an all-time low of 0.10% in 2014 Q2. Also shown are the 10-year Treasury rate (cmt10), and the 1-year LIBOR rate (LIBOR_1y).

[34] For valuing options, "risk-neutral" future paths of interest rates, e.g., are postulated and developed that permit estimation of option values based on observed option prices and the prices of the underlying asset upon which the options are based. These paths do not resemble actual historical movements in interest rates and are not suitable for the purpose of this actuarial review.

Exhibit F-2. Historical Interest Rates (%)

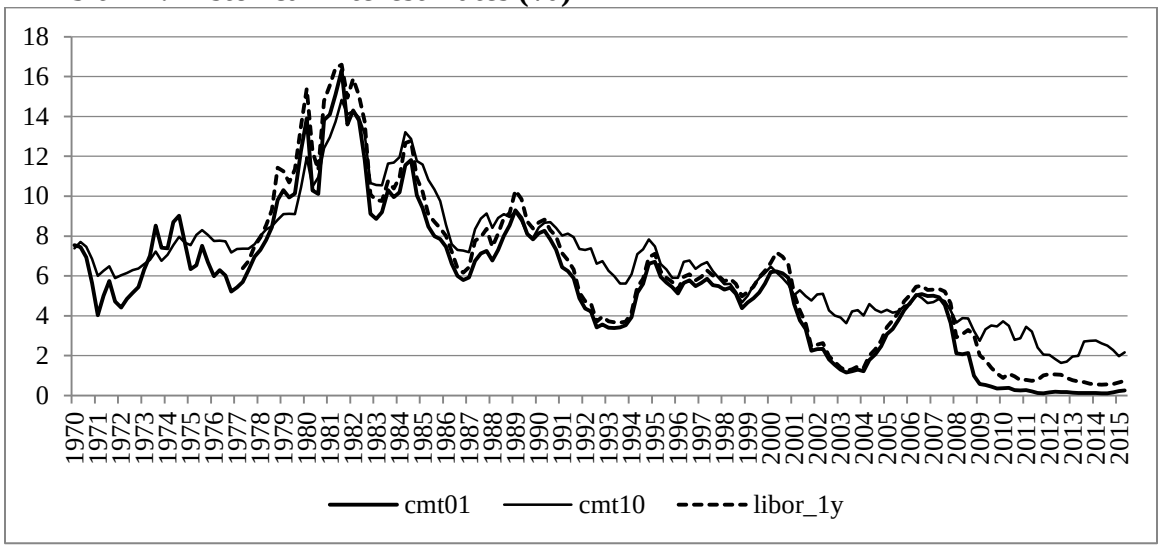
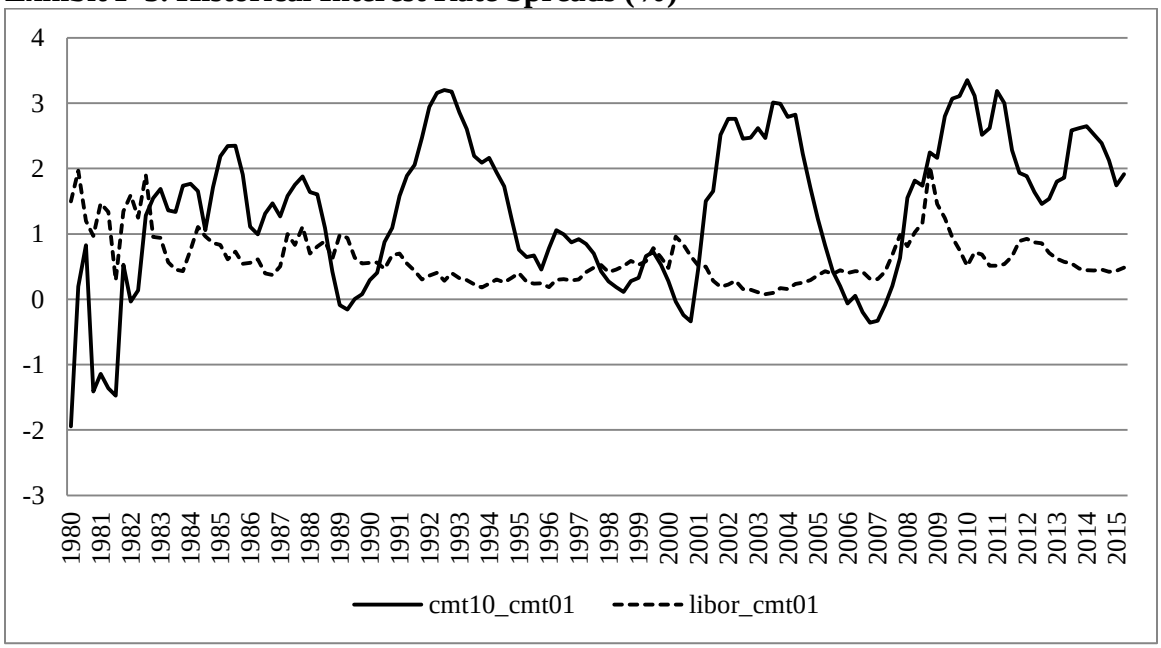


Exhibit F-3 shows historical interest rate spreads, including the spread between the 10-year and the 1-year Treasury rates, and the spread between the 1-year LIBOR and the 1-year Treasury rate. The spread between the 10-year and 1-year Treasury rates appears to have long cycles and the spread is not always positive. However, the spread of LIBOR over the 1-year Treasury rate has always been positive, primarily reflecting the premium for credit risk.

Exhibit F-3. Historical Interest Rate Spreads (%)



F1.2. House Price Appreciation Rates

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

Exhibit F-4 shows the National HPI and quarterly HPA from 1991 Q1 to 2015 Q1. The long-term average quarterly HPA is around 0.814 % (3.20% annual rate).

The HPI increased steadily before 2004, and the quarterly appreciation rate was around 1.14%. Then house prices rose sharply starting 2004. The average quarterly house price appreciation rate was 1.88% during the subprime mortgage expansion period from 2004 to 2006, and reached its peak of 2.59% in 2005 Q2. After 2006, the average growth rate became negative. Exhibit F-4 shows the annual HPA by selected historical time periods.

Exhibit F-4. National HPI and HPA

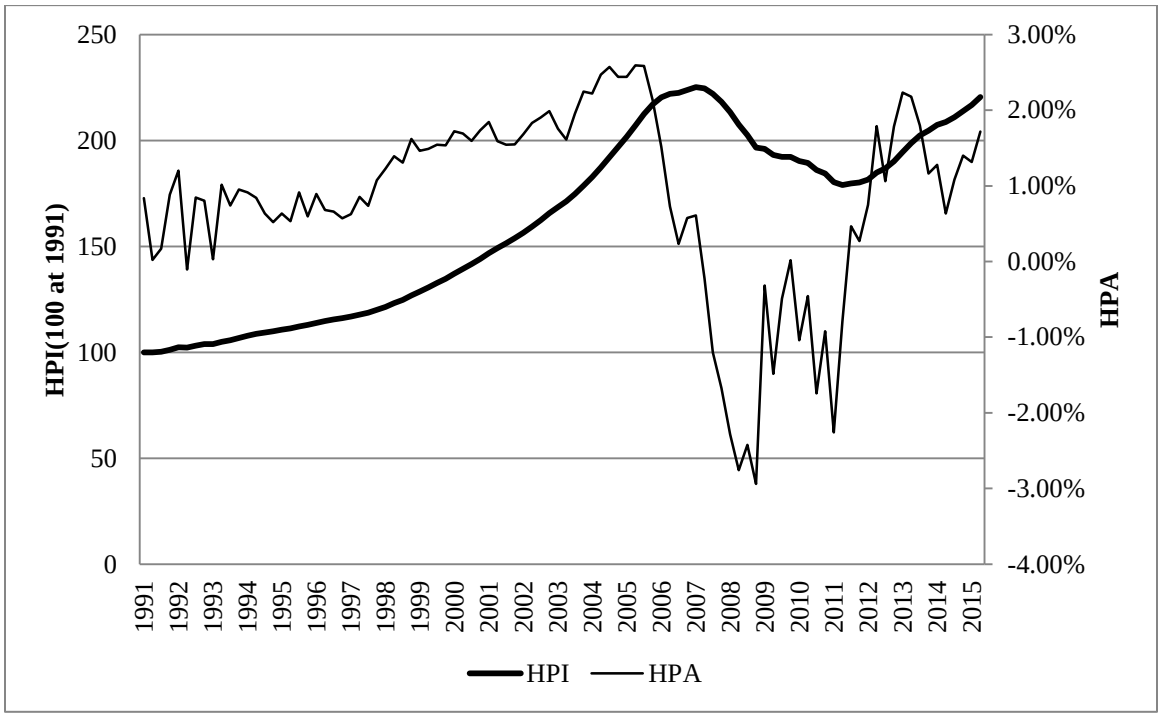


Exhibit F-5. Average Quarterly HPA by Time Span

Period	Average Quarterly HPA
1991 – 2003	1.13%
2004 – 2006	1.88%
2007 – 2010	-1.21%
2011 – 2014	1.01%

F2. 1-Year Treasury Rate

In this section, we present some historical statistics on the one-year Treasury rate, and then describe the estimation model for the stochastic process and finally report the parameter estimates and their standard errors. Exhibit F-6 shows the summary statistics of the historical 1-year Treasury rates using two sample periods, one started in 1962 and the other started in 1980.

Exhibit F-6. Statistics for the 1-Year Treasury Rates

Statistics	Since 1980	Since 1962
Mean	5.13%	5.41%
Standard Deviation	3.82%	3.34%
Max	16.31%	16.31%
95- Percentile	13.50%	11.65%
90- Percentile	10.11%	9.68%
50- Percentile	5.47%	5.44%
10- Percentile	0.21%	0.37%
5- Percentile	0.13%	0.17%
Min	0.10%	0.10%

We used a generalized GARCH(1,1) parameterization to model the 1-Year Treasury rate (r_1) and estimated it using data from 1980 Q1 to 2015 Q2.[35] The process takes the following form:

$$r_{1,t} = A + B * r_{1,t-1} + \sigma_t dZ_1 \qquad (1)$$

where Z_1 is the independent Wiener random process with distribution N(0,1).

The variance (σ^2) of the residual term follows a generalized GARCH (1,1) process:

$$\sigma_t{}^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 \sigma_{t-1}^2 + \gamma_1 r_{1,t-1} \qquad (2)$$

where ε is the error term, which equals $\sigma_t dZ_1$ from equation (1)

[35] For an example of using a GARCH model for fixed income analysis, see Heston and Nandi (2003).

The Full Information Maximum Likelihood (FIML) method was used to estimate the parameters in equations (1) and (2). The estimated results are presented in Exhibit F-7.

Exhibit F-7. Estimation Results for 1-Year Treasury Rate Model

Parameter	Estimate	Std Dev	t-value	prob>t
A	8.6E-04	0.000113	0.76	0.451
B	0.972	0.0114	85.3	0.000
β_0	-2.5E-07	9.26E-08	-2.71	0.008
β_1	0.403	0.17	2.32	0.022
β_2	0.336	0.10	3.41	0.001
γ_1	0.00025	0.000084	2.98	0.004
Adj. R^2	0.959			

The model based on these parameters is used to simulate the 1-year Treasury rates for 2015 Q3 and future. When the simulation is implemented, the "constant" term A is further calibrated to different time-dependent values to match Moody's baseline forecast in each forecasted quarter. The values were chosen so that the median value among 100 simulations matches Moody's July 2015 baseline forecast of the 1-year Treasury rate quarter by quarter. We applied the same procedure for the "constant" terms in the interest and HPA equations below.

Note that Moody's July forecast only covers the period until 2045 Q4. After 2045, we repeated Moody's last quarter forecasts for all remaining quarters. All the other interest rates and HPA series are expanded to the year 2100 using the same methodology. A lower bound of 0.01 percent was applied to the simulated future 1-year Treasury rates to avoid negative nominal rates in the simulation.

F3. 10-Year Treasury Rate

The 10-year Treasury rate is modeled by adding a stochastic spread term to the 1-year rate. We estimate the dynamics of the spread between 10-year Treasury rate and 1-year Treasury rate from the historical data. The spread term is assumed to depend on the one-year rate, the lagged value of the spread term and a random component. The model for the spread is

$$s_{10,t} = \alpha_{10,t} + \beta_{10} r_{1,t} + \gamma_{10} s_{10,t-1} + \varepsilon_{10,t} \quad (3)$$

where $s_{10,t}$ is the spread between the 10-year and 1-year Treasury rates at time t and $r_{1,t}$ is 1-year Treasury rate at time t. The variance of the residual term is assumed to follow an ARCH (1) process:

$$\sigma_t^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 \quad (4)$$

FIML was used to estimate the parameters. The estimated parameters are shown in the following Exhibit F-8.

Exhibit F-8. Estimation Results for 10-Year Treasury Rate Spread Model

Parameter	Estimate	Std Dev	t-value	prob>t
α_{10}[36]	0.004	0.001	2.79	0.006
β_{10}	-0.022	0.013	-1.66	0.100
γ_{10}	0.836	0.045	18.78	0.000
β_0	1.30E-05	2.82E-06	4.54	0.000
β_1	0.542	0.279	1.95	0.054
Adj. R^2	0.832			

We used the estimated parameters to simulate the spread between the 10-year and 1-year Treasury rates, and added the simulated spread to the simulated 1-year Treasury rate. Then we adjusted the constant term $\alpha_{10,t}$ to calibrate the series such that the median value among 100 simulated paths matched Moody's July 2015 base forecast of the 10-year Treasury rates quarter by quarter. We also set a floor value at 0.01 percent to the simulated 10-year Treasury rates.

F4. LIBOR

The 1-year LIBOR rate was modeled as a constant term plus a term proportional to the 1-year Treasury rate and a random term:

$$r_{L,t} = \alpha_{L,t} + \beta_L r_{1,t} + \varepsilon_{L,t} \quad (5)$$

where $r_{L,t}$ is the LIBOR rate and $r_{1,t}$ is 1-year Treasury rate.

Ordinary Least Squares was used to estimate the parameters α_L and β_L. The estimated parameters are shown in Exhibit F-9.

Exhibit F-9. Estimation Results for the LIBOR Rate Model

Parameter	Estimate	Std Dev	tValue	Prob>t
α_L[37]	0.005	0.001	10.71	0.000
β_L	0.999	0.011	91.59	0.000
Adjusted R^2	0.987			

[36] The intercept term is calibrated each time period so that the median simulated spread matches Moody's baseline forecast.
[37] The intercept term is calibrated each time period so that the median simulated spread matches Moody's baseline forecast.

We used the estimated parameters to simulate the LIBOR rate. Then we adjusted the constant term $\alpha_{L,t}$ to calibrate the series such that the median value among 100 simulations will match Moody's July 2015 base forecast of the LIBOR rates quarter by quarter. As with the other interest rates, we also set a floor value at 0.01 percent to the simulated LIBOR rate.

F5. House Price Appreciation Rate (HPA)

F5.1. National HPA

We specified the national HPA to depend on its own lags, seasonal dummy variables, the level of short rates and on various spreads and their lags. The model takes the following form:

$$HPA_t = \mu_t + \beta_1 HPA_{t-1} + \beta_2 HPA_{t-2} + \beta_3 r_{1,t} + \beta_4 r_{1,t-1} + \beta_5 s_{10,t} + \beta_6 s_{10,t-1} + \beta_7 s_{m,t} + \beta_8 s_{m,t-1} + \sigma_{h,t} dZ_h \quad (6)$$

where, $r_{1,t}$ is the 1-year Treasury rate,
$s_{10,t}$ is the spread between the 10-year and 1-year Treasury rates,
$s_{m,t}$ is the spread between mortgage rate and 10-year Treasury rate, and
Z_h is independent Wiener random process with distribution N(0,1)

The variance of the residual term follows a GARCH (1,1) process:

$$\sigma_{h,t}{}^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 \sigma_{h,t-1}{}^2 \quad (7)$$

The lags and variable inclusions were determined by achieving appropriate coefficient signs and significance and overall model fit. FIML was used to estimate parameters in equations (6) and (7). The results are shown in Exhibit F-10.

Exhibit F-10. Estimation Results the National HPA Model

Parameter	Estimate	Std Dev	t-value	prob>t
μ	0.002	0.002	1.32	0.1876
β_1	0.626	0.083	7.53	0.000
β_2	0.239	0.081	2.94	0.004
β_3	-0.113	0.066	-1.72	0.088
β_4	0.087	0.066	1.33	0.186
β_5	-0.212	0.088	-2.41	0.017
β_6	0.184	0.088	2.10	0.038
β_7	-0.158	0.107	-1.47	0.145
β_8	0.238	0.090	2.64	0.009
γ_0	2.88E-07	3.43E-07	0.84	0.402
γ_1	0.424	0.124	3.41	0.001
γ_2	0.627	0.075	8.38	0.000
Adj. R^2	0.665			

We used these parameters to simulate future HPA from 2015 Q3 onwards. Also, we calibrated the mean of HPA (μ_t in the equation) by matching the median value across 100 simulated paths to Moody's July base forecast. Moody's July forecast extends only to year 2045 Q4, so we repeated the last four quarters for the subsequent quarters.

F5.2. Geographic Dispersion

The MSA-level HPA forecasts were based on Moody's forecast of local and the national HPA forecasts. Specifically, at each time *t*, there is a dispersion of HPAs between the i^{th} MSA and the national forecast:

$$Disp_{i,t}^{Base} = (HPA_{i,t}^{Base} - HPA_{national,t}^{Base})$$

This dispersion forecast under Moody's base case is preserved for all local house price forecasts under individual future economic paths. That is, for economic path *j*, the HPA of the i^{th} MSA at time *t* was computed as:

$$HPA_{i,t}^{j} = (HPA_{national,t}^{j} + DISP_{i,t}^{Base})$$

This approach retains the relative current housing market cycle among different geographic locations and it allows us to capture the geographical concentration of FHA's current endorsement portfolio. This approach is also consistent with Moody's logic in creating local market HPA forecasts relative to the national HPA forecast under alternative economic scenario forecasts.[38] We understand this approach is equivalent to assuming perfect correlation of dispersions among different locations across simulated national HPA paths, which creates a systematic house price decrease during economic downturns and vice versa during booms.

[38] The dispersion of each MSA remains the same as Moody's baseline scenario among all alternative Moody's forecast scenarios.

F6. Unemployment Rate

F6.1. National Unemployment Rate

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

We used quarterly data from CY 1975 to CY 2015 Q2 to estimate the national unemployment rate. The model we adopted was:

$$ue_t = \mu_t + \beta_1 ue_{t-1} + \beta_2 ue_{t-2} + \beta_3 r_{1,t} + \beta_4 r_{m,t} + \beta_5 HPA_t + \varepsilon_t \qquad (8)$$

where, $r_{1,t}$ is the 1-year Treasury rate,
$r_{m,t}$ is the 30-year mortgage rate,
HPA_t is the annualized house price growth rate at the national level, and
ue_t is the unemployment rate.

Exhibit F-11: Estimation Results for the National Unemployment Rate Model

Parameter	Estimate	Std Dev	t-value	prob>t
μ	0.184	0.092	1.99	0.048
β_1	1.510	0.062	24.22	0.000
β_2	-0.581	0.059	-9.88	0.000
β_3	-0.046	0.019	-2.40	0.018
β_4	0.070	0.022	3.09	0.002
β_5	-1.533	0.450	-3.41	0.001
Adj. R^2	0.981			

From the simulated interest rates and house prices, we applied the parameters shown in Exhibit F-11 to calculate the corresponding national unemployment rate. Based on historical statistics, the national unemployment rate was capped at 20% with a floor of 2%.

References

References

Begg, C. B. and Gray, R. (1984). *Calculation Of Polychotomous Logistic Regression Parameters Using Individualized Regressions.* Biometrika (71), 1, 11-18.

Capone, C. A., K. L. Chang and C. A. Cushman (2010). *Identification of Home Maintenance Risk in Reverse Mortgages: An Empirical Examination of Home Price Appreciation among HECM Borrowers.* American Real Estate and Urban Economics Association 2010 Mid-Year Conference: Washington, D.C.

Glasserman, P., (2003), *Monte Carlo Methods in Financial Engineering*, Springer.
Heston, Steven L and Saikat Nandi (2003*). A Two-Factor Term Structure Model under GARCH Volatility.* The Journal of Fix Income(13),1,87-95.

IBM Global Services (2010). *An Actuarial Analysis of FHA Home Equity Conversion Mortgage Loans in the Mutual Mortgage Insurance Fund Fiscal Year 2010.* U. S. Department of Housing and Urban Development: Washington, D.C.

IFE Group (2010). *Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund (Excluding HECMs) for Fiscal Year 2010*. U. S. Department of Housing and Urban Development: Washington, D.C.

McNeil, A. J., Frey, R., and P. Embrechts, (2006), *Quantitative Risk Management: Concepts, Techniques, and Tools***,** Princeton University Press.

Shiller, R. J. and A. N. Weiss (2000). *Moral Hazard in Home Equity Conversion.* Real Estate Economics (28.1):1-32.

Szymanoski, E. J., DiVenti, T. R. and Chow, M. H. (2000). *Understanding reverse mortgage cash flows: a hazard model of HECM loan terminations.* U. S. Department of Housing and Urban Development: Washington, D.C.

U. S. Department of Housing and Urban Development (9/1/2010). Mortgagee Letter 2010-28. Changes to FHA Mortgage Insurance. Washington, D.C.

U. S. Department of Housing and Urban Development (9/21/2010). Mortgagee Letter 2010-34. Home Equity Conversion Mortgage Program – Introducing HECM Saver; Mortgage Insurance Premiums and Principal Limit Factor Changes for HECM Standard. Washington, D.C.

U. S. Department of Housing and Urban Development (1/3/2011). Mortgagee Letter 2011-01. Home Equity Conversion Mortgage Property Charge Loss Mitigation. Washington, D.C.

U. S. Department of Housing and Urban Development (8/19/2011). Mortgagee Letter 2011-29. Federal Housing Administration's (FHA) Maximum Loan Limits Effective October 1, 2011 through December 31, 2011. Washington, D.C.

U. S. Department of Housing and Urban Development (9/3/2013). Mortgagee Letter 2013-27. Changes to the HECM Program Requirements. Washington, D.C.

U. S. Department of Housing and Urban Development (4/25/2014). Mortgagee Letter 2014-07. Home Equity Conversion Mortgage (HECM) Program: Non-Borrowing Spouse. Washington, D.C.

U. S. Department of Housing and Urban Development (6/27/2014). Mortgagee Letter 2014-12. Home Equity Conversion Mortgage (HECM) Program: New Principal Limit Factors. Washington, D.C.

U. S. Department of Housing and Urban Development (3/27/2015). Mortgagee Letter 2015-09. Home Equity Conversion Mortgage (HECM) Program – Life Expectancy Set-Aside Growth Rate and Clarification to Section 3.98 of the HECM Financial Assessment and Property Charge Guide. Washington, D.C.

U. S. Department of Housing and Urban Development (4/23/2015). Mortgagee Letter 2015-10. Home Equity Conversion Mortgage (HECM) Due and Payable Policies. Washington, D.C.

Yuen-Reed, G. and Szymanoski, E. J. (2007). *What's a Savvy Senior to Do? A Competing Risk Analysis of HECM Reverse Mortgage Loan Terminations.* American Real Estate and Urban Economics Association 2007 Mid-Year Conference: Washington, D.C.