# Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund HECM Loans For Fiscal Year 2013

**December 11, 2013**

**Prepared for**

**U.S. Department of Housing and Urban Development**

**By**

**Integrated Financial Engineering, Inc.**

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December 11, 2013

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

Dear Ms. Galante:

IFE Group has completed and, along with this letter, is submitting the fiscal year 2013 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 2013 was $6.54 billion and the insurance in force was $87.67 billion. We project that at the end of fiscal year 2020 the HECM Fund's economic value will be $15.38 billion and the insurance in force will be $161.48 billion.

The financial estimates presented in this Review require projections of events more than 30 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 2013**

I have reviewed the "Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund, HECM Loans, for Fiscal Year 2013". 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)
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December 11 2013

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## 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. The Reverse Mortgage Stabilization Act of 2013 eliminated the HECM Standard and HECM Saver programs and is replacing them starting in FY 2014 with HECMs that will reduce the initial and total allowable drawdowns to strengthen the financial condition of the program.[2]

The National Housing Act requires an independent annual actuarial study of FHA's MMI Fund.[3] Accordingly, an actuarial review must be conducted on HECM loans within the MMI Fund. This document reports the estimated economic values of the FY 2013 through FY 2020 MMI HECM portfolios. A fiscal year's MMI HECM 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. 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 2013, the HECM portion of the MMI fund has an expected economic value of $6,541 million. The economic value includes a transfer of $4,263 million from the MMI Capital Account and a $1,686 million mandatory appropriation. Projected long-term improvements in house price growth rates contribute to a steadily increasing economic value of the MMI HECM portfolio from FY 2013 through FY 2020.

## 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 data reported by FHA through March 30, 2013. We developed loan-level termination and recovery models to estimate the relationship between HECM terminations and recoveries using various economic and loan-specific factors. We then estimated the future loan performance of the FY 2013 to FY 2020 MMI HECM portfolios using various assumptions,

[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] The *Reverse Mortgage Stabilization Act of 2013* was passed by the Senate on July 30, 2013 and signed by President Obama into law H.R. 2167 on August 9, 2013. This law amends the *National Housing Act* to empower the HUD Secretary to make changes to the Home Equity Conversion Mortgage (HECM) program via Mortgagee Letters (MLs).
[3] 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).

including macroeconomic forecasts based on stochastic simulation of 100 possible future economic scenarios and the expected HECM portfolio characteristics provided by FHA.

Based on our evaluation of the HECM loans in the FY 2013 portfolio, we estimated the economic value of the HECM portion of the MMI fund to be $6,541 million. We estimated that the economic value of the HECM portfolio will subsequently improve over time with the addition of new endorsements. Policy changes and forecasted improvement of future economic condition are predicted to increase the estimated value of future endorsements as well as the existing books of business.[4] The estimated economic value of the fund as of the end of FY 2020 is $15,378 million.

The maximum claim amount (MCA) of a HECM loan serves as 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 total MCAs over the active portfolio. As new endorsements are added to the portfolio, projected HECM IIF increases from $87,672 million in FY 2013 to $161,479 million in FY 2020. Exhibit ES-1 provides the baseline economic values of the HECM portfolio, IIF and new endorsements for FY 2013 through FY 2020.

**Exhibit ES-1. Economic Value, Insurance-in-Force, and Endorsements for FY 2013-FY 2020 ($ 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 |
|---|---|---|---|---|---|
| 2013 | $6,541 | $87,672 | $14,331 | $395 | |
| 2014 | 7,523 | 96,480 | 13,850 | 969 | 13 |
| 2015 | 8,551 | 103,850 | 16,369 | 998 | 30 |
| 2016 | 9,643 | 115,229 | 17,806 | 1,002 | 91 |
| 2017 | 10,870 | 126,580 | 18,621 | 1,044 | 183 |
| 2018 | 12,260 | 137,810 | 19,665 | 1,106 | 284 |
| 2019 | 13,765 | 149,365 | 20,937 | 1,150 | 355 |
| 2020 | 15,378 | 161,479 | 22,317 | 1,195 | 419 |

*All values, except the volume of new endorsements, 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.

## B. Sources of Change in the Status of the Fund

The economic value of the HECM portfolio in the MMI fund increased by $9,340 million from the estimated FY 2012 economic value of *negative* $2,799 million estimated in the FY 2012 review. This change was primarily driven by three main factors[5]:

[4] Details of the policy changes are provided in Section I of the review.
[5] Only major driving factors are listed here. Details of the decomposition of changes of economic value are in Section II of this report.

- Total capital resources increased by $4,332 million due primarily to a $4,263 million transfer from the MMI Capital Reserve account to the HECM Financing Account.
- This year's OMB published discount factors are higher than the corresponding values used in last year's Review. This change reflects lower interest rate assumptions and hence less discounting of future cash flows resulting in the higher discount factors. The higher discount factors increase the present value of future cash inflows such as insurance premiums and recovery revenue. They also increase the present value of future cash outflows such as claims. However, future cash inflows typically occur much later than the future cash outflows, and the impact of the higher discount factors is greater on the more distant cash inflows. As the result of the change in discount rates, the FY 2013 HECM economic value increased by $3,240 million.
- The house price forecast for this year shows stronger recovery than last year's forecast. Federal Housing Finance Agency (FHFA) published the Purchase-Only (PO) Home Price Index (HPI) of 75 MSAs for the first time in 2013. This allowed us to replace the all-transaction HPI which was used in previous Reviews. The PO Index is based on repeat sales of actual housing sale prices and does not involve any appraised values. As such it provides a more direct and accurate measure of housing market conditions. Compared with the house price forecast used in the last year's Review, this year's house price forecast shows a 1 percentage point increase in house price appreciation rate after FY 2026. The impact is especially large on the recovery associated with payoff or conveyance, since payoff or conveyance events mostly happen after the loan is twelve years of age.[6] Also, the PO index shows larger volatility[7] than the all-transaction HPI during the historical and forecast periods, which indicates larger recovery revenue due to larger house price appreciation rates (HPA) between origination time and property sale time. The difference in HPA between last year's forecast and this year's forecast has a favorable impact on the fund. The net increase in economic value caused by the combination of the house price index replacement and the change in the house price forecast was $2,197 million.

## C. Impact of Economic and Loan Factors

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

- House Price Appreciation Rates: HPA rates impact the recovery FHA receives upon loan terminations and the rate at which borrowers will refinance or move out of the property. HPA rates are generated by our stochastic simulation of economic variables. These rates for the Monte Carlo simulation are centered on Moody's July 2013 forecast.
- One-year and ten-year Treasury interest rates and one-year and ten-year LIBOR rates: Interest rates impact the growth rate of the loan balances and the amount of equity available

[6] The earliest book of business in the Review is the 2009 book, therefore around the peak time of recovery, house prices are predicted to improve significantly compared with last year's prediction. This leads to a large positive impact on the present value of the portfolio.
[7] The HPA difference between this year's forecast and last year's forecast is showed in Section I -Ex 1-3a.

to the borrower at origination. Interest rate projections used are also based on stochastic simulation centered on Moody's July 2013 forecast.

- Mortality Rates: Mortality rates are obtained from the U.S. Decennial Life Table for 1999-2001 published by the Centers for Disease Control and Prevention (CDC) in 2004.
- 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 2014.

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 and five alternative scenarios from our simulated paths. 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 future interest rate and house price appreciation rates simulated for each path. The results indicate that there is approximately a 50 percent chance that the economic value would fall in the range of positive $2,696 million to positive $9,914 million, and an 80 percent chance to be within the range of *negative* $1,521 million to positive $14,542 million. Under the worst simulated scenario, the economic value could be negative $17,026 million. Based on our model and our assumptions, we estimate this represents a 99.5 percent stress test for the Fund.

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

| Fiscal Year* | Economic Value of the HECM Portfolio in the MMI Fund | | | | | |
|---|---|---|---|---|---|---|
| | Baseline Monte Carlo 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 |
| 2013 | $6,541 | $14,542 | $9,914 | $2,696 | -$1,521 | -$17,026 |
| 2020 | $15,378 | $23,763 | $19,086 | $10,830 | $4,503 | -$14,312 |

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

Note that the 10th or the 25th best and worst paths presented in Exhibit ES-2 may not correspond to the 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 HECM and forward combined portfolio 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.

One alternative scenario was also tested in this Review. Under the most stressful scenario projected by Moody's, the protracted slump scenario, the FY 2013 economic value of the Fund is *negative* $7,894 million. This is similar to the 5$^{th}$ worst path in our simulation. Thus, it is equivalent to about 95 percentile stress test based on our model and assumptions.

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# 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.[8] 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)[9] 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 2013 through FY 2020. This review also provides the HECM portion of the insurance-in-force (IIF) used to assess the overall MMI Fund capital ratio.

## B. HECM Program Overview

The U.S. Department of Housing and Urban Development (HUD), Federal Housing Administration (FHA), provides reverse mortgage insurance through the HECM program, which enables older 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 822,485 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 equity in 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 any payments to them 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

[8] 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).
[9] 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 value 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 also assign the mortgage note to FHA when the loan balance reaches 98 percent of the MCA and be reimbursed for the balance of the loan. When note assignment occurs, FHA switches from being the insurer to the holder of the note and services the loan until termination. At loan termination (post-assignment), FHA will attempt to recover the loan balance including any interest accrued.

In 2010, FHA introduced the "Saver" alternative to the Standard HECM product. The HECM Saver program charges a lower upfront mortgage insurance premium (MIP) but also reduces 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 as in order to pay a lower mortgage insurance premium than the two percent fee charged by the Standard HECM program.

Starting from FY 2014, FHA will replace the existing Standard and Saver programs by a new program to improve the financial viability of the HECM program. The new program has a lower principal limit factor than the current Standard program, and also has an initial disbursement limitation. Furthermore, the initial MIP is charged based on the mortgagor's initial disbursement. Appendix B provides more details on the impact of this new product on HECM demand and the future HECM endorsement composition.

We now provide definitions of several common HECM terms:

**1. Maximum Claim Amount (MCA)**

The MCA is the minimum of the appraised value of the home and the FHA HECM 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[10] can be used to pay off the outstanding loan balance, regardless of whether the size of the MCA was capped by the FHA HECM 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 illustrates a selected number of PLFs published in October 2010 as well as the PLFs based on the new

[10] Net sales proceeds are the proceeds from selling the home minus transaction costs.

program for FY 2014 and later.[11] For a given HECM applicant, a PLF is multiplied by the MCA according to the HECM program features and the borrower's age and gender. The result is the maximum HECM principal limit available to the applicant. The PLF increases with the borrower's age at origination[12] and decreases with the expected mortgage interest rate (with a floor of 3.0 percent).[13] 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 new program is 85 percent of those in comparable Standard program. 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 servicing fees. Once the HECM unpaid loan balance reaches the principal limit, no more cash advances are available to the borrower (except for the tenure plan which acts as an annuity).

**Exhibit I-1. Selected Principal Limit Factors**[14]

| Expected Mortgage Interest Rate | Borrower Age at Origination | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 65 | | | 75 | | | 85 | | |
| | Standard | Saver | New Program | Standard | Saver | New Program | Standard | Saver | New Program |
| 5.50% | 0.569 | 0.468 | 0.483 | 0.636 | 0.508 | 0.540 | 0.703 | 0.554 | 0.597 |
| 7.00% | 0.428 | 0.316 | 0.363 | 0.516 | 0.376 | 0.438 | 0.606 | 0.443 | 0.515 |
| 8.50% | 0.326 | 0.192 | 0.277 | 0.425 | 0.264 | 0.361 | 0.531 | 0.341 | 0.451 |

### 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;
- Combinations of all of the above.

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

[11] Mortgagee Letter 2013-27.
[12] For couples, the age of the younger borrower is used to determine the corresponding PLF.
[13] For adjustable rate mortgages, "expected" interest rates are calculated by the lender as the sum of an index rate (10-year LIBOR or Treasury) 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.
[14] The PLFs shown here are based on the 10/4/2010 values provided at:
http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/hecm/hecmhomelenders
The new PLFs for FY2014 new program shown here are provided at
http://www.hud.gov/offices/hsg/sfh/hecm/hecmhomelenders.cfm

## 4. Unpaid Principal Balance (UPB) and Loan Costs

HECMs differ from normal mortgage products as they require no repayment as long as the borrower continues to live in the home and follows FHA guidelines on property maintenance, real estate taxes and insurance. In general, the loan balance continues to grow with borrower cash draws, and accruals of interest, premiums, and service fees until the loan terminates.[15] HECMs can be fixed or adjustable interest rate, 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 out-of-pocket, which reduces the remaining principal limit 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 premium comprises an upfront premium of two percent of the MCA and an annual premium of half a percent of the unpaid principal balance. After October 4, 2010, the upfront premium remained at two percent for the Standard program but was set as one basis point of the MCA for the Saver program, whereas 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 FY2014, under the new program, the annual MIP rate of 1.25 percent will remain the same, but the upfront MIP will be determined based on the amount of the initial cash drawn at loan closing. An initial MIP of 0.50 percent of the maximum claim amount will be charged if the initial draw amount is less than or equal to 60 percent of the available principal limit. An initial MIP of 2.50 percent of the maximum claim amount will be charged if the initial draw amount exceeds 60 percent of the available principal limit.

## 5. Loan Terminations

HECM loans typically terminate when the borrowers die, move out of the home so that their primary residence changes, the HECM is refinanced, or the house is sold. Loans can also terminate under foreclosure when the borrowers fail to pay property taxes or homeowner's insurance. Appendix D provides detail on tax and insurance defaults.

When a HECM loan terminates, the current loan balance becomes due. If the net sale 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 entire 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 of the borrowers can be accessed to cover any shortfall.

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

### 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 selling the mortgage note to 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 and service the note until termination. During the note holding period, the loan balance will continue to grow by accruing interest, premiums, and service 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.

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 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, as it reduces the likelihood that the unpaid principal balance will exceed the net proceeds from a house sale. Exhibit I-2 also indicates that the FY 2014 new program is more conservative than current Standard program, in which the principal limit factors for the new program equals 85 percent of the current Standard program.

**Exhibit I-2. Selected Principal Limit Factors Changes for Standard HECMs and New Program**

| Borrower Age at Origination | Expected Mortgage Interest Rate | PLFs for Standard Program | | | PLFs for New Program |
|---|---|---|---|---|---|
| | | FY 2009 and Prior | FY 2010 | FY 2011 – FY2013 | FY 2014 and onward |
| 65 | 5.50% | 0.649 | 0.584 | 0.569 | 0.483 |
| 65 | 7.00% | 0.489 | 0.440 | 0.428 | 0.363 |
| 65 | 8.50% | 0.369 | 0.332 | 0.326 | 0.277 |
| 75 | 5.50% | 0.732 | 0.659 | 0.636 | 0.540 |
| 75 | 7.00% | 0.609 | 0.548 | 0.516 | 0.438 |
| 75 | 8.50% | 0.503 | 0.453 | 0.425 | 0.361 |
| 85 | 5.50% | 0.819 | 0.737 | 0.703 | 0.597 |
| 85 | 7.00% | 0.738 | 0.664 | 0.606 | 0.515 |
| 85 | 8.50% | 0.660 | 0.594 | 0.531 | 0.451 |

In early 2009, the U.S. Congress passed the American Recovery and Reinvestment Act of 2009 (ARRA)[16] 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.[17] Mortgage Letters 2011-29 and 2011-39 further extended the $625,500 loan limit through December 31, 2012.

## 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 interest rates. This distribution is centered on Moody's July 2013 baseline forecasts in the sense that our projected values are just as likely to be above Moody's forecast values as below them. We discuss future house price growth in Section I and future interest rates in Section I in terms of Moody's forecasts since our simulated distribution is centered around these forecasts.

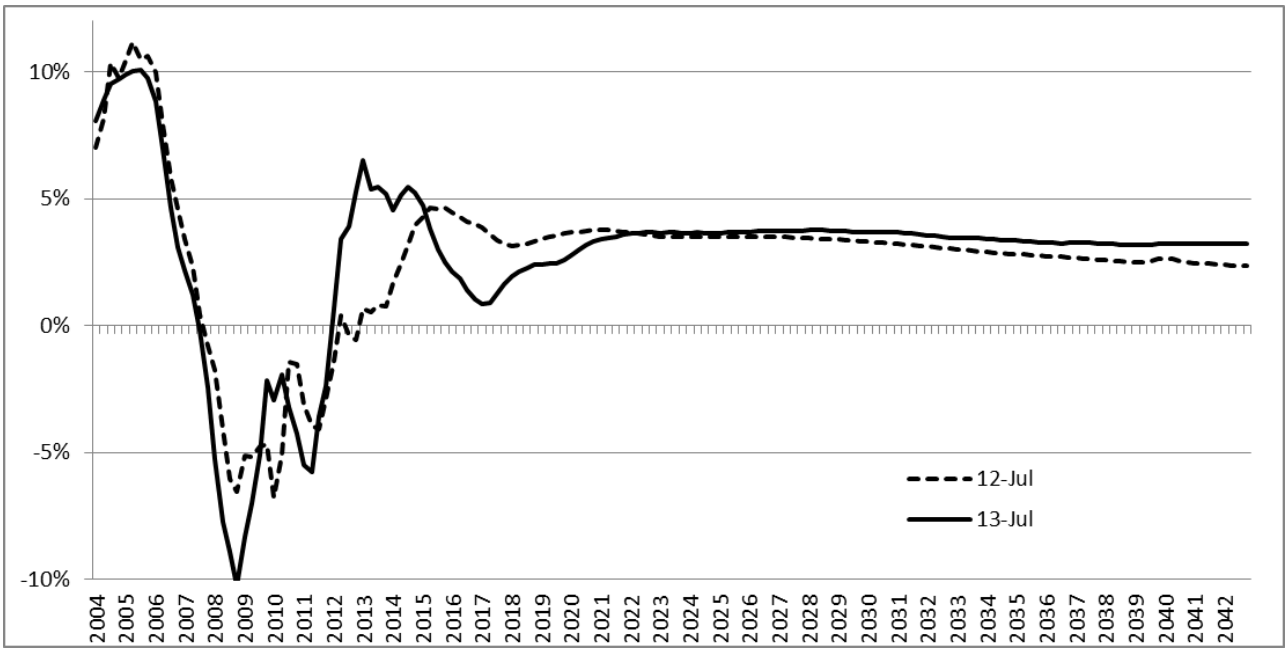
[16] ARRA was passed by the U.S. Congress on February 13, 2009 and signed by President Barack Obama on February 17, 2009.
[17] Department of the Interior, Environment, and Related Agencies Appropriations Act (H.R. 2996) was passed by the U.S.Congress on October 29, 2009 and signed by President Barrack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

## 1. House Price Growth Rate

The house price growth rate trend forecasts for the nation, states and MSAs were obtained from Moody's July 2013 forecast of the FHFA Purchase-Only (PO) repeat-sales House Price Index (HPI), which replaces the all-transaction HPI that was used in previous reviews. The Purchase-Only Index is based on repeat sales at market prices and does not involve any appraised values. As such it provides a more direct and accurate measure of housing market conditions. In our FY 2013 Actuarial Review of forward mortgages we provide reasons for this change. Moody's state and MSA house price forecasts take into consideration local area economic conditions including unemployment rates. Moody's July 2013 forecast provides estimates from FY 2013Q2 to the end of FY 2043. We used the forecasts for FY 2043 as the basis for forecasts beyond that year.

Exhibit I-3a presents a brief summary of the July 2013 Moody's baseline national house price growth rate forecast as compared to the one used in the 2012 Review. According to this year's forecast, the annualized national house price growth rate during the remainder of FY 2013 is 5.31 percent. National house prices are projected to grow at 5.00 percent per annum basis through the first quarter of FY 2015. Then the rate drops to positive 0.85 percent per annum by the second quarter of FY 2017, representing a minor recession. After that, the house price growth rate gradually rises to a long-run average annual rate of around 3.50 percent thereafter.

**Exhibit I-3a. House Price Appreciation Rates: Actuals and Forecasts from Year 2004 to 2042**




The above Exhibit also shows the difference between the all-transaction house price index used for last year's Review and the PO index for this year's Review. We show the prior actual values of each series up to the respective forecasted values. Compared with the all-transaction house

price index, the PO index shows a deeper drop during the 2008 recession and a stronger recovery since 2011. Meanwhile, this year's forecast of long term growth rates was faster than those of last year and house price index level is higher than last year's forecast in the long-term trend. This difference increased the economic value of the HECM portfolio in this year's Review compared to last year.

The house price projections for individual states generally differ from the overall national level. The HECM portfolio active at the end of FY2013 is concentrated in California, Florida, New York and Texas. A near-term strong recovery is forecasted for California, while a mild increase is forecasted for Texas and Florida. Except for Florida, the long-term trends of house price growth for these states remain similar to those in last year's Moody's forecast. The differences compared to last year's Review are shown below in Exhibit I-3b for these large states and nationally.

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

| State | Percent of FY2013 Endorsements | House Price Growth Forecast | | | |
|---|---|---|---|---|---|
| | | Short-Term Trend [18] | | Long-Term Trend | |
| | | Forecast in FY2013 Review | Forecast in FY2012 Review | Forecast in FY2013[19] Review | Forecast in FY2012 Review |
| California | 13.50% | 10.40% | 0.46% | 3.30% | 3.40% |
| Texas | 8.80% | 3.82% | 2.86% | 2.60% | 2.70% |
| Florida | 6.40% | 3.87% | 2.53% | 3.30% | 4.00% |
| New York | 6.50% | 1.47% | 3.48% | 3.10% | 3.00% |
| National Average | | 5.44% | 2.93% | 3.50% | 3.40% |

The strong recovery in house price growth 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. A recovering housing market leads to more refinancing and less claim payment. The positive house price growth rates in 2013 and the mild long-term house price growth projection increase the recovery revenue of HECM loans. Consequently, HECM insurance losses would be lowered.

Second, a near-term strong house price forecast and long-term positive growth rate increases 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 new program. 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 discussion of HECM refinancing analysis.

[18] Short-term trend means the growth rate over CY 2012Q3-CY 2013Q3. Long-term trend means the annualized growth rate from CY 2013 to CY 2033.
[19] 2013 (2012) means the average projected house price growth rate used in the 2013 (2012) Review.

Compared with last year's baseline scenario, house price growth forecast under this year's baseline scenario is more optimistic, which led to larger recoveries at termination and fewer assignments. Future endorsements are predicted to have better financial performance than those in the existing portfolio.

### 2. Interest Rates

According to Federal Reserve Board statistics, the one-year U. S. Treasury rate declined steadily over the past several years. In response to the Federal Reserve's second round of quantitative easing (QE2) in November 2010, and "Operation Twist" starting in September 2011, the 10-year Treasury rate continued to drop since 2010 and reached its lowest point since the 1950s in the second quarter of 2012, as shown in Exhibit I-4a. Similarly, the one-year London Interbank Offered Rate (LIBOR) reached an historical low in the second quarter of CY 2013 of 0.70 percent.

**Exhibit I-4a. Comparison of Interest Rates**

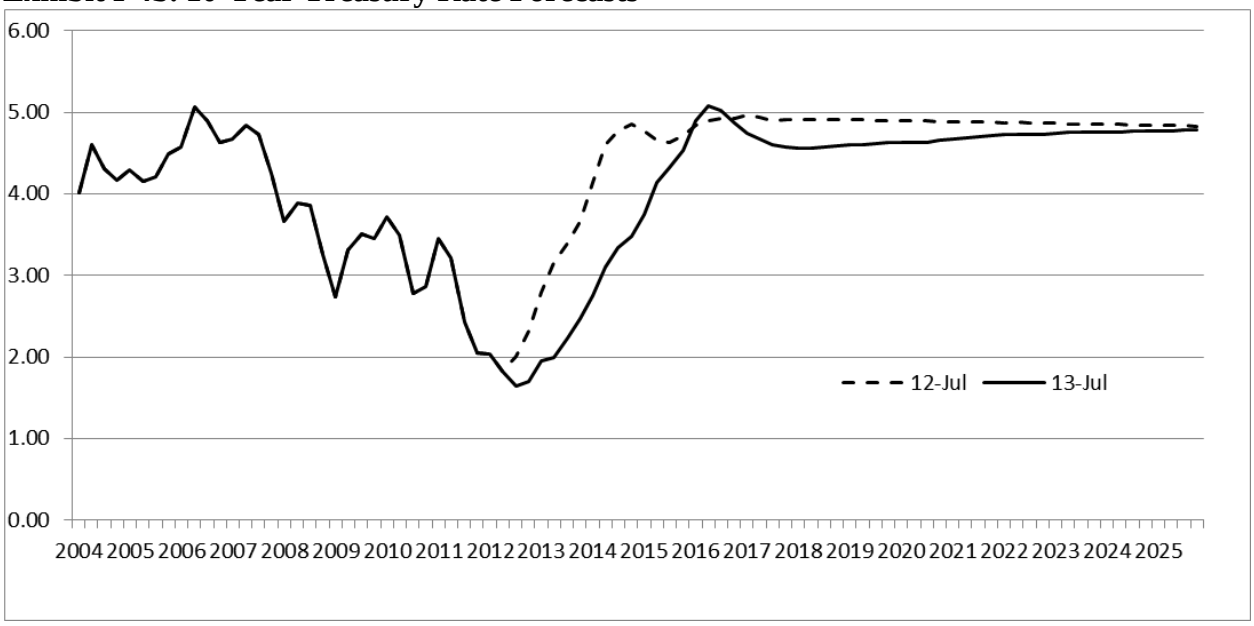
| Rate type | Interest Rate | | |
|---|---|---|---|
| | July-2011 | July-2012 | July-2013 |
| 1yr CMT | 0.26% | 0.24% | 0.26% |
| 10yr CMT | 3.18% | 2.01% | 2.24% |
| 1yr LIBOR | 0.79% | 1.05% | 0.70% |

The expected mortgage interest rate, which is calculated as the sum of the ten-year rate and the lender's margin for a variable rate HECM, affects the percentage of equity available to borrowers. The PLF increases as the expected rate declines for a given borrower age. Moody's has forecasted the ten-year Treasury rate to rise steadily to 3.5 percent by 2014 and then stabilize at around 4.6 percent after 2017.[20] The ten-year Treasury rate forecast implies a continued low interest rate environment, which enables borrowers to access a large percentage of their home equity. However, even though ten-year Treasury rates remain at a low level, average lender margins have increased from an average of 1.5 percent for 2008 and prior years to 2.5 percentage points from 2009 to 2011. In 2012, lender margins further increased to 3.0 percentage points. According to FHA projections, for new originations starting from FY2014, lenders' margin would be 2.73 percentage points for fixed-rate loans, and average lenders' margin would be 2.67 percentage points for adjustable-rate loans. This increase may partially offset the impact of low interest rates and limit the increase in equity available to borrowers.

Exhibit I-4b shows the forecasts of the 10-year Treasury rate during the past years. The realized 10-year Treasury rates during the last year turned out to be much lower than what was forecasted by Moody's in July 2012. Also, the forecast of long-term stable rates was also adjusted downward this year.

[20] At the time of the review, Moody's did not forecast the LIBOR ten-year SWAP rate. For modeling purposes, we leveraged the FHA-estimated relationship between the U. S. Treasury and the LIBOR ten-year rates, and accordingly estimated the future LIBOR ten-year rate using the Moody's Treasury rate forecast.

**Exhibit I-4b. 10-Year Treasury Rate Forecasts**




Approximately 28 percent of loans in the FY 2013 book of business are monthly 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. Moody's has forecasted the one-year Treasury rate to rise steadily to 3.5 percent by FY 2016 and stabilize to a long-run rate of around 4.0.

### 3. HECM Demand

HECM 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 PLF for the FY 2014 introduced new program are likely to decrease HECM demand compared with future volume projected in 2012 Review. Exhibit I-5 shows the actual numbers and dollars of endorsements in FY 2009 through FY 2012 as well as the annualized values for FY 2013 (based on data as of June 30, 2013). The Exhibit also contains the volume projections for FY 2014 through FY 2020 based on our updated HECM demand model described in Appendix E.

**Exhibit I-5. Actual and Forecasted FY 2009 to FY 2020 Endorsements**

| Fiscal Year | Number of Endorsements | Average MCA per Endorsement | Total Endorsements ($millions) |
|---|---|---|---|
| 2009 | 114,412 | $262,839 | $30,072 |
| 2010 | 79,056 | $266,562 | $21,073 |
| 2011 | 73,114 | $249,131 | $18,215 |
| 2012 | 54,816 | $240,134 | $13,163 |
| 2013 | 61,296 | $242,757 | $14,880 |
| 2014 | 54,687 | $253,258 | $13,850 |
| 2015 | 62,469 | $262,035 | $16,369 |
| 2016 | 66,906 | $266,133 | $17,806 |
| 2017 | 69,380 | $268,393 | $18,621 |
| 2018 | 72,040 | $272,968 | $19,665 |
| 2019 | 75,128 | $278,688 | $20,937 |
| 2020 | 78,170 | $285,496 | $22,317 |

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 in the senior population. In 2010, 16 percent of the population (approximately 50 million) was 62 or older. According to the U.S. Census Bureau's projection, 20 percent of the population (approximately 67 million) will be 62 or older in 2020 and this will grow to 22 percent of the population (approximately 84 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 HECM secondary market increases 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 has been the largest portfolio investor of HECM loans. As of 2013Q1, Fannie Mae held for investment $50.2 billion in HECM loans representing about 57 percent of the HECM insurance in force.

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 HMBS compared to $5.1 billion in

FY 2009. The FY 2011 issuance level dropped to $10.8 billion, the FY 2012 level was $9.0 billion, and around $ 9.4 billion in FY2013.

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 2013 endorsement cohorts that were active at the end of FY 2013. 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 specifications. 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, 2013. 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 economy.com website. These data include the one-year and ten-year Treasury rates, and one-year LIBOR rates, and house median price, the unemployment rate, the purchase-only house price appreciation rates for the Federal Housing Finance Agency (FHFA) conventional and conforming loans. FHA provided estimates of borrower characteristics for future endorsements. The cash flow model used to estimate the present value of future cash flows on outstanding insurance tracks cash flows on a fiscal year basis.

## 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 2013 through FY 2020 MMI HECM portfolios. It also provides a step-by-step description 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 to 2013.
- 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 which was the basis of the simulation scenario as well as for six 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 projection.
- 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.

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## Section II. Summary of Findings

This section presents the economic values and projected insurance in force of the FY 2013 to FY 2020 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 losses. In addition to initial capital resources and net earnings through the 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 from future fiscal years.

### A. The FY 2013 Actuarial Review

The FY 2013 Actuarial Review assessed the actuarial soundness of the HECM portfolio in the MMI Fund as of the end of FY 2013 and projected the status of the portfolio through FY 2020. In this Review, we:

- Analyzed all HECM historical termination experience and the associated recoveries using loan-level HECM data maintained by FHA through June 2013.
- 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 and house price indices. These economic paths were calibrated to center around the baseline macroeconomic forecasts published by Moody's Analytics in July 2013.
- Estimated future cash flows associated with the FY 2013 to FY 2020 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 2013 through FY 2020, using expected cash flows from the Monte Carlo simulation and discount rates prescribed by OMB.
- Conducted scenario analysis using five scenarios from our Monte Carlo simulation paths and one of Moody's alternative scenarios.

The following is a summary of the major findings in this Review, as shown in Exhibit II-1. These findings come from the stochastic simulations 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 at the end of FY 2013 was estimated to be $6,541 million.
- The economic value of the HECM MMI portfolio was projected to improve steadily over the next seven years and become $15,378 million by FY 2020.

- 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 $87,672 million at the end of FY 2013 and was estimated to increase to $161,479 million by the end of FY 2020.

**Exhibit II-1. Economic Value, Insurance-In-Force, and Endorsements for FY 2013 through FY 2020 ($ Millions)**

| Fiscal Year* | Economic Value | Insurance in Force** | Volume of New Endorsements*** | Economic Value of Each New Endorsement Book | Investment Earnings on Fund Balance |
|---|---|---|---|---|---|
| 2013 | $6,541 | $87,672 | $14,331 | $395 | |
| 2014 | 7,523 | 96,480 | 13,850 | 969 | 13 |
| 2015 | 8,551 | 103,850 | 16,369 | 998 | 30 |
| 2016 | 9,643 | 115,229 | 17,806 | 1,002 | 91 |
| 2017 | 10,870 | 126,580 | 18,621 | 1,044 | 183 |
| 2018 | 12,260 | 137,810 | 19,665 | 1,106 | 284 |
| 2019 | 13,765 | 149,365 | 20,937 | 1,150 | 355 |
| 2020 | 15,378 | 161,479 | 22,317 | 1,195 | 419 |

* All values, except the volume of new endorsements, 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.

## B. Changes in the Economic Value

The FY 2012 HECM Review estimated that the HECM portfolio had an economic value of *negative* $2,799 million at the end of FY 2012 compared to the estimate of this year's Review of positive $6,541 million at the end of FY 2013. Exhibit II-2 shows the accounting line items that underlie the year-over-year change in value. Total HECM capital resources were reported to be $2,496 million at the end of FY 2012. Based on actual results through June 30, 2013, and projections from that time through September 31, 2013, the net insurance income, the net gains from investments, the net change in value of properties in inventory, mandatory appropriation, and transfer from the MMI Capital increased the HECM capital resources to $9,119 million. We estimated the net present value of future cash flows for surviving loans at the end of FY 2013 as *negative* $2,578 million. The economic value at the end of FY 2013 was therefore estimated as $6,541 million.

**Exhibit II-2. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2013 ($ Millions)**

| Item | End of FY2012[(1)] | End of FY2013 |
|---|---|---|
| Cash | $2,412 | |
| Investments | 0 | |
| Properties and Mortgages | 130 | |
| Other Assets and Receivables | 0 | |
| Total Assets | $2,542 | |
| Liabilities (Account Payables) | (46) | |
| Total Capital Resources | $2,496 | |
| Net Gain from Investment[(2)] | | $352 |
| Net Insurance Income in FY 2013[(3)] | | (38) |
| Net Change in Value of Property Inventory | | 328 |
| Net Change in Accounts Payable | | 33 |
| Mandatory Appropriation[(4)] | | 1,686 |
| Transfer to HECM Financing Account | | 4,263 |
| **Total Capital Resources as of EOY** | | **$9,119** |
| PV of Future Cash Flows on Outstanding Business | | -2,578 |
| **Economic Value** | | **$6,541** |
| | | |
| **Insurance- In- Force** | | **$87,672** |

(1) Source: Audited Financial Statements for FY 2012
(2) Net Gain from Investment is annualized based on the investment income from the Capital Reserve account and the interest income in the MMI Financing account as of July 2013
(3) Includes premium inflow and claim outflow during the fiscal year
(4) From the permanent indefinite Budget authority provided by the Federal Credit Reform Act of 1990

## C. Decomposition of the Differences in the FY 2013 Economic Value as Reported in the FY 2012 Review and the FY 2013 Review

The economic value of the HECM portfolio in the MMI Fund changed from *negative* $2,799 million in FY 2012 as estimated in the FY 2012 Review to positive $6,541 million in FY 2013 as reported in this year's Review, representing an increase in value of $9,340 million. This change resulted from data changes, economic forecast changes and modeling changes.

In Exhibit II-3, we present the step-by-step changes in the economic value from the FY 2012 Review to the FY 2013 Review. A similar analysis for FY 2019 is also included. Note that FY 2019 is the last projected fiscal year common to both Reviews.

The FY 2013 HECM portfolio economic value presented in the FY 2012 Review was *negative* $2,668 million. After updating the net change in Account Payable, the net change in value of properties in inventory, a $1,686 million mandatory appropriation, and transfer of $4,263 from the MMI Capital, as shown in the table, we describe the decomposition in more detail starting with the FY 2013 Fund valued at $1,351 million.

**Exhibit II-3. Sources of the Change in Economic Value for the HECM Portfolio in the MMI Fund between FY 2012 and FY 2013 ($ Millions)**

| Decomposition Steps | Change in FY 2013 Economic Value | FY2013 Economic Value | Change in FY 2019 Economic Value | FY 2019 Economic Value |
|---|---|---|---|---|
| FY 2012 Economic Value Presented in the FY 2012 Review | | -$2,799[(1)] | | |
| FY 2013 Economic Value Presented in the FY 2013 Review Excluding the FY 2013 Book-of-Business | -20 | -2,819[(1)] | | |
| Plus: Forecasted Value of FY 2013 Book-of-Business Presented in the FY 2012 Review | 151 | | | |
| Equals: FY 2013 Economic Value Presented in the FY 2012 Review | | -2,668 | | -426 |
| Plus: Updated Capital Resources as the End of FY2012 | -2,291 | -4,959 | -2,726 | -3,152 |
| Plus: Net Change in Value of Property Inventory | 328 | -4,631 | 390 | -2,761 |
| Plus: Net Change in Account Payable | 33 | -4,598 | 39 | -2,722 |
| Plus: Transfer from MMI Capital Account to Fund Budget Re-estimate | 4,263 | -335 | 5,072 | 2,350 |
| Plus: Mandatory Appropriation | 1,686 | 1,351 | 2,006 | 4,355 |
| Plus: a. Updated Origination Volume in FY 2012 and Later Books | 4 | 1,355 | -928 | 3,428 |
| Plus: b. Updated Discount Factors | 3,240 | 4,595 | 5,994 | 9,422 |
| Plus: c. Updated Forecasting Model | 137 | 4,732 | 3,554 | 12,976 |
| Plus: d. Updated New Program Starting from FY 2014 | -47 | 4,685 | -1,670 | 11,306 |
| Plus: e. Updated Economic Forecast: HPI and Purchase Only Index Replacement | 2,197 | 6,882 | 2,306 | 13,612 |
| Plus: f. Updated Economic Forecast: Interest Rates | 353 | 7,235 | 763 | 14,375 |
| Plus: g. Updated Loan Conveyance Projection | 234 | 7,469 | 303 | 14,678 |
| Plus: h. Updated Maintenance and Depreciation Forecast | -928 | 6,541 | -1,025 | 13,653 |
| Equals: Estimate of Economic Value | 9,209 | 6,541 | 14,079 | 13,653 |

(1) Economic value as of the end of FY 2012.

### a. Updated Endorsement Volumes in FY 2012 and Later Books

In the 2013 Review, the volume of endorsements occurring in FY 2012 and FY 2013 was approximately $2,106 million lower than the endorsement projections used in the 2012 Review. The lower volume doesn't have much effect in economic value of the FY2012 portfolio. However, lower volumes of projected future books reduce the economic value of the FY 2019 portfolio by $928 million.

### b. Updated FY 2014 Office of Management and Budget (OMB) Discount Factors

This decomposition step shows the effect of the updated FY2014 budget discount factors, which is released in November 2012. The latest OMB published discount factors are larger than the values used in last year's Review. (See Appendix C in each year's Review.) This change reflects lower interest rate assumptions and hence less discounting of future cash flows, as represented by the higher discount factors. The higher discount factors increase the present values of future positive and negative cash flows. The net impact of discount factors is a balance among these cash flow items. As HECM recoveries occur at much longer durations in the future than claims, the lower interest rate assumption in the long run has a larger impact on the cash inflows than outflows. As the result, the FY 2013 HECM economic value increased by $3,240 million and the FY 2019 HECM economic value increased by $5,994 million.

### c. Updated Forecasting Model

The updated valuation model decomposition step refers primarily to changes to projected cash flows resulting from model changes. However, it also includes all changes that were not or could not otherwise be separated in the decomposition analysis.

As discussed in Appendix A, we re-estimated the base termination model. Compared to last year's econometric models, the updated and enhanced termination rate models of this year have slower termination rate during the early years and faster termination rate during the later age of the loan. The asymmetry impact of the new termination models led to an increase in economic value in FY 2013 by $137 million, and an increase in economic value in FY 2019 by $3,554 million.

### d. Updated New Program starting from FY2014

Starting from FY 2014, a new HECM program will replace the previous Standard and Saver HECM programs. The annual MIP rate of 1.25 percent will remain the same, but the initial MIP will be determined based on the amount of the mortgagor's initial disbursement. Initial disbursement refers to the collective disbursements issued to a borrower within a twelve month period of the loan's closing date. Based on the amount of the mortgagor's initial disbursement at loan closing, an initial MIP of 0.50 percent of the maximum claim amount is charged when a mortgagor's initial disbursement is 60 percent or less of the available principal limit. An initial MIP of 2.50 percent of the maximum claim amount is charged when a mortgagor's initial disbursement is greater than 60 percent of the available principal limit.

This new program change will reduce the probability of refinance for the existing books due to the lower PLF and more stringent limit on the initial disbursement in the new program. Therefore it will reduce the economic value for the current books. For the future books, the new program reduces the initial cash draw and total cash amount available to borrowers, therefore, it will reduce the claim rate of HECMs and delay the timing of Type II claims. As a result, the new program will have a lower claim expenses for loan assignment. On the other hand, house price is predicted to improve in the future and this year's OMB discount rate discounts future cash flow by less compared with last year's[21]. Consequently, the recovery from the old program is larger than the new program. The impacts of claim expenses and recovery mostly offset each other between the new and old programs.

Since the UPB under the new program grows slower than the old program, and around 60 percent of the future loans are projected to have an initial disbursement equal or smaller than 60 percent, the premium income generated by the new program will be less than the old program. The net impact of the policy change is a reduction on the economic value of future books. The program change reduced the FY 2013 and FY 2019 economic values by $47 million and $1,670 million, respectively.

### e. Updated Economic Forecast: House Price Growth Rates and Purchase Only Index Replacement

The HECM portfolio is more concentrated in states that had higher short-term house price growth rates compared to last year's projection. The high-volume states of California, Texas, Florida and New York had an average increase of 2.20 percentage points in the short-term house price growth rate in this year's Review compared to the 1.99 percent of last year's Moody's forecast. The HECM portfolio values will remain very sensitive to house prices, which affect the incidence and severity of pre-assignment claims as well as post-assignment recovery values.

This year's Review replaces the all transaction (AT) house price index with the purchase only (PO) price index to better capture the trend of house price appreciation and housing market conditions. The PO index shows a higher short-term house price growth rate than the AT index. For instance, the average house price appreciation from FY 2012 to FY 2013 for the high-volume states (CA, TX, FL and NY) is 3.72 percentage points higher in the PO index than in the AT index. As a result, these two changes have a positive impact on the FY 2013 and the FY 2019 economic values: they are estimated to increase by $2,197 million and $2,306 million, respectively.

### f. Updated Economic Forecast: Interest Rates

One-year Treasury rates decreased since mid-2011 and are now forecasted by Moody's to remain much lower than last year's forecast level through 2019. Lower interest rates have offsetting effects: they increase loan endorsement volume and delay assignment dates. They also slow down the interest accrual on unpaid principal balances and hence they lower annual insurance premiums. The effects also depend on the product type. For example, fixed-rate HECM balances

[21] See Appendix C for details about the discount rate.

accrue depends on the HECM's initial ten-year Treasury rate, whereas adjustable-rate HECM balances accrue depends on the one-year Treasury or LIBOR rates. These offsetting effects resulted in increase of economic values in FY 2013 and FY 2019 of $353 million and $763 million, respectively.

### g. Updated Loan Conveyance Projection

A conveyance share model was developed for this year's Review (see Appendix B for details). Compared with last year's projection, this year predicts a lower conveyance percentage in the long run. Due to the higher expenses associated with the conveyance type termination, the adoption of the conveyance share model leads to increase in the economic values of the HECM portfolio by $234 million and $303 million for FY 2013 and FY 2019, respectively.

### h. Update Maintenance and Depreciation Forecast

A model of maintenance risk and house price depreciation was developed this year using actual sales prices of terminated HECMs. The model provides a direct measure of maintenance risk adjustment factors for projected HECM home sales prices[22]. The model predicts a higher house price depreciation adjustment in the short run than what was assumed in last year's maintenance risk factors. The net impact on the HECM portfolio is a $928 million decrease in the FY 2013 economic value and a $1,025 million decrease in the FY 2019 economic value.

[22] Please refer to Appendix B of this year's Review for details of the new model and AR2012 for last year's maintenance risk factors.

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## Section III. Current Status of HECMs in the MMI Fund

This section presents the components of the economic value for FY 2013 and also the projections through FY 2020. The HECM portion of the MMI Fund has an estimated economic value of $6,541 million at the end of FY 2013. The economic value and the insurance-in-force of the HECM program are both projected to increase over time.

### 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 2013. Exhibit III-1 presents the components of the economic value for FY 2013.[23] Data through June 2013 was annualized to estimate the total capital resources and the loan performance to the end of FY 2013. The total economic value consists of the following components:

- *Total Capital Resources* equals assets less liabilities in FY 2012 plus additional cash available from investments, fund transfers, and operational activities during FY 2013. We estimated the total capital resources to be $9,119 million at the end of FY 2013, which consists of the following components:

    - *Total Assets* include cash and other assets, Treasury investments, and properties and notes held by FHA. The total assets were $2,542 million as of the end of FY 2012.

    - *Total Liabilities* include the accounts payable. This is $46 million as of the end of FY 2012.

    - *Net Gain from Investments* includes the estimated revenue from the investment of capital resources and the interest from the HECM Financing Account during FY 2013. The total investment gain is $352 million.

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

- *Net Insurance Income in FY 2013* includes the estimated premiums, claims and recoveries, derived by annualizing the year-to-date data for FY 2013. The net insurance income for FY 2013 from the still-active FY 2009 through FY 2013 endorsements is *negative* $38 million.

- *Net Change in Value of Property Inventory* refers to the change in the value of the inventory of HECM-funded properties that are held by FHA. The value of properties in inventory is projected to increase by $328 million by the end of FY 2013, largely due to the increase in the number of such properties.

- *Net Change in Accounts Payable* is the change in the balance in Accounts Payable from the beginning to the end of FY 2013. It is $33 million.

- *Mandatory Appropriation* is $1,686 million in FY2013.

- *Transfer to HECM Financing Account*, which is the transfer of funds from the MMI Capital Reserve account to the HECM Financing Account, is $4,263 million in FY 2013.

- *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 *negative* $2,578 million as of the end of FY 2013.

**Exhibit III-1. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2013 ($ Millions)**

| Item | End of FY2012[(1)] | End of FY2013 |
|---|---|---|
| Cash | $2,412 | |
| Investments | 0 | |
| Properties and Mortgages | 130 | |
| Other Assets and Receivables | 0 | |
| Total Assets | $2,542 | |
| Liabilities (Account Payables) | (46) | |
| Total Capital Resources | $2,496 | |
| Net Gain from Investment[(2)] | | $352 |
| Net Insurance Income in FY 2013[(3)] | | (38) |
| Net Change in Value of Property Inventory | | 328 |
| Net Change in Accounts Payable | | 33 |
| Mandatory Appropriation [(4)] | | 1,686 |
| Transfer to HECM Financing Account | | 4,263 |
| **Total Capital Resources as of EOY** | | **$9,119** |
| PV of Future Cash Flows on Outstanding Business | | -2,578 |
| **Economic Value** | | **$6,541** |
| | | |
| **Insurance-In-Force** | | **$87,672** |

(1) Source: Audited Financial Statements for FY 2012.

(2) Net Gain from Investment is annualized based on the investment income from the Capital Reserve account and the interest income in the MMI Financing account as of July 2013.
(3) Includes premium inflow and claim outflow during the fiscal year.
(4) From the permanent indefinite Budget authority provided by the Federal Credit Reform Act of 1990.

### 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 2013. 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 HECM, using the current loan balances to estimate the IIF could over- or 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 can pay out at insurance termination. Therefore, we use MCA as the measure of IIF.

At the end of FY 2013, the estimated IIF for originations occurring in FYs 2009 through 2013 are, respectively, $25.67 billion, $18.49 billion, $16.63 billion, $12.55 billion and $14.33 billion, for a total of $87.67 billion.

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

In this section, we present the forecasts of the future economic values and insurance-in-force projections for MMI HECMs. We estimated these future values by applying our termination 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 loan-level composition of future endorsements.

Exhibit III-2 shows the estimated economic value 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 $6,541 million in FY 2013 to $15,378 million in FY 2020, as shown in the first column of Exhibit III-2. This increase is due mainly to the projected positive economic value brought to the Fund by new endorsements. The initial disbursement limitation and the strong housing market recovery make these newer books profitable.

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

With the addition of new endorsements, the total insurance-in-force is estimated to increase from $87,672 million at the end of FY 2013 to $161,479 million in FY 2020. This represents an average increase of $10,544 million per year.

**Exhibit III-2. Projected 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 |
|---|---|---|---|---|---|
| 2013 | $6,541 | $87,672 | $14,331 | $395 | |
| 2014 | 7,523 | 96,480 | 13,850 | 969 | 13 |
| 2015 | 8,551 | 103,850 | 16,369 | 998 | 30 |
| 2016 | 9,643 | 115,229 | 17,806 | 1,002 | 91 |
| 2017 | 10,870 | 126,580 | 18,621 | 1,044 | 183 |
| 2018 | 12,260 | 137,810 | 19,665 | 1,106 | 284 |
| 2019 | 13,765 | 149,365 | 20,937 | 1,150 | 355 |
| 2020 | 15,378 | 161,479 | 22,317 | 1,195 | 419 |

* All values, except the volume of new endorsements, 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 by the demand volume forecast model in Appendix E.

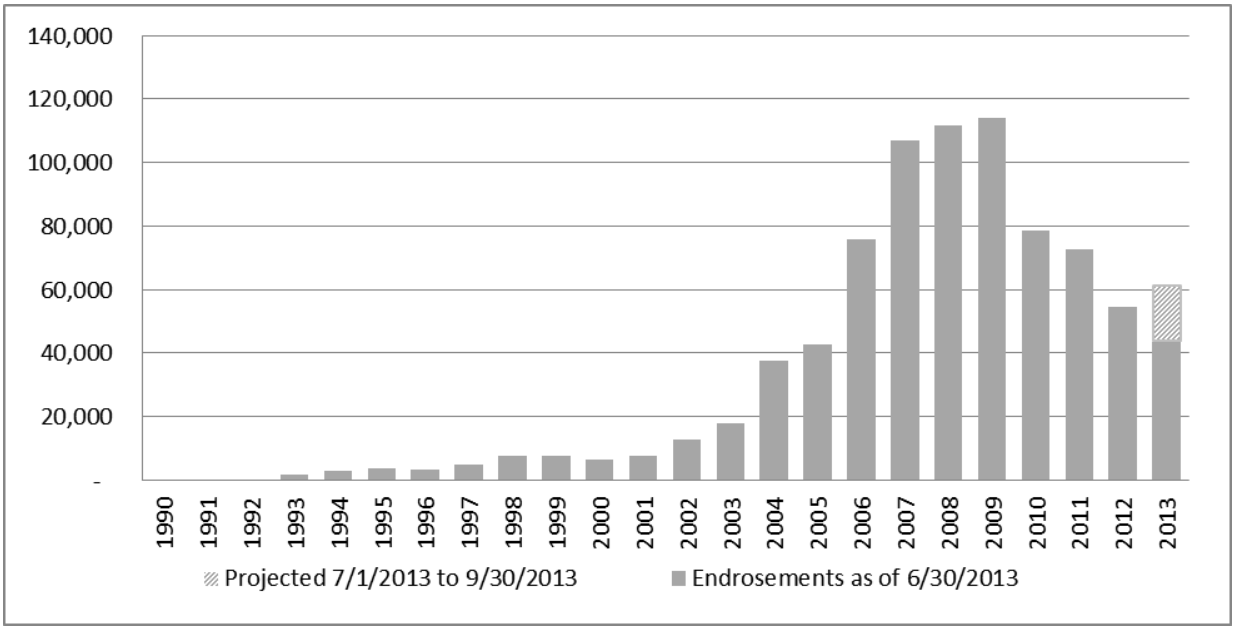
## Section IV. Characteristics of the MMI HECM Books of Business

This section presents the characteristics of the HECM portfolio for the HECM loans endorsed from FY 2009 through FY 2013. This is because HECM loans were included in the MMI Fund starting from FY2009. The loans from these books of business that have not terminated constitute the MMI HECM portfolio as of the end of FY 2013. 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, 2013.

### A. Volume and Share of Mortgage Originations

FHA endorsed 43,916 HECM loans from October 1, 2012 to June 30, 2013, with a total dollar value, defined as the MCA, of $10.66 billion. FHA estimates that the total annual endorsements in FY 2013 will be 61,296 and the corresponding dollar value will be $14.88 billion. The number of endorsements in FYs 2009-2012 were 114,412; 79,056; 73,114 and 54,816; respectively. The corresponding dollar values were $30.07 billion, $21.07 billion, $18.21 billion and $13.16 billion. Since the inception of the HECM program, this program has been the largest reverse mortgage product in the US market, representing more than 90 percent of total 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, *e.g*., term, line of credit, tenure and combinations. Exhibit IV-2 presents the distributions of HECM endorsement between FYs 2009 and 2013 by payment plan. Compared with last year's Review, the line of credit and lump sum options are combined as one category (line of credit) in this year's calculation. As of June 30, 2013, the majority of HECM borrowers selected the line of credit option. This option accounted for 95 percent of the FY 2013 endorsements.

**Exhibit IV-2. Distribution of FY 2009-FY 2013 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 | 1,107 | 104,334 | 2,088 | 4,310 | 2,572 | 114,412 |
| | Percentage | 0.97% | 91.19% | 1.83% | 3.77% | 2.25% | 100.00% |
| 2010 | Number of Loans | 443 | 74,162 | 896 | 2,198 | 1,357 | 79,056 |
| | Percentage | 0.56% | 93.81% | 1.13% | 2.78% | 1.72% | 100.0% |
| 2011 | Number of Loans | 386 | 68,765 | 829 | 1,967 | 1,167 | 73,114 |
| | Percentage | 0.05% | 94.05% | 1.13% | 2.69% | 1.60% | 100.00% |
| 2012 | Number of Loans | 255 | 51,707 | 645 | 1,363 | 846 | 54,816 |
| | Percentage | 0.05% | 94.33% | 1.18% | 2.49% | 1.54% | 100.00% |
| 2013 | Number of Loans | 302 | 41710 | 558 | 758 | 588 | 43,916 |
| | Percentage | 0.69% | 94.98% | 1.27% | 1.73% | 1.34% | 100.00% |

## C. Interest Rate Type

HECM borrowers can select fixed or adjustable rate mortgages. Exhibit IV-3 shows the distribution of HECM endorsements over FYs 2009 to 2013 by interest rate type. The majority of HECM borrowers (88 percent) 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 stabilized at 69 percent of endorsements in FY 2011 and FY 2012 and climbed to 72 percent of endorsements in FY 2013.

The LIBOR-indexed loans constituted 35 percent, 31 percent, 32 percent, 30 percent and 25 percent of the FY 2009 through FY 2013 HECM endorsements, respectively. FHA introduced LIBOR as a HECM index option on October 12, 2007. LIBOR-indexed endorsements have decreased since FY2009.

**Exhibit IV-3. Distribution of FY 2009-FY 2013 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 | 39,629 | 699 | 60,752 | 13,309 | 114,412 |
| | Percentage | 0.02% | 34.64% | 0.61% | 53.10% | 11.63% | 100% |
| 2010 | Number of Loans | 7 | 24,171 | 9 | 400 | 54,469 | 79,056 |
| | Percentage | 0.00% | 30.57% | 0.01% | 0.51% | 68.90% | 100% |
| 2011 | Number of Loans | 8 | 23,314 | 2 | 47 | 49,742 | 73,114 |
| | Percentage | 0.01% | 31.89% | 0.00% | 0.06% | 68.04% | 100% |
| 2012 | Number of Loans | 3 | 16,663 | 5 | 100 | 38,044 | 54,816 |
| | Percentage | 0.00% | 30.40% | 0.00% | 0.18% | 69.40% | 100% |
| 2013 | Number of Loans | 3 | 11,074 | - | 1119 | 31720 | 43,916 |
| | Percentage | 0.01% | 25.22% | | 2.55% | 72.23% | 100% |

## D. Product Type

Almost all of the loans endorsed in FY 2009 through FY 2013 are "traditional" HECMs, where the borrowers had purchased their homes prior to taking out the reverse mortgage. A new 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 represent a small portion of the total FYs 2009 through 2013 HECM endorsements, as seen in Exhibit IV-4.

**Exhibit IV-4. Distribution of FY 2009-FY 2013 HECM Loans by Product Type**

| FY | Product Type | Traditional HECMs | HECM 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 | 113,854 | 84 | 474 | 114,412 |
| | Percentage | 99.51% | 0.07% | 0.41% | 100% |
| 2010 | Number of Loans | 77,667 | 199 | 1,190 | 79,056 |
| | Percentage | 98.24% | 0.25% | 1.51% | 100% |
| 2011 | Number of Loans | 71,576 | 326 | 1,212 | 73,114 |
| | Percentage | 97.90% | 0.45% | 1.66% | 100% |
| 2012 | Number of Loans | 53,188 | 390 | 1,238 | 54,816 |
| | Percentage | 97.03% | 0.71% | 2.26% | 100% |
| 2013 | Number of Loans | 42,414 | 56 | 1,446 | 43,916 |
| | Percentage | 96.58% | 0.13% | 3.29% | 100% |

## E. Endorsement Loan Counts by State

Among all endorsements between FY 2009 and FY 2013, approximately 36 percent were originated in California, Florida, Texas, and New York as measured by loan counts. California had the highest endorsement volume from FY 2009 to 2013 at 13.7 percent, 14 percent, 13.5 percent, 12.7 percent, and 13.5 percent respectively. While Florida had the second highest endorsement volume in both FY 2009 and FY 2010, the percentage in FY 2010 decreased by more than one-third, from 13.2 percent of the previous year to 9.0 percent. Its volume continued to drop to 6.8 percent in FY 2011, 6.2 percent in FY 2012 and 6.4 percent in FY 2013. The endorsement volume in Texas increased steadily from FY 2009 to 2013 and has been the second highest state of endorsement volume since FY 2011. 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 2013 HECM Loans**

| FY | State | California | Florida | New York | Texas | Total |
|---|---|---|---|---|---|---|
| 2009 | Number of Loans | 15,658 | 15,091 | 6,085 | 7,591 | 114,412 |
| | Percentage | 13.7% | 13.2% | 5.3% | 6.6% | |
| 2010 | Number of Loans | 11,059 | 7,109 | 4,624 | 6,307 | 79,056 |
| | Percentage | 14.0% | 9.0% | 5.8% | 8.0% | |
| 2011 | Number of Loans | 9,852 | 4,971 | 4,342 | 6,671 | 73,114 |
| | Percentage | 13.5% | 6.8% | 5.9% | 9.1% | |
| 2012 | Number of Loans | 6,961 | 3,369 | 3,944 | 4,898 | 54,816 |
| | Percentage | 12.7% | 6.1% | 7.2% | 8.9% | |
| 2013 | Number of Loans | 5,921 | 2,794 | 2,840 | 3,862 | 43,916 |
| | Percentage | 13.5% | 6.4% | 6.5% | 8.8% | |

## 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 appraisal). 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 between FYs 2009 and 2013 by MCA. Approximately 69 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 number of loans with MCA less than $300,000 increased to 70 percent in FY 2011, 71.9 percent in FY 2012, and 71.3 percent in FY 2013.

The percentage of endorsements with an MCA between $300,000 and $417,000 dropped from 19 percent in 2009 to 13 percent in 2011, and remained around 13 percent from 2011 to 2013. The percentage of endorsements with an MCA greater than $417,000 decreased from 20 percent in 2010 to 17 percent in 2011 and further dropped to 16 percent in 2012 and 2013. The primary driver for this decrease is the shift of endorsements from historically high-cost areas like Florida, to the lower-cost areas like Texas and the Midwestern states.

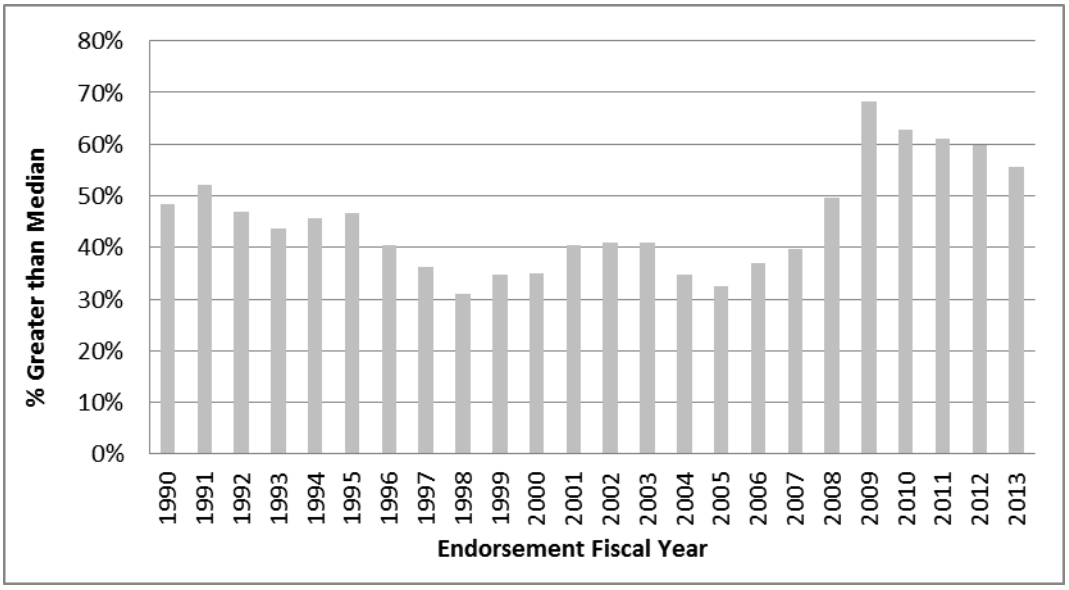
**Exhibit IV-6. Distribution of FY 2009-FY 2013 HECM Loans by MCA Level**

| FY | Less Than $100k | $100k to $200k | $200k to $300k | $300k to $417k | Greater Than $417k | Total |
|---|---|---|---|---|---|---|
| **2009** | 10.2% | 34.2% | 24.5% | 18.9% | 12.1% | 100% |
| **2010** | 12.1% | 34.0% | 20.0% | 13.8% | 20.1% | 100% |
| **2011** | 14.9% | 35.7% | 19.4% | 12.9% | 17.1% | 100% |
| **2012** | 16.1% | 37.0% | 18.8% | 12.6% | 15.5% | 100% |
| **2013** | 15.9% | 36.6% | 18.8% | 13.0% | 15.7% | 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 have lower home maintenance risk than those below the area median. Exhibit IV-7 shows the percentage of HECM borrowers 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, 68 percent of the HECM properties were appraised at higher than the area median. In the FY 2010 and FY 2011 endorsement books-of-business, 62 and 61 percent of the HECM properties were appraised at higher than the area median, respectively. Properties with higher than the area median appraisal value fell to 60 percent and 57 percent of all endorsements in FY 2012 and FY 2013, respectively.

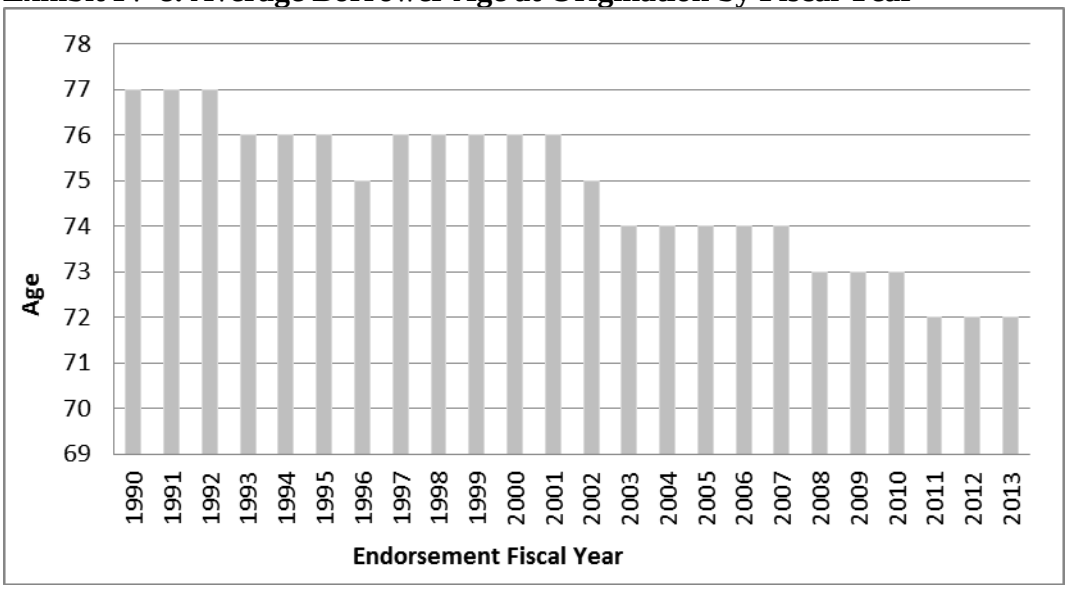
**Exhibit IV-7. Percentage of Borrowers with Appraised House Value Greater than Area Median Value**



## 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 from FY 1990 to 2013 endorsements (recall that only endorsements in FY 2009 and later are part of the MMI Fund). The average borrower age has declined over time. This indicates that HECMs are becoming more popular with relatively younger borrowers. 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 (See Section I), are lower for younger borrowers, limiting them to a smaller portion of their equity. The average borrower age was about 73 years for FYs 2009-2010 endorsements, and 72 years for FYs 2011-2013 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, and possibly other factors. The gender distribution of the HECM portfolio has remained steady over time. HECM loan behavior indicates that males tend to terminate their loans the fastest, females terminate the second fastest, and couples terminate the slowest. Exhibit IV-9 presents the gender distribution of HECM endorsements from FY 2009 to 2013. Females comprise the largest gender cohort of the FY 2009 endorsements at 41 percent, followed by couples at 37 percent, and males at 22 percent. A similar distribution pattern is observed for FYs 2010, 2011 and 2012 endorsements. Among the FY 2013 endorsements, couples comprise 39 percent, the first time surpassing females to become the largest gender cohort. The female share reduced to 38 percent while males remain the lowest at 21 percent, about the same as prior years.

**Exhibit IV-9. Distribution of FY 2009-FY 2013 HECM Endorsements by Gender**

| Endorsement Fiscal Year | Male | Female | Couple | Missing |
|---|---|---|---|---|
| **2009** | 21.7% | 40.9% | 36.8% | 0.6% |
| **2010** | 21.5% | 41.9% | 35.3% | 1.3% |
| **2011** | 20.9% | 40.3% | 37.1% | 1.7% |
| **2012** | 21.2% | 39.2% | 37.4% | 2.2% |
| **2013** | 21.1% | 37.7% | 38.8% | 2.4% |

## J. Cash Draw Distribution

Data show that loans which have drawn a higher percentage of the initial amount of equity available 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 to FY 2013.

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 the initial principal limit, compared with 44 percent of 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 during the FY 2010-2012 endorsements. This was mainly driven by the disproportionally high initial draws required by most fixed-rate HECMs during that period. This trend reversed dramatically in FY 2013, where only 39 percent of the 62-65 age group drew over 80 percent of the initial principal limit compared to 30 percent for greater-than-85 years-old age group. Only about 36 percent of the FY 2013 book of business is associated with initial draws greater than 80 percent of the principal limit.

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 their longer life expectancy.

**Exhibit IV-10. First-Month Borrower Cash Draw of FY 2009-FY 2013 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 | 23,708 | 12.00% | 24.20% | 50.20% | 0.50% | 13.10% |
| | 66-70 | 28,211 | 14.60% | 24.80% | 47.60% | 0.40% | 12.70% |
| | 71-75 | 24,929 | 19.00% | 24.90% | 44.80% | 0.30% | 11.10% |
| | 76-85 | 28,897 | 24.70% | 24.40% | 40.80% | 0.30% | 9.70% |
| | 85+ | 8,667 | 35.40% | 20.30% | 36.30% | 0.20% | 7.60% |
| | Total | 114,412 | 19.10% | 23.80% | 45.50% | 0.30% | 11.30% |
| 2010 | 62-65 | 17647 | 7.40% | 8.10% | 4.30% | 1.30% | 79.00% |
| | 66-70 | 18,821 | 9.30% | 9.70% | 5.20% | 1.30% | 75.00% |
| | 71-75 | 16,651 | 13.50% | 11.50% | 5.80% | 1.00% | 67.30% |
| | 76-85 | 19,450 | 19.90% | 14.10% | 6.80% | 1.00% | 58.70% |
| | 85+ | 6,487 | 31.70% | 14.50% | 8.60% | 0.70% | 44.70% |
| | Total | 79,056 | 14.20% | 11.20% | 5.70% | 1.00% | 68.10% |
| 2011 | 62-65 | 18,804 | 8.60% | 10.20% | 5.10% | 1.10% | 77.70% |
| | 66-70 | 18,809 | 11.00% | 10.80% | 5.00% | 1.10% | 74.80% |
| | 71-75 | 14,799 | 15.70% | 11.90% | 5.00% | 0.90% | 68.80% |
| | 76-85 | 16,055 | 22.60% | 13.90% | 5.30% | 0.90% | 59.10% |
| | 85+ | 5,447 | 36.20% | 13.20% | 5.60% | 0.50% | 45.50% |
| | Total | 73,114 | 15.80% | 11.50% | 5.10% | 1.00% | 66.30% |
| 2012 | 62-65 | 15,269 | 8.70% | 10.20% | 5.40% | 2.60% | 73.00% |
| | 66-70 | 13,490 | 11.20% | 10.20% | 4.40% | 2.50% | 71.70% |
| | 71-75 | 10,526 | 14.60% | 11.40% | 4.30% | 2.40% | 66.30% |
| | 76-85 | 11,437 | 20.90% | 12.00% | 4.80% | 2.60% | 60.00% |
| | 85+ | 4,094 | 33.10% | 12.70% | 4.90% | 2.30% | 46.90% |
| | Total | 54,816 | 14.80% | 11.00% | 4.80% | 2.50% | 66.90% |
| 2013 | 62-65 | 12,407 | 14.32% | 5.25% | 2.60% | 41.80% | 35.90% |
| | 66-70 | 11,191 | 16.01% | 5.09% | 2.36% | 40.70% | 35.90% |
| | 71-75 | 8,563 | 19.79% | 5.79% | 2.23% | 39.00% | 33.10% |
| | 76-85 | 8,856 | 25.90% | 6.59% | 2.70% | 33.40% | 31.40% |
| | 85+ | 2,899 | 36.10% | 5.90% | 2.90% | 27.90% | 27.10% |
| | Total | 43,916 | 19.60% | 5.60% | 2.60% | 38.40% | 33.80% |

## Section V. HECM Performance under Alternative Scenarios

The realized economic value of HECM will vary from the Review's estimate if the drivers of loan performance deviate from the baseline case projections. In this section, we present the baseline case economic value from the Monte Carlo simulation and six 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 rate 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 2013. The six alternative scenarios are[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 2013.

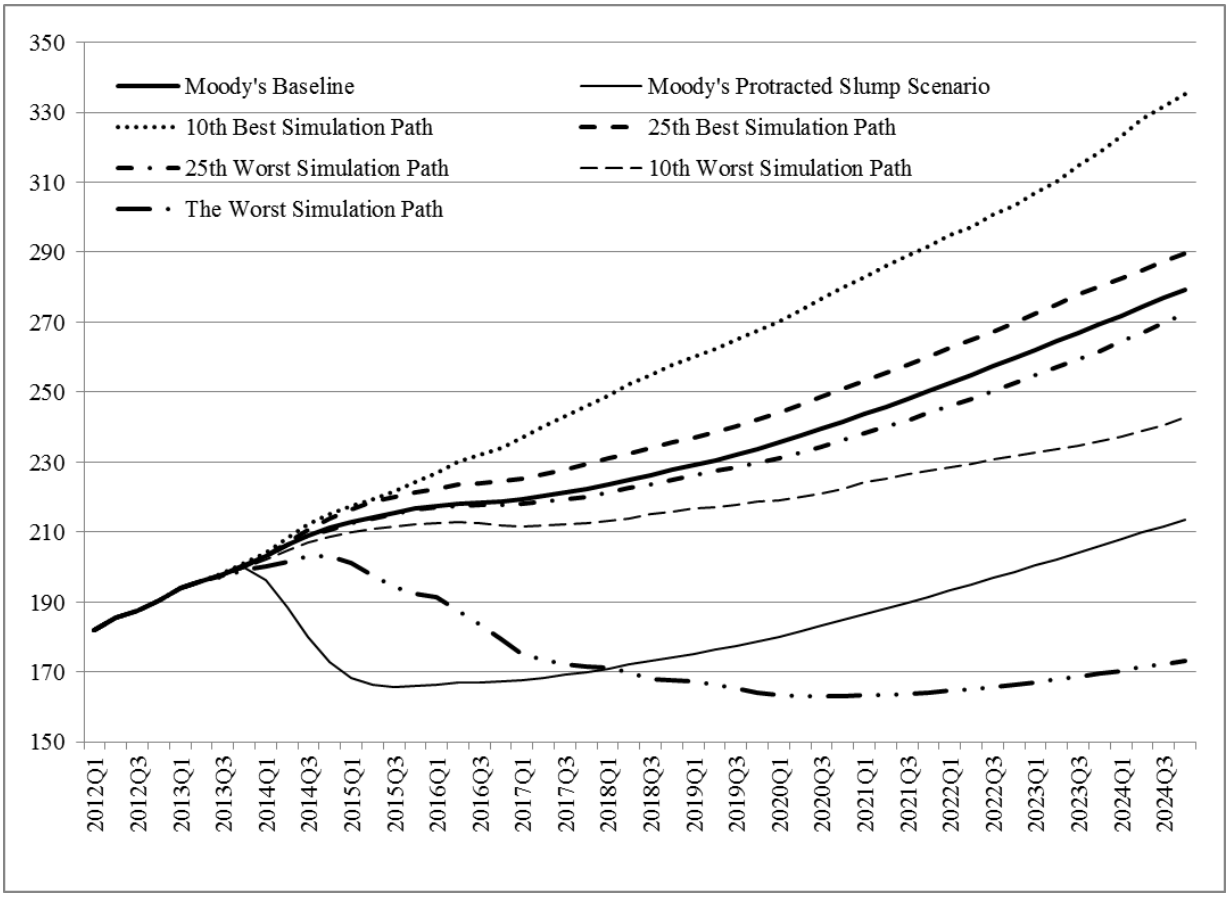
Under Moody's protracted slump scenario, the levels of the house price indices converge to a long-term index level similar to its baseline forecast. As a result, this scenario shows low house price growth rates in the short-term, followed by higher growth after it passes the lowest point. We applied a similar adjustment to this methodology as we did last year, where the growth rates converge to long-run growth rates, instead of the Moody's methodology where indices converge to their long-term levels. This adjustment avoids having the stress scenarios 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.

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. As noted in Section I,

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

this year 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 one-year and ten-year Treasury rates and the one-year and ten-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 based on the 1999-2001 U.S. Decennial Life Tables published by the Center for Disease Control and Prevention in 2004. 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 value from FY 2013 through FY 2020 from our Monte Carlo simulation. This is our baseline case. Recall that this involves taking the average of 100 randomly simulated paths.[26] The estimated economic value of the HECM

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

portfolio in the MMI Fund at the end of FY 2013 is $6,541 million, and its economic value is projected to grow steadily to $15,378 million by the end of FY 2020.

**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 |
|---|---|---|---|---|---|
| 2013 | $6,541 | $87,672 | $14,331 | $395 | |
| 2014 | 7,523 | 96,480 | 13,850 | 969 | 13 |
| 2015 | 8,551 | 103,850 | 16,369 | 998 | 30 |
| 2016 | 9,643 | 115,229 | 17,806 | 1,002 | 91 |
| 2017 | 10,870 | 126,580 | 18,621 | 1,044 | 183 |
| 2018 | 12,260 | 137,810 | 19,665 | 1,106 | 284 |
| 2019 | 13,765 | 149,365 | 20,937 | 1,150 | 355 |
| 2020 | 15,378 | 161,479 | 22,317 | 1,195 | 419 |

* All values, except the volume of new endorsements, 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.

The impact of each of the alternative scenarios on the performance of the HECM portion of the MMI Fund is now presented.

## A. Selected Scenarios from Monte Carlo Simulation

The Monte Carlo simulation approach provided additional information about the probability distribution of the economic value of HECM 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 provided the economic value associated with each one of the 100 possible future economic paths. In other words, the simulation is composed of 100 different scenario analyses. The distribution of economic values based on these scenarios allowed us to gain insights into the sensitivity of the Fund's economic value to different economic conditions.

Exhibit V-3 presents the projected economic values for FY 2013 to FY 2020 under five different simulated future economic paths. The 10$^{th}$ best economic value at the end of FY 2013 is estimated to be $14,542 million. Compared with the baseline result (the mean across the 100 paths), the estimated economic value is $8,001 million 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 $14,542 million.

The projected economic value for FY 2013 under the 10$^{th}$ worst simulated path is *negative* $1,521 million. 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 $1,521 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* $1,521 and positive $14,542 million in FY 2013. From these two scenarios, we observe that the downside risk of HECM economic value is almost equal to the upside potential. This indicates that HECM net revenues are very sensitive to the economic conditions. When market conditions deteriorate, claim severity increases and recoveries decrease; on the other hand, when market conditions improve, claim severity decreases and recoveries increase.

Under the 25th best scenario, the HECM economic value is projected to be positive $9,914 million in FY 2013, whereas the economic value under the 25th worst scenario is projected to be positive $2,696 million. These two alternative scenarios suggest that there is a 50 percent chance that the economic value of the HECM portfolio would be between positive $2,696 million and positive $9,914 million in FY 2013. Under the worst scenario, the economic value is *negative* $17,026 million in FY 2013. This is an extreme depression-like scenario with very low probability to occur.

**Exhibit V-3. HECM Economic Value under Different Simulated 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 |
|---|---|---|---|---|---|---|
| 2013 | $6,541 | $14,542 | $9,914 | $2,696 | -$1,521 | -$17,026 |
| 2014 | 7,523 | 15,238 | 10,904 | 3,724 | -947 | -16,485 |
| 2015 | 8,551 | 16,010 | 11,968 | 4,826 | -446 | -15,874 |
| 2016 | 9,643 | 17,003 | 13,229 | 5,920 | 214 | -15,378 |
| 2017 | 10,870 | 18,264 | 14,653 | 7,052 | 953 | -15,077 |
| 2018 | 12,260 | 20,018 | 15,870 | 8,274 | 1,867 | -14,827 |
| 2019 | 13,765 | 21,922 | 17,240 | 9,399 | 3,125 | -14,581 |
| 2020 | 15,378 | 23,763 | 19,086 | 10,830 | 4,503 | -14,312 |

The impact of each of the simulated scenarios on the performance of the HECM portion of the MMI Fund is presented in Exhibit V-4 to V-8.

Exhibit V-4 presents the projected economic values for FY 2013 through FY 2020 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 2013 and FY 2020 are estimated to be positive $14,542 million and positive $23,763 million, respectively. The high economic value in this alternative path is generated by a stable and moderate house price appreciation rate before FY 2016 and a high house price appreciation after FY 2016. This creates low claim losses and high recoveries. As a result, it led to the highest economic value among the six presented scenarios through FY 2020.

**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 |
|---|---|---|---|---|---|
| 2013 | $14,542 | $86,171 | $14,966 | $1,600 | |
| 2014 | 15,238 | 99,609 | 13,482 | 667 | 29 |
| 2015 | 16,010 | 115,949 | 16,419 | 711 | 61 |
| 2016 | 17,003 | 134,517 | 18,628 | 823 | 169 |
| 2017 | 18,264 | 155,063 | 20,609 | 938 | 323 |
| 2018 | 20,018 | 177,673 | 22,699 | 1,278 | 477 |
| 2019 | 21,922 | 202,019 | 24,442 | 1,323 | 580 |
| 2020 | 23,763 | 227,818 | 25,901 | 1,174 | 668 |

Exhibit V-5 presents the projected economic values for FY 2013 through FY 2020 under the 25th best simulated path. The economic values at the end of FY 2013 and at the end of FY 2020 are estimated to be positive $9,914 million and positive $19,086 million, respectively. The FY 2013 economic value under this scenario is $4,628 million less than the FY2013 economic value under the 10th best scenario. This alternative path has faster house price appreciation before FY 2016 and a milder house price appreciation rate thereafter. This also creates relatively low claim losses and high recoveries.

**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 |
|---|---|---|---|---|---|
| 2013 | $9,914 | $87,968 | $14,750 | $958 | |
| 2014 | 10,904 | 101,937 | 14,013 | 971 | 20 |
| 2015 | 11,968 | 118,908 | 17,058 | 1,020 | 44 |
| 2016 | 13,229 | 137,638 | 18,792 | 1,134 | 127 |
| 2017 | 14,653 | 157,220 | 19,658 | 1,173 | 251 |
| 2018 | 15,870 | 177,926 | 20,780 | 835 | 382 |
| 2019 | 17,240 | 199,830 | 21,992 | 910 | 460 |
| 2020 | 19,086 | 223,054 | 23,334 | 1,321 | 525 |

Exhibit V-6 presents the projected economic values for FY 2013 through FY 2020 under the 25th worst simulated path. Under this path, house prices appreciate at a slow rate and experience a drop during FY 2016. Consequently, this path projects a relatively low economic value through FY 2020. The economic values at the end of FY 2013 and at the end of FY 2020 are estimated to be positive $2,696 million and positive $10,830 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 |
|---|---|---|---|---|---|
| 2013 | $2,696 | $85,219 | $13,800 | -$202 | |
| 2014 | 3,724 | 98,816 | 13,649 | 1,022 | 5 |
| 2015 | 4,826 | 114,813 | 16,089 | 1,087 | 15 |
| 2016 | 5,920 | 132,287 | 17,541 | 1,043 | 51 |
| 2017 | 7,052 | 150,393 | 18,178 | 1,020 | 112 |
| 2018 | 8,274 | 169,331 | 19,022 | 1,038 | 184 |
| 2019 | 9,399 | 189,388 | 20,131 | 885 | 240 |
| 2020 | 10,830 | 210,529 | 21,243 | 1,145 | 286 |

Exhibit V-7 presents the projected economic values for FY 2013 through FY 2020 under the 10th worst simulated path. Under this path, house prices appreciate slowly until FY 2016. In 2016, house prices drop and then stay low for the rest of the period. As a result, the economic value under the 10th worst path projects a low economic value through FY 2020. The economic values at the end of FY 2013 and FY 2020 are estimated to be *negative* $1,521 million and positive $4,503 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 |
|---|---|---|---|---|---|
| 2013 | -$1,521 | $86,378 | $14,094 | -$692 | |
| 2014 | -947 | 99,793 | 13,458 | 577 | -3 |
| 2015 | -446 | 115,359 | 15,649 | 505 | -4 |
| 2016 | 214 | 132,080 | 16,795 | 664 | -5 |
| 2017 | 953 | 149,168 | 17,184 | 735 | 4 |
| 2018 | 1,867 | 166,858 | 17,785 | 890 | 25 |
| 2019 | 3,125 | 185,472 | 18,728 | 1,203 | 54 |
| 2020 | 4,503 | 204,884 | 19,520 | 1,283 | 95 |

Exhibit V-8 presents the projected economic values as for FY 2013 through FY 2020 under the worst simulated path. This stress path has a long protracted house price decrease until FY 2020 and very slow house price growth afterwards. This creates a severe claim loss 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 2013 and FY 2020 are estimated to be *negative* $17,026 million and *negative* $14,312 million, respectively.

**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 |
|---|---|---|---|---|---|
| 2013 | -$17,026 | $87,685 | $14,119 | -$3,181 | |
| 2014 | -16,485 | 101,446 | 13,806 | 575 | -34 |
| 2015 | -15,874 | 116,273 | 14,914 | 677 | -66 |
| 2016 | -15,378 | 130,269 | 14,052 | 664 | -168 |
| 2017 | -15,077 | 142,789 | 12,576 | 593 | -292 |
| 2018 | -14,827 | 155,143 | 12,418 | 644 | -394 |
| 2019 | -14,581 | 167,834 | 12,759 | 675 | -430 |
| 2020 | -14,312 | 180,761 | 13,003 | 714 | -444 |

## B. Moody's Protracted Slump Scenario

Exhibit V-9 presents the estimated economic value of HECM 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 2013 decreases from the base case positive $6,541 million to *negative* $7,894 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 2020 value is about $18,940 million lower than in the baseline scenario. The protracted slump scenario projects an economic value that corresponds approximately to the 5$^{th}$ worst economic value in our simulation, so the projected economic values lie between those of the 10$^{th}$ worst path and the worst path from our 100 simulated paths.

**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 |
|---|---|---|---|---|---|
| 2013 | -$7,894 | $87,672 | $14,331 | -$1,791 | |
| 2014 | -7,186 | 96,013 | 12,445 | 724 | -16 |
| 2015 | -6,611 | 97,930 | 10,199 | 604 | -29 |
| 2016 | -6,055 | 102,896 | 10,563 | 626 | -70 |
| 2017 | -5,510 | 109,122 | 11,910 | 660 | -115 |
| 2018 | -4,944 | 116,429 | 13,362 | 710 | -144 |
| 2019 | -4,306 | 124,554 | 14,852 | 782 | -143 |
| 2020 | -3,562 | 133,384 | 16,354 | 874 | -131 |

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## 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, move-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 structure 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 national loan limit at the time of origination.
- Dynamic variables based entirely on loan/borrower characteristics: loan age, updated borrower's age (i.e., policy year and termination rates).
- 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 projected termination rates for the outstanding endorsement portfolio at the end of FY 2013. For future

books' economic values, we also used projections of the composition and volume of future endorsements. Each loan creates annual observations from its origin to the policy year when the loan reaches 35 years old, the maximum assumed duration of a HECM loan. The assumed characteristics of the future HECM endorsements for FY 2014 through FY 2020 followed FHA's projections.

## C. HECM Cash Flow Analysis (Appendix C)

The cash flow model estimates the HECM economic values for the FY 2009 through FY 2020 books of business. It computes the net present value of future cash flows for these books of business. 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.[27]

## 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 or after loan assignment. The HECM portfolio of active loans as of the end of FY 2013 has a base-case projected cumulative tax and insurance default rate of 5.72 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 2014 through FY 2020. Different economic scenarios or simulations 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 2013. 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

[27] At the time of this Review, the latest annual discount factors were published by the Office of Management Budget (OMB) in November 2012.

rates, HECM tax and insurance default rates and the HECM demand volume in each of the stochastic simulation paths and the specified deterministic alternative scenarios.

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## 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 Fund. Two of the critical economic variables used in making these projections are future house prices and future interest rates. We use stochastic models to project the future distribution of house prices and interest rates using Monte Carlo simulation. Our stochastic models are calibrated so that they are centered on Moody's July 2013 base-case economic forecast. Hence the estimated results captured the impact of future deviations from Moody's base-case projections.

Our estimate of the Fund's economic value depends on our projected distribution of house prices and interest rates. This dependence is captured mostly by the central core of the distribution which is anchored on Moody's baseline projections. If future realized house prices and interest rates turn out to be more favorable than Moody's projections, the Fund will perform better than our base case predicts. Conversely, if future realized house prices and interest rates turn out to be less favorable than Moody's projections, the Fund will perform worse than our base case predicts.

The results of the alternative scenario analyses in Section V represent outcomes in the projected distribution of house prices and interest rates. The estimated probabilities of economic values depend 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 will vary with the changing demographic 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 behavioral assumptions.

As discussed previously, FHA started to offer the HECM Saver option to borrowers in FY 2011. The HECM Saver has a lower upfront mortgage insurance premium and also lower principal limit factors. The pricing option should attract borrowers who require fewer funds and may not consider a Standard HECM due to the upfront mortgage insurance premium of two percent. These borrowers' cash draws and termination patterns will likely differ from the past experience of the HECM program. The modeling assumptions for HECM Saver are adjusted accordingly based on the insights drawn from FHA's industry research on similar commercial products. The impact of this on the HECM economic value will depend on the actual number of endorsements and the realized borrower behavior under this option.

In FY 2011, FHA increased the annual premium for HECMs from 0.5 percent to 1.25 percent. For each newer endorsement, this change tends to generate larger cash inflows. On the other hand, the change may reduce HECM demand and lower portfolio-level revenues and realized economic values if the change had not been made. It also results in a more rapid accumulation of loan balances with borrowers reaching the maximum claim amounts more quickly. Quantifying the tradeoffs between insurance rates and economic values should remain an area of attention of the HECM program management.

Starting from FY 2014, FHA announced that the current Standard and Saver products will be eliminated and replaced by a single new program. The new program would have a principal limit factor of 85 percent of the level of the current Standard program. It reduces the allowable initial disbursement, where mortgagors are subject to an initial 12-month disbursement limitation of the greater 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 will continue to be in effect. The initial MIP will be determined based on the amount of the mortgagor's initial draw down at loan closing. A borrower would be charged an initial MIP of 0.50 percent of the maximum claim amount if the initial cash draw is equal to or less than 60 percent of the available principal limit. A borrower would be charged 2.50 percent of the maximum claim amount when the initial cash draw is greater than 60 percent of the available principal limit. The new origination requirements tend to defer cash outflows and increase cash inflows. On the other hand, it may reduce future HECM demand. The impact on HECM economic value will depend on the actual number of endorsements.

This Review has not explicitly modeled the impact of future possible changes in borrower's longevity on the HECM program. 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 behavior of HECM loans. In the 2013 actuarial review we updated the methodology and the model specification from the FY 2012 HECM Review. We also updated the data and 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 was specified and estimated to capture the loan termination behavior. Pursuant to Mortgagee Letter 2011-01, HECM loans can be also terminated under foreclosure when borrowers fail to pay their real estate taxes or property insurance premiums as required by the HECM contract. Building upon the econometric model of tax and insurance (T&I) defaults constructed last year, we refined our specification for 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, the HECM insurance terminates at mortgage note assignment (because then HUD owns the loan and in essence self-insures) but the HECM loan itself does not terminate at this time as the borrower continues to live in the home. Hence, note assignments were not modeled as HECM loan terminations. Also note that the HECM model is an annual model, whereas the models we use for FHA forward mortgages are quarterly based.

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 2013. 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 2012), a competing-risk multinomial logistic model was 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:

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

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

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

The probability of remaining active during the period is simply one minus the sum of these three probabilities. The constant terms $\alpha_D$, $\alpha_R$ and $\alpha_M$ as well as the coefficient vectors $\beta_D$, $\beta_R$ and $\beta_M$ are parameters estimated by the multinomial logistic model. The subscripts D, R and M denote mortality, 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 held 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 refinancings would lead to an FHA endorsement of a new HECM. 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,[28] 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 2013 Actuarial Review (IFE Group 2013) 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. IFE Group received updated mortality data in March of 2013. Death dates were aligned with two years shift after termination dates and one year before termination dates to determine which loans terminated due to death, in order to account for the time lag between the dates of the recorded termination and the actual death.

We use 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 is used as the baseline of the mortality model. It corresponds to the gender-specific mortality rates $m_g(t)$ from the 1999-2001 U.S. Decennial Life Table from the

28 For loans with multiple borrowers, the most recent date of death among all borrowers is used.

Center for Disease Control and Prevention. For loans with co-borrowers (couples), we created joint mortality table, and calculated the likelihood of both borrowers not surviving up to the period. *Equation 4* depicts the *Mortality* [*M(t)*] calculation.

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

*{Equation 4}*

where *M(t)* represents the mortality rate at t ;
$m_g(t)$ represents the conditional mortality rate (gender and age specific) for 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; 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, we use equation 5 to transform *M(t)* into *xbetaM(t)* as the input explanatory variable for the regression:

$$xbetaM(t) = -log(\frac{1}{M(t)-1}) \qquad \textit{\{Equation5\}}$$

A piece-wise linear spline function was used to capture the increasing rate of mortality as the age of the borrower increases.

Even though the second part of equation 4 is supposed to account 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 in general. A piece-wise linear spline function of time-dependent variable *PolicyYear* is used to capture the variation of trend over year (see the details in the next section). As the majority of HECM loans have been endorsed in the past twenty-three years, but do not become significant program until 2002, we have a limited number of loans that have been in the HECM program for more than 11 years. Due to the limited number of loan terminations in late policy years, we restricted our sample to observations that are less 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 draw-down of their eligible draw in the first month. Therefore, the variable *CashDraw* captures this self-selection of borrowers into the HECM program.

## 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, and economic variables. We use loan observations with less than or equal to 18 policy years due to thin observations afterwards.

### 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* as defined in the mortality model is included. The series of piece-wise linear functions for loan age are defined as follows[29]:

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

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

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

where $k_1 = 2$, $k_2 = 6$ and $k_3 = 11$.

Coefficient estimates for each variable are the slopes of the line segments between each knot point and the line segments join with their adjacent segments. The overall generic *PolicyYear* function for the three Pol_yr segment is given by:

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

### 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 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 (and it is not included in the equation). Historical experience suggests that couples and males are more likely to refinance than females.

29 All piece-wise linear functions for other variables are defined in a similar way. The boundary values are specified in exhibits for each estimated model.

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 a piece-wise linear functions of the variable percentage cash draw.

In this year's Review, we removed state dummy variables like *state_CA, state_FL, state_NY* and *state_TX*, and replaced them with the ratio of local area median house price to national loan limit at HECM origination. This ratio is to capture how expensive a house is compared to national average. A high ratio indicates more dollar amount saving if borrowers chose to refinance, thus implies higher probability of refinance.

### A1.2.3. Economic Variables for the Refinance Model

The refinance incentive measure was designed to model HECM borrowers' willingness and ability to refinance a loan. The refinance incentive measure represents the net increase in principal limit for a borrower relative to the costs associated with refinancing. Equation 6 is the refinance incentive measure we used:

$$rfi_t\_new = \frac{\min\left(MCA_0 \times \Delta H, LoanLimit_t\right) \times PLF_t - C - PL_t}{C} \qquad \{Equation6\}$$

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 $t$

We also used a piece-wise linear function of the period-by-period interest rate change (*int_change1-int_change2*) to measure the periodical refinance incentive.

At loan origination, the relative value of the property affects the future house price appreciation. Properties with higher values were found to have a faster appreciation rate 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 local area median house price. The local median house price data was obtained from 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 to define this last sub-model specification. For the same reason as the refinance model, we limit our sample to loan aged less 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 model of termination due to mobility.

### 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* to capture the borrowers' age at origination.

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, especially health reasons, involving moving to a nursing home or to an assisted-living facility, or to live with their children.

We also included a line of credit indicator variable *LOC*, as historical experience suggests that HECM borrowers using the HECM line-of-credit option are more likely to move out.

### A1.3.3. Economic Variables for the Mobility Model

In order to capture HECM programs 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 replaced the Probability of Positive Equity with updated loan-to-value ratio and house price volatility. Historical experience indicated that HECM borrowers with higher updated loan-to-value ratios tend to move out of their homes earlier than borrowers with lower loan-to-value ratios. The house price dispersion parameter estimated by FHFA was used to capture the variability among locational house price appreciation rates.

### A1.4. Combining the Three Risks

The joint termination hazard rate can be defined as

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

where $P_j$ is defined in Equations 1, 2, and 3; and are constructed from the binomial logistic models for mortality, refinance, and mobility following the methodology of Begg and Gray (1984). *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 seven 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 potentially limited. Experience with HECMs has shown that as the borrower ages, the likelihood of move-out (mobility) and refinancing decreases and hence mortality tends to dominate among three causes of terminations.

## A2. Model Estimation Results

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

**Exhibit A-1. Mortality Termination Model Estimation Results**

| Parameter | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|
| **Intercept** | 1 | -0.811 | 0.030 | 738.229 | <.0001 |
| **PolicyYear[1,2]** | 1 | 0.161 | 0.013 | 157.318 | <.0001 |
| **PolicyYear(2,6]** | 1 | -0.081 | 0.004 | 458.438 | <.0001 |
| **PolicyYear(6,35]** | 1 | 0.103 | 0.006 | 310.943 | <.0001 |
| **Couple** | 1 | -0.237 | 0.015 | 263.359 | <.0001 |
| **Mortality_xbeta(-∞,-2]** | 1 | 0.814 | 0.006 | 15804.958 | <.0001 |
| **Mortality_xbeta(-2,+∞)** | 1 | 1.333 | 0.032 | 1762.238 | <.0001 |
| **CashDraw%** | 1 | -1.062 | 0.014 | 6028.590 | <.0001 |

| Association of Predicted Probabilities and Observed Responses | | | |
|---|---|---|---|
| **Percent Concordant** | 76.9 | **Somers' D** | 0.586 |
| **Percent Discordant** | 21.8 | **Gamma** | 0.571 |
| **Percent Tied** | 2.4 | **Tau-a** | 0.021 |
| **Pairs** | 112665322200 | **c** | 0.773 |

* Mortality rates shifted 2 years to account for delay in termination date after death date

**Exhibit A-2. Refinance Termination Model Estimation Results**

| Parameter | Boundary Values | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| **Intercept** | | 1 | -4.415 | 0.150 | 860.607 | <.0001 |
| **PolicyYear1** | **[1,2]** | 1 | 0.310 | 0.015 | 451.894 | <.0001 |
| **PolicyYear2** | **(2,6]** | 1 | -0.082 | 0.005 | 238.776 | <.0001 |
| **PolicyYear3** | **(6,11]** | 1 | -0.114 | 0.009 | 175.890 | <.0001 |
| **PolicyYear4** | **(11,35]** | 1 | -0.446 | 0.038 | 135.084 | <.0001 |
| **Orig_Age** | | 1 | -0.024 | 0.001 | 270.849 | <.0001 |
| **House price above local median** | | 1 | 0.481 | 0.010 | 2142.335 | <.0001 |
| **Mortality_xbeta1** | **(-∞,-0.5]** | 1 | 0.120 | 0.010 | 144.191 | <.0001 |
| **Mortality_xbeta2** | **(-0.5,+∞)** | 1 | 3.585 | 0.977 | 13.453 | 0.0002 |
| **RFI_new1** | **(-∞,0]** | 1 | 0.120 | 0.002 | 4965.180 | <.0001 |
| **RFI_new2** | **(0,+∞)** | 1 | 0.196 | 0.003 | 4437.928 | <.0001 |
| **pct_cashdd1** | **(0,0.7]** | 1 | 1.585 | 0.036 | 1976.624 | <.0001 |
| **pct_cashdd2** | **(0.7,1]** | 1 | -0.148 | 0.062 | 5.773 | 0.0163 |
| **int_change1** | **(-∞,0]** | 1 | 0.467 | 0.014 | 1161.578 | <.0001 |
| **int_change2** | **(0,+∞)** | 1 | 0.422 | 0.018 | 548.563 | <.0001 |
| **Limit1** | **[0,1]** | 1 | 2.557 | 0.021 | 15097.799 | <.0001 |
| **Limit2** | **(1,+∞)** | 0 | 0.000 | | | |
| **Gender_Couple** | | 1 | 0.149 | 0.020 | 53.620 | <.0001 |
| **Gender_Male** | | 1 | 0.065 | 0.015 | 18.310 | <.0001 |
| **gender_missing** | | 1 | -0.247 | 0.106 | 5.469 | 0.0194 |
| **LOC** | | 1 | -0.120 | 0.017 | 52.415 | <.0001 |

| Association of Predicted Probabilities and Observed Responses | | | |
|---|---|---|---|
| **Percent Concordant** | 74.8 | **Somers' D** | 0.528 |
| **Percent Discordant** | 22.6 | **Gamma** | 0.546 |
| **Percent Tied** | 3.3 | **Tau-a** | 0.019 |
| **Pairs** | 107352222711 | **C** | 0.761 |

**Exhibit A-3. Mobility Termination Model Estimation Results**

| Parameter | Boundary Value | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| **Intercept** | | 1 | -6.174 | 0.133 | 2170.796 | <.0001 |
| **1Year CMT Change<-0.1** | | 1 | -0.354 | 0.011 | 1040.835 | <.0001 |
| **1Year CMT Change>0.1** | | 1 | -0.055 | 0.012 | 20.379 | <.0001 |
| **PolicyYear1** | **[1,2]** | 1 | 0.214 | 0.015 | 195.625 | <.0001 |
| **PolicyYear2** | **(2,3]** | 1 | 0.126 | 0.014 | 85.026 | <.0001 |
| **PolicyYear3** | **(3,35]** | 1 | 0.021 | 0.004 | 24.427 | <.0001 |
| **Gender_Couple** | | 1 | 0.425 | 0.015 | 772.236 | <.0001 |
| **Gender_Male** | | 1 | -0.079 | 0.013 | 36.422 | <.0001 |
| **gender_missing** | | 1 | 0.223 | 0.070 | 10.082 | 0.0015 |
| **mortality_xbeta1** | **(-∞,-6]** | 1 | -0.039 | 0.015 | 6.656 | 0.0099 |
| **mortality_ xbeta2** | **(-6, -0.5)** | 1 | 0.332 | 0.011 | 915.137 | <.0001 |
| **mortality_ xbeta3** | **(-0.5,+∞)** | 1 | -2.224 | 0.503 | 19.536 | <.0001 |
| **Orig_Age** | | | 0.016 | 0.001 | 142.772 | <.0001 |
| **pre2004** | | | 0.818 | 0.010 | 6892.406 | <.0001 |
| **LOC** | | | 0.220 | 0.011 | 425.206 | <.0001 |
| **Relative house price** | | | 0.111 | 0.008 | 191.926 | <.0001 |
| **ltv_current1** | **[0,0.4]** | | -0.563 | 0.055 | 106.419 | <.0001 |
| **ltv_current2** | **(-0.4,1.0]** | | -2.113 | 0.027 | 6254.382 | <.0001 |
| **ltv_current3** | **(-1.0,+∞)** | | 0.000 | | | |
| **sigma** | | | -1.473 | 0.223 | 43.477 | <.0001 |

| Association of Predicted Probabilities and Observed Responses | | | |
|---|---|---|---|
| **Percent Concordant** | 74.1 | **Somers' D** | 0.501 |
| **Percent Discordant** | 24.1 | **Gamma** | 0.512 |
| **Percent Tied** | 3.0 | **Tau-a** | 0.021 |
| **Pairs** | 124432668541 | **C** | 0.746 |

## A3. Base Termination Model Implementation

Representing the joint hazard, Exhibit A-4 below shows the average conditional HECM termination rates among Monte Carlo simulation paths for standard loans by policy year (loan age) and the fiscal years that loans were endorsed.

## 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 |
| 1 | . | . | . | . | . | 4.89% | 4.72% | 4.60% | 4.54% | 4.70% | 4.67% | 4.68% |
| 2 | . | . | . | . | 5.00% | 5.44% | 5.79% | 6.00% | 6.31% | 5.89% | 5.97% | 6.26% |
| 3 | . | . | . | 5.00% | 4.59% | 5.35% | 6.06% | 6.55% | 6.35% | 6.03% | 6.18% | 6.70% |
| 4 | . | . | 5.19% | 4.44% | 4.27% | 5.33% | 6.10% | 6.37% | 6.08% | 5.95% | 6.30% | 6.35% |
| 5 | . | 4.99% | 4.57% | 4.12% | 4.09% | 5.39% | 5.88% | 5.99% | 5.96% | 5.95% | 6.11% | 6.34% |
| 6 | 4.81% | 4.47% | 4.21% | 3.96% | 4.14% | 5.25% | 5.47% | 5.91% | 5.87% | 5.79% | 6.16% | 6.27% |
| 7 | 4.80% | 4.48% | 4.34% | 4.25% | 4.41% | 5.13% | 5.59% | 6.08% | 5.92% | 6.09% | 6.18% | 6.47% |
| 8 | 4.97% | 4.69% | 4.67% | 4.55% | 4.53% | 5.32% | 5.92% | 6.17% | 6.34% | 6.21% | 6.33% | 6.32% |
| 9 | 5.28% | 5.12% | 5.00% | 4.73% | 4.74% | 5.78% | 6.10% | 6.60% | 6.58% | 6.46% | 6.44% | 6.66% |
| 10 | 5.83% | 5.60% | 5.25% | 5.02% | 5.27% | 6.06% | 6.57% | 6.83% | 6.79% | 6.67% | 6.77% | 6.79% |
| 11 | 6.42% | 5.99% | 5.61% | 5.61% | 5.80% | 6.58% | 6.95% | 7.16% | 6.96% | 7.14% | 7.06% | 7.31% |
| 12 | 6.88% | 6.40% | 6.15% | 6.03% | 6.10% | 6.95% | 7.15% | 7.26% | 7.32% | 7.22% | 7.35% | 7.40% |
| 13 | 7.50% | 7.10% | 6.68% | 6.54% | 6.89% | 7.35% | 7.53% | 7.72% | 7.65% | 7.73% | 7.73% | 7.83% |
| 14 | 8.39% | 7.83% | 7.33% | 7.33% | 7.34% | 7.98% | 8.18% | 8.29% | 8.31% | 8.30% | 8.33% | 8.33% |
| 15 | 9.30% | 8.67% | 8.21% | 7.99% | 8.12% | 8.79% | 8.93% | 9.08% | 9.05% | 9.06% | 9.04% | 9.02% |
| 16 | 10.35% | 9.71% | 9.03% | 8.86% | 9.00% | 9.71% | 9.88% | 9.95% | 9.94% | 9.93% | 9.89% | 9.89% |
| 17 | 11.56% | 10.74% | 10.04% | 9.87% | 10.06% | 10.83% | 10.92% | 10.97% | 10.96% | 10.93% | 10.91% | 10.88% |
| 18 | 12.82% | 11.93% | 11.18% | 11.04% | 11.21% | 12.04% | 12.09% | 12.14% | 12.12% | 12.10% | 12.06% | 12.17% |
| 19 | 14.22% | 13.26% | 12.50% | 12.34% | 12.56% | 13.39% | 13.44% | 13.46% | 13.46% | 13.42% | 13.51% | 13.42% |
| 20 | 15.80% | 14.77% | 13.96% | 13.82% | 14.00% | 14.93% | 14.95% | 14.98% | 14.96% | 15.02% | 14.94% | 14.94% |
| 21 | 17.58% | 16.44% | 15.62% | 15.43% | 15.64% | 16.65% | 16.66% | 16.67% | 16.75% | 16.68% | 16.67% | 16.63% |
| 22 | 19.55% | 18.32% | 17.43% | 17.26% | 17.48% | 18.59% | 18.58% | 18.66% | 18.64% | 18.62% | 18.58% | 18.59% |
| 23 | 21.75% | 20.36% | 19.48% | 19.31% | 19.53% | 20.75% | 20.81% | 20.80% | 20.81% | 20.78% | 20.77% | 20.74% |
| 24 | 24.15% | 22.66% | 21.79% | 21.60% | 21.84% | 23.23% | 23.20% | 23.22% | 23.23% | 23.22% | 23.18% | 23.17% |
| 25 | 26.86% | 25.26% | 24.37% | 24.20% | 24.50% | 25.93% | 25.93% | 25.94% | 25.97% | 25.93% | 25.92% | 25.89% |
| 26 | 29.88% | 28.14% | 27.26% | 27.18% | 27.40% | 28.98% | 28.96% | 28.98% | 28.99% | 28.97% | 28.95% | 28.94% |
| 27 | 33.20% | 31.37% | 30.57% | 30.46% | 30.72% | 32.35% | 32.36% | 32.35% | 32.37% | 32.34% | 32.34% | 32.31% |
| 28 | 36.94% | 35.06% | 34.25% | 34.21% | 34.41% | 36.13% | 36.12% | 36.11% | 36.14% | 36.12% | 36.09% | 36.11% |
| 29 | 41.05% | 39.10% | 38.34% | 38.30% | 38.54% | 40.22% | 40.21% | 40.19% | 40.22% | 40.19% | 40.20% | 40.21% |
| 30 | 45.39% | 43.45% | 42.70% | 42.76% | 42.91% | 44.54% | 44.53% | 44.51% | 44.53% | 44.53% | 44.53% | 44.51% |
| 31 | 49.96% | 48.05% | 47.38% | 47.42% | 47.58% | 49.04% | 49.03% | 49.00% | 49.05% | 49.03% | 49.01% | 49.04% |
| 32 | 54.64% | 52.86% | 52.20% | 52.29% | 52.40% | 53.65% | 53.63% | 53.61% | 53.66% | 53.62% | 53.63% | 53.65% |
| 33 | 59.41% | 57.72% | 57.13% | 57.22% | 57.30% | 58.28% | 58.28% | 58.25% | 58.27% | 58.27% | 58.27% | 58.28% |
| 34 | 64.08% | 62.57% | 62.02% | 62.11% | 62.16% | 62.88% | 62.87% | 62.83% | 62.88% | 62.86% | 62.85% | 62.86% |
| 35 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

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# 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 for the future fiscal years 2014-2020.

## 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 all HECM loans will terminate no later than 35 years. To illustrate the initial conditions of the forecast, a loan endorsed in FY 2009, that is still active in FY2013, has its first termination rate estimated in policy year six since the first five policy years have already elapsed by the end of FY 2013 (the starting date of the forecast). Active loans are distinguished by the fiscal year of endorsement from FY 2009 through FY 2013. Future endorsements are generated for FY 2014 to FY 2020 as described in Section B4 below.

The variables used in the analysis are derived from loan characteristics and economic forecasts. Moody's July 2013 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 depend on various macroeconomic variables including the local unemployment rate.

For each loan during future policy years, the derived loan variables serve as inputs to the logistic termination models described in Appendix A. The HECM model is based on annual frequency. The termination projections by type 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 2013 to generate our benchmark result. We also include six alternative economic scenarios for sensitivity analysis, including five economic paths from our stochastic simulation and the "Protracted Slump Scenario" reported by Moody's economy.com

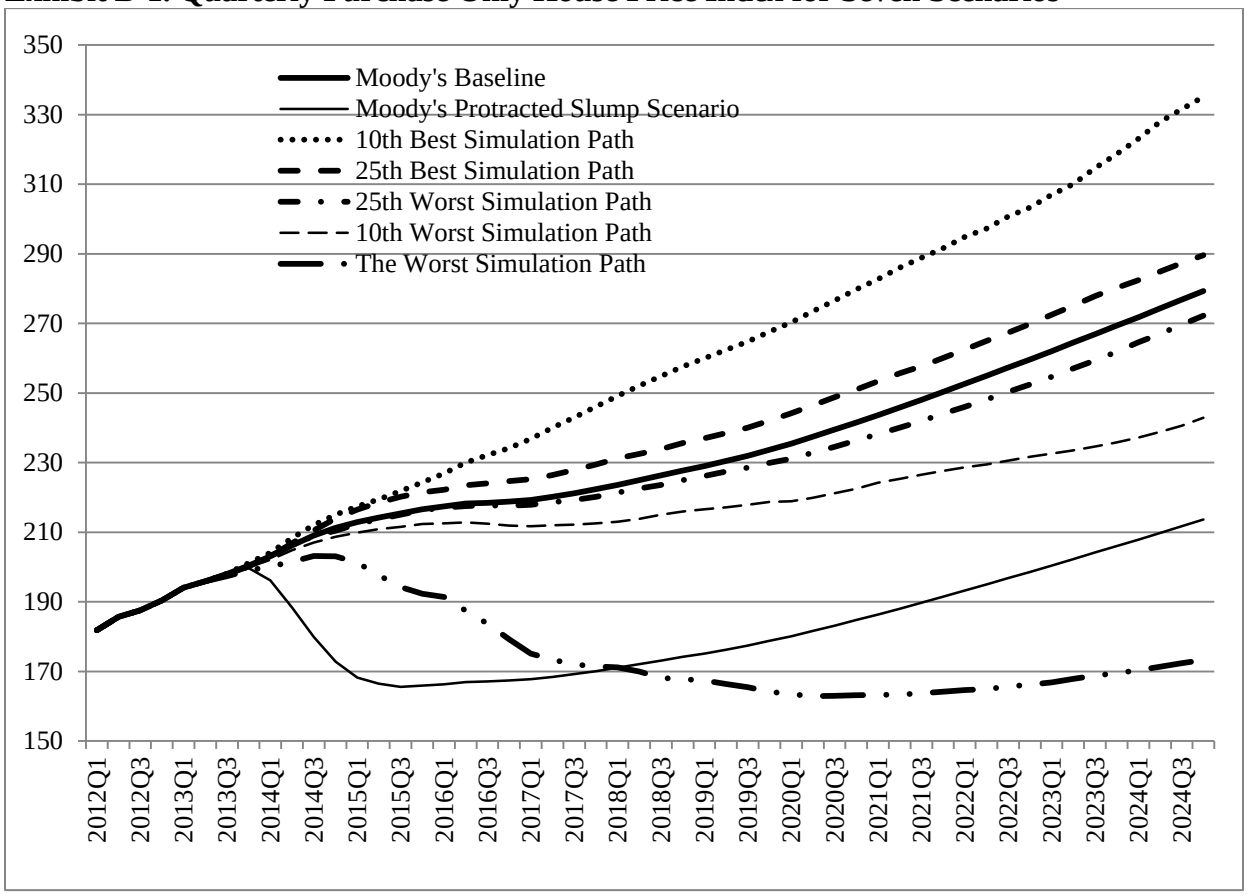
website as of July 2013. The economic factors include the FHFA national, state and MSA purchase-only house price indices, the 10-year Treasury rate, the 1-year Treasury rate and the 1-year LIBOR rate.

The six alternative scenarios are:

- $10^{th}$ 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.

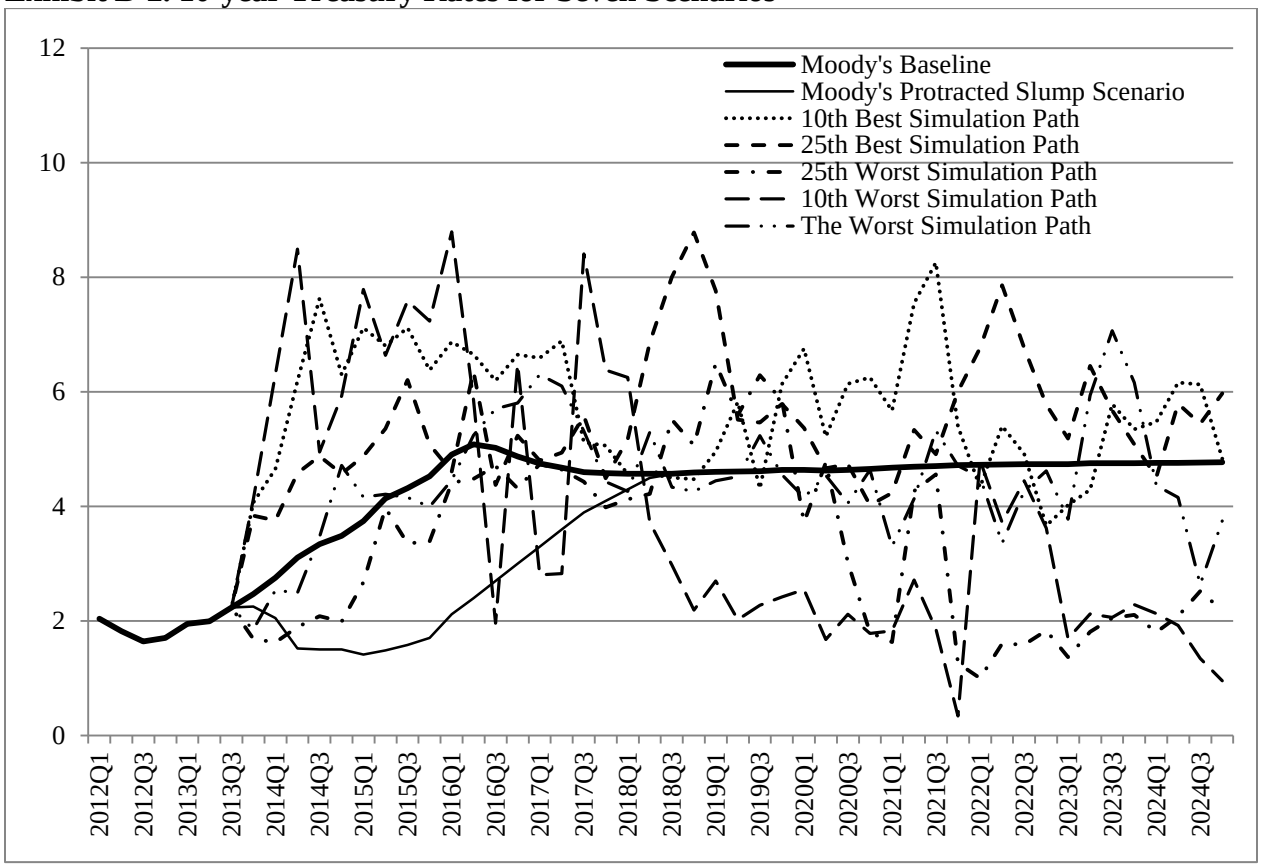
Under Moody's forecast methodology, the levels of the home price indices for any scenario converge to the base-case long-term index values. As a result, the stress scenarios show faster house price growth after the index bottoms out. As in the corresponding Actuarial Review for forward mortgages, we made an adjustment to this methodology whereby the 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 above.

**Exhibit B-1. Quarterly Purchase Only 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. However, due to the concern of the effectiveness of the Quantitative Easement III reduction, the long-term interest rate has increased sharply since July 2013. 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 spread over Treasury rates of the same duration. These LIBOR series are not shown for brevity.

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




## B3. Maintenance-Risk Adjustments

Recent research 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. First we derive the cumulative house price discount factor by using the HECM property sale price data collected from CoreLogic. The formula for the discount is

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

where $HP_t$ is the sale price obtained from the CoreLogic database;

$HP_0$ is the appraisal value at origination;

$HPI_t$ is the local FHFA purchase only housing price index. We calculated the average housing price discount factor for HECM termination loans regardless of termination type. Then, we used

an exponential decay function of the policy year to fit the historical average, as shown in the formula below. Based on the work of Capone, et al. (2010), 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.

$$House\ price\ discount\ factor\ at\ loan\ age\ t = \begin{cases} 0.2 - 0.3 * e^{-0.2*\min(age,6)} & if\ age < 10 \\ 0.25 - 0.9 * e^{-0.2*age} & if\ age \geq 10 \end{cases} \quad if\ hp\_above\_med = 0$$

$$House\ price\ discount\ factor\ at\ loan\ age\ t = \begin{cases} 0.13 - 0.25 * e^{-0.35*\min(age,4)} & if\ age < 10 \\ 0.2 - 0.8 * e^{-0.2*age} & if\ age \geq 10 \end{cases} \quad if\ hp\_above\_med = 1$$

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

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

And the net sale price of the property is:

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

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

## B4. Conveyance and Payoff Selection Model

In this year's Review, we use HECM loans terminated with payoff and conveyance type from 2005 to 2013 to analyze HECM's conveyance and payoff selection choice. There are 6,096 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 captures high probability of conveyance in a bad economy. The results also indicate that HECM borrowers in areas with higher house price than national average are more likely to payoff. For example, borrowers in California may have more incentive to keep their houses than borrowers in Texas. Also, HECM

borrowers with higher appreciation in 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 coefficients of model estimation.

**Exhibit B-3. Conveyance and Payoff Selection Model Coefficients**

| Parameter | Description | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|
| **Intercept** | | -11.04 | 0.90 | 150.18 | <.0001 |
| **Pol_yr1** | loan age <=7 | 0.48 | 0.06 | 58.77 | <.0001 |
| **Pol_yr2** | loan age >7 | 0.28 | 0.02 | 198.64 | <.0001 |
| **Orig_Age** | borrower's age at origination | 0.07 | 0.01 | 82.13 | <.0001 |
| **Limit1** | ratio of median local house price to national loan limit at origination <= 1 | -3.65 | 0.20 | 335.04 | <.0001 |
| **Rel_ue_usa** | ratio of unemployment rate to past 10y average at termination, at national level | 1.53 | 0.18 | 72.75 | <.0001 |
| **Pct_cashdd** | first month cash draw | 0.68 | 0.13 | 28.16 | <.0001 |
| **Rel_hp** | relative house price | -1.30 | 0.11 | 129.28 | <.0001 |
| **Cumulative_HPI_Chang** | Cumulative HPA between termination and origination | -0.02 | 0.00 | 183.15 | <.0001 |
| **Cltv** | updated loan to value ratio | 3.09 | 0.22 | 195.75 | <.0001 |

Exhibit B-4 describes the model's performance.

**Exhibit B-4. Conveyance and Payoff Selection Model Fit Statistics**

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 8315.292 | 4737.693 |
| SC | 8322.008 | 4804.847 |
| -2 Log L | 8313.292 | 4717.693 |
| **Association of Predicted Probabilities and Observed Responses** | | |

| | | | |
|---|---|---|---|
| Percent Concordant | 91.1 | Somers' D | 0.824 |
| Percent Discordant | 8.8 | Gamma | 0.825 |
| Percent Tied | 0.1 | Tau-a | 0.403 |
| Pairs | 9081455 | C | 0.912 |

## B6. Forecasted Endorsement Volume and Portfolio Composition

Based on HECM loan data observed through June of 2013, the Moody's baseline economic forecast, and the HECM total demand count model in Appendix E, Exhibit B-5 shows forecasted HECM endorsement volumes and MCAs for FY 2014 through FY 2020. Starting in FY 2014, FHA will cancel the Standard and Saver programs and introduce a new program which has an initial disbursement limitation and 85% of principal limits in comparison to the original Standard product. We assume that the maximum claim amount (MCA) will grow by Moody's July 2013 forecast of national HPI from FY 2014 through FY 2020.

**Exhibit B-5. HECM Volume and MCA Projections for the New Program**

| FY | Total Average MCA | Total Count Volume | Total Dollar Volume ($m) |
|---|---|---|---|
| **2014** | $253,258 | 54,687 | $13,850 |
| **2015** | $262,035 | 62,469 | $16,369 |
| **2016** | $266,133 | 66,906 | $17,806 |
| **2017** | $268,393 | 69,380 | $18,621 |
| **2018** | $272,968 | 72,040 | $19,665 |
| **2019** | $278,688 | 75,128 | $20,937 |
| **2020** | $285,496 | 78,170 | $22,317 |

The assumptions on the age and gender distribution for FY 2014-2020 new programs were based on the distribution of the FY 2013 endorsements and are shown in Exhibit B-6.

**Exhibit B-6. Future Endorsement Age and Gender Distribution**

| New program FY 2014-2020 | | | | |
|---|---|---|---|---|
| Age Group | Male | Female | Couple | Row Totals |
| 62 to 65 | 24.70% | 31.10% | 44.20% | 100.00% |
| 66 to 70 | 20.40% | 32.20% | 47.40% | 100.00% |
| 71 to 75 | 19.10% | 38.50% | 42.40% | 100.00% |
| 76 to 85 | 20.80% | 49.50% | 29.70% | 100.00% |
| 85+ | 23.50% | 66.80% | 9.70% | 100.00% |
| **All Ages** | **21.60%** | **38.70%** | **39.70%** | **100.00%** |

Based on recent data and expected market changes, assumptions about the future market shares of loan amortization types were projected by FHA as shown in Exhibit B-7.

**Exhibit B-7. Future Distribution of Loan Amortization Types**

| FY | Fixed Rate Loan % | Variable Rate Loan % |
|---|---|---|
| **2014-2020** | 72% | 28% |

Based on the distribution of FY 2013 actual cash draws, assumptions for each future cohort were projected by FHA in Exhibit B-8. These buckets represent the cash draw preferences of future borrowers from the 3rd to the 35th policy years, without policy restrictions on upfront draw amounts. However, since predicted behavior is expected to change due to new policy mandates, borrowers can draw the maximum of 60 percent of the initial principal limit or 10 percent of the initial principal limit(IPL) amount and their obligations/debt amount (if it exceeds 60 percent of IPL) in the first year. The mandatory draw distribution was provided by FHA. Also, we assume that the first-month cash draw equals the first-year cash draw for future cohorts during termination and T&I projections.

**Exhibit B-8. Future Distribution of Projected Cash Draws for FY 2014- 2020**

| Percentages | Cash draw to initial principal limit (CDD Bucket) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age Group** | **0%-10%** | **10%-20%** | **20%-30%** | **30%-40%** | **40%-50%** | **50%-60%** | **60%-70%** | **70%-80%** | **80%-90%** | **90%-100%** | **100%** | **Row Totals** |
| **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% | 100.0% |
| **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% | 100.0% |
| **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% | 100.0% |
| **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% | 100.0% |
| **85+** | 12.4% | 9.4% | 6.4% | 4.0% | 3.3% | 2.8% | 2.0% | 1.5% | 1.6% | 3.1% | 53.5% | 100.0% |
| **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%** | **100.0%** |

The above assumptions form the basis for generating projected future HECM endorsements for FY 2014 to 2020. The technique clones recent endorsement records and updates the loan variables according to the various assumptions described above regarding the future HECM market.

# 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 sales price, and the national HECM FHA loan limit ($625,500 for FY 2013).

- **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 maximum claim amounts.

- **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.

- **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, assignment costs, 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 or property disposition 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, 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 will accrue additional UPB at an annual rate of 2.5 percent of the estimated property value for the assumed two years between the default date and the property disposition date. The possibility of Tax and Insurance (T&I ) defaults and their accrual assumption has the effect of potentially worsening the present value of HECM insurance losses, depending on property values at termination relative to the UPB.

## 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 or, if financed, accrued by the 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 to be introduced in FY 2014, the upfront premium rate will be 0.5 percent of the MCA if the first-year cash draw is less than or equal than 60 percent of initial principal limit, and 1.25 percent of MCA if first year cash draw is more than 60 percent of initial principal limit. Typically, the upfront premium is financed by the HECM loan and hence added to the loan balance. In this Review, we assume the upfront premium is paid in full to FHA at the loan closing, so it is treated as a positive cash flow.

#### C2.2.2. Annual Premiums

The annual premium is calculated as a percentage of the current loan balance. For FY 2009 and FY 2010 books of business, the annual premium was 0.5 percent of the UPB. From FY 2011 and onward, the annual premium was set to 1.25 percent of the UPB for all Standard, Saver, and the new program to be introduced in FY2014. Before a loan is assigned, the annual premium is assumed to be 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 relatively rare. The losses from claim type 1 can be expressed as:

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

#### C.2.3.2. 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 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 at approximately 99 percent of the MCA. The net losses from claim type 2 also depend on the two components, the note holding expenses after assignment and recoveries from assigned notes, now discussed.

### C2.4. Note Holding Expenses after Assignment

The note holding cash flows after assignments are the additional borrower cash draws that occur under the contractual cash drawdown assumptions.

### 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) depends on the termination model in Appendix A and the T&I default model in Appendix D. The amount of recovery equals the minimum of the loan balance and the predicted net sales proceeds at termination, where net sales proceeds equals the projected property value less selling expenses. For tax and insurance (T&I) defaults that occur after assignment, the dollar amount of T&I default accruals are subtracted from the recovery. In effect, FHA books the T&I arrearage through UPB accrual and then pays out the T&I arrearage at loan termination using recovered revenue. According to this convention, T&I arrearage can be viewed as additional property selling expenses.

## C3. Net Future Cash Flows

The portfolio cash flow for a HECM book of business can be computed by summing individual components:

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

Note that a positive net cash flow indicates that inflows exceed outflows and a negative cash flow indicates the opposite. In the first case the HECM program generates positive net income. As an example of the second case, negative cash flows will occur for a portfolio of HECM loans when the upfront premiums were received in a previous period and there was a preponderance of claim type 2s paid in the current period prior to subsequent recoveries associated with those claims.

To obtain the present value of cash flows, the cash flows are discounted for each policy year and cohort according to the latest discount factors published by the Office of Management and Budget (OMB). The discount factors used in this Review were released in November 2012 to discount cash flows in 2014 and future years. They are given in Exhibit C-2. As these discount factors represent the standard to be used by all federal agencies, they do not vary with the different interest rate and home price scenarios that are discussed in Appendix B and F. The OMB is expected to update the discount factors again in November 2013.

**Exhibit C-2. OMB Discount Factors as of November 2012**

| Fiscal Year | Discount Factor | Fiscal Year | Discount Factor |
|---|---|---|---|
| 2014 | 0.9980 | 2033 | 0.5491 |
| 2015 | 0.9940 | 2034 | 0.5287 |
| 2016 | 0.9836 | 2035 | 0.5090 |
| 2017 | 0.9653 | 2036 | 0.4900 |
| 2018 | 0.9407 | 2037 | 0.4717 |
| 2019 | 0.9142 | 2038 | 0.4541 |
| 2020 | 0.8872 | 2039 | 0.4371 |
| 2021 | 0.8590 | 2040 | 0.4207 |
| 2022 | 0.8298 | 2041 | 0.4049 |
| 2023 | 0.7999 | 2042 | 0.3897 |
| 2024 | 0.7706 | 2043 | 0.3751 |
| 2025 | 0.7423 | 2044 | 0.3610 |
| 2026 | 0.7150 | 2045 | 0.3475 |
| 2027 | 0.6887 | 2046 | 0.3344 |
| 2028 | 0.6632 | 2047 | 0.3219 |
| 2029 | 0.6387 | 2048 | 0.3098 |
| 2030 | 0.6151 | 2049 | 0.2981 |
| 2031 | 0.5923 | 2050 | 0.2869 |
| 2032 | 0.5703 | 2051 | 0.2762 |

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# Appendix D

# HECM Tax and Insurance Default Model

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

This Appendix discusses 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. We developed a methodology for treating HECM T&I defaults in the 2011 Actuarial Review, and the 2013 T&I default model is based on the same methodology.

### 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 ML 2011-01 or for other reasons, and some may cure. For purposes of this analysis, "default" is defined as a T&I delinquent loan not making any partial repayment over a 12-month consecutive period. Correspondingly, a loan can stay in delinquency as long as a partial repayment is made in any 12-month window period. 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 loan that owes $1,000 T&I in month 1 will not be considered in default if this borrower makes a mere $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. Since we do not model loan cures, 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. Experimenting with more stringent definitions of default yielded similar statistical results. This definition of T&I default is the same as that used in 2012 Review.

We processed the HECM loan data provided by FHA to create a unique record for each loan/activity year combination. The panel data's annual periodicity conforms to the general HECM implementation framework. In order to build the predictive model, we obtained the following static loan attributes for the entire active HECM loan universe as of March 31, 2013: collateral property state, product type (ARM vs. FRM), loan type (line of credit or others),

borrower age at origination, borrower gender, origination date, initial month cash drawdown as a percentage of the maximum allowable draw, an indicator of whether the home value at origination was above or below the local area median value and loan age.

### D2.1. Variable Definitions

We used the following variable specifications in our regression analysis:

**timeDfltAny** = 1 when the loan reaches 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 cut point of 90%. For the new program starting from FY2014, we assume the first-month cash draw percentage is the same with first-year 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 with missing gender; 0 otherwise

**stateCA** = 1 if collateral property in California; 0 otherwise.

**stateTX** = 1 if collateral property in Texas; 0 otherwise.

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

**PolicyYear =** current loan age. The model uses a linear spline function for policy year, with cut points of 2 and 3.

### D2.2. Descriptive Statistics

Exhibit D-1 shows selected statistics for the estimation sample dataset. The data indicate that 11.9 percent of HECM loans have had a T&I delinquency history, among which 37 percent are currently in default.

**Exhibit D-1. Descriptive Statistics, Static Attributes, Active Loans**

| Variable | Number of Observations | Mean | Standard Deviation |
|---|---|---|---|
| Ever in Default | 66,903 | 0.374 | 0.483 |
| Default Policy Year | 25,032 | 3.319 | 1.455 |
| pct_cashdd | 559,927 | 0.696 | 0.299 |
| Orig_Age | 559,927 | 72.034 | 7.019 |
| LOC | 559,927 | 0.899 | 0.301 |
| Gender_Male | 559,927 | 0.183 | 0.387 |
| Gender_Male | 559,927 | 0.414 | 0.492 |
| gender_missing | 559,927 | 0.005 | 0.071 |
| State CA | 559,927 | 0.162 | 0.368 |
| State TX | 559,927 | 0.068 | 0.252 |
| Relative house price to median | 559,927 | 1.183 | 0.621 |

## D3. T&I Default Model

In estimating the T&I default model, we used active loans as of 3/31/2013. Endorsements prior to FY 2000 are excluded because of data limitations. Regression results are presented below in Exhibits D-2 to D-4.

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

| Parameter | Boundary Values | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|
| **Intercept** | | -7.9830 | 0.0977 | 6670.0219 | <.0001 |
| **pct_cashdd1** | (0,0.9) | 3.3894 | 0.0461 | 5409.8875 | <.0001 |
| **pct_cashdd2** | (0.9,+∞) | -11.6201 | 0.3265 | 1266.4027 | <.0001 |
| **Orig_Age** | | 0.00430 | 0.000958 | 20.1741 | <.0001 |
| **LOC** | | 0.9683 | 0.0511 | 359.2335 | <.0001 |
| **Gender_Female** | | 0.8003 | 0.0165 | 2354.4967 | <.0001 |
| **Gender_Male** | | 0.8698 | 0.0187 | 2158.7785 | <.0001 |
| **gender_missing** | | 0.3113 | 0.1180 | 6.9581 | 0.0083 |
| **stateCA** | | -0.4130 | 0.0217 | 362.5389 | <.0001 |
| **stateTX** | | 0.3314 | 0.0201 | 272.3906 | <.0001 |
| **Relative house price to median** | | -0.3765 | 0.0140 | 724.8175 | <.0001 |

| Parameter | Boundary Values | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|
| **PolicyYear1** | (1,2) | 0.0852 | 0.0158 | 28.9619 | <.0001 |
| **PolicyYear2** | (2,3) | -0.5135 | 0.0178 | 833.1129 | <.0001 |
| **PolicyYear3** | (3,+∞) | -0.3004 | 0.00902 | 1108.4114 | <.0001 |

**Exhibit D-3. Odds Ratio Estimates**

| Odds Ratio Estimates | | | |
|---|---|---|---|
| **Effect** | **Point Estimate** | **95% Wald Confidence Limits** | |
| **pct_cashdd1** | 29.649 | 27.088 | 32.451 |
| **pct_cashdd2** | <0.001 | <0.001 | <0.001 |
| **Orig_Age** | 1.004 | 1.002 | 1.006 |
| **LOC** | 2.634 | 2.383 | 2.911 |
| **Gender_Female** | 2.226 | 2.155 | 2.299 |
| **Gender_Male** | 2.386 | 2.300 | 2.476 |
| **gender_missing** | 1.365 | 1.083 | 1.720 |
| **stateCA** | 0.662 | 0.634 | 0.690 |
| **stateTX** | 1.393 | 1.339 | 1.449 |
| **Relative house price to median** | 0.686 | 0.668 | 0.705 |
| **PolicyYear1** | 1.089 | 1.056 | 1.123 |
| **PolicyYear2** | 0.598 | 0.578 | 0.620 |
| **PolicyYear3** | 0.740 | 0.728 | 0.754 |

**Exhibit D-4. Association of Predicted Probabilities and Observed Responses**

| Association of Predicted Probabilities and Observed Responses | | | |
|---|---|---|---|
| **Percent Concordant** | 75.1 | **Somers' D** | 0.543 |
| **Percent Discordant** | 20.8 | **Gamma** | 0.566 |
| **Percent Tied** | 4.1 | **Tau-a** | 0.011 |
| **Pairs** | 57900267600 | **c** | 0.771 |

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, as expected. However,

default propensity is lower to full cash draw, mostly among fixed-rate borrowers. Default risk shows a slightly positive relationship with original borrower age. Default risk is higher in Texas, and lower in California, other things equal. Except for the first two years, 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 couple borrowers.

## 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. 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 delinquent UPB at an annual rate of 2.5 percent of the then-property value. We also assume a fixed two-year period will elapse between the T&I default event and subsequent property disposition.

### D4.1. Treatment of HECM loans meeting the default definition 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 with 12 or more months of delinquency history without any repayment, will be resolved through involuntary termination. There were approximately 25,000 such loans as of March 31, 2013. In view of the two-year disposition time assumption, these defaulted loans were treated as if defaults occurred in FY 2013 and the dispositions are assumed to occur in FY 2015. 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 likelihood of default. Once a loan is flagged as a default, we set the effective date of property disposition 2 years into the future.

Since the release of the Mortgagee Letter 2011-01, we have observed a trend of more T&I delinquent loans making periodic repayments of owed T&I balance. Should this trend become stable, T&I default incidences might diminish in the future. Incoming empirical evidence of borrower and servicer responses to ML 2011-01 should be used to review the reasonableness of the current projected cumulative default level which is based on historical T&I default behavior.

## 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, 2013 for all remaining years of the 35-year limit assumed for every HECM loan. The resultant cumulative lifetime T&I default rates by historical fiscal years of endorsement for the active loans appear in the Exhibit D-5 below. The results include loans meeting the default definition as of the forecast start date (July 1, 2013). The projected T&I default rate indicates a lower default rate for recent cohorts.

**Exhibit D-5. Lifetime T&I Default Rates for the Current Portfolio by Endorsement Year**

| Fiscal Year of Endorsements | HECM Loan Count | Lifetime T&I Default Rate |
|---|---|---|
| 1990 | 4 | 0.00% |
| 1991 | 16 | 0.00% |
| 1992 | 51 | 0.00% |
| 1993 | 106 | 3.77% |
| 1994 | 247 | 0.00% |
| 1995 | 266 | 0.38% |
| 1996 | 305 | 0.33% |
| 1997 | 475 | 2.11% |
| 1998 | 873 | 6.64% |
| 1999 | 1,176 | 7.50% |
| 2000 | 1,012 | 7.91% |
| 2001 | 1,527 | 12.18% |
| 2002 | 3,503 | 11.18% |
| 2003 | 6,917 | 10.41% |
| 2004 | 16,480 | 11.38% |
| 2005 | 25,206 | 10.36% |
| 2006 | 53,844 | 9.51% |
| 2007 | 85,392 | 9.76% |
| 2008 | 94,608 | 10.86% |
| 2009 | 99,165 | 9.42% |
| 2010 | 70,532 | 7.47% |
| 2011 | 67,697 | 3.59% |
| 2012 | 52,652 | 1.04% |
| 2013* | 42,264 | 1.42% |
| **Total** | **624,318** | **5.72%** |
| *2013 endorsements through 6/30/2013 | | |

# Appendix E
# HECM Demand Model

# Appendix E. HECM Demand Model

## E1. Background

The Actuarial Review requires forecasting future borrower demand for HECM loans for the FYs 2014 - 2020 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. While the HECM analysis uses an annual periodicity, this demand model uses a quarterly periodicity that is then aggregated to an annual basis.

## E2. Data

The HECM demand model predicts demand by loan counts, not dollar volumes. Quarterly historical and forecast for FHFA purchase-only repeat-sales home price indices were obtained from Moody's Analytics as of the end of July 2013.

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:

*http://www.census.gov/population/www/projections/downloadablefiles.html.*

The census forecast of future senior population had an annual instead of quarterly periodicity. We applied linear interpolation to fill in quarterly observations.

The number of quarterly observations used in the regression was 41 (CYs 2003 Q1-2013 Q1), reflecting data availability and taking into account the lags used in connection with the explanatory variables. The forecasted data cover CYs 2013 Q2 through 2020 Q3 to encompass the new endorsements during FYs 2014-2020. Forecasts for CYs 2013 Q2 and 2013 Q3 are needed to update the HECM insurance portfolio base for 2013 Q4 and beyond. Exhibit E-1 summarizes the input data for the demand model.

**Exhibit E-1. Input Data for the Demand Model**

| Period | HECM Loan Count | US. Pop>= 62years Old | HPI Index |
|---|---|---|---|
| 1994Q1 | 744 | 38,938,452 | 107.75 |
| 1994Q3 | 1,276 | 39,035,124 | 109.34 |
| 1995Q1 | 1,226 | 39,200,444 | 110.61 |
| 1995Q3 | 947 | 39,424,388 | 112.22 |
| 1996Q1 | 894 | 39,587,624 | 113.91 |
| 1996Q3 | 1,025 | 39,682,600 | 115.45 |
| 1997Q1 | 1,341 | 39,816,000 | 116.83 |
| 1997Q3 | 1,395 | 39,926,648 | 118.71 |
| 1998Q1 | 1,439 | 40,065,052 | 121.47 |
| 1998Q3 | 2,354 | 40,240,384 | 124.78 |
| 1999Q1 | 1,851 | 40,386,276 | 128.69 |
| 1999Q3 | 2,150 | 40,515,796 | 132.67 |
| 2000Q1 | 1,737 | 40,785,720 | 137.05 |
| 2000Q3 | 1,070 | 41,450,780 | 141.62 |
| 2001Q1 | 1,809 | 41,753,388 | 146.78 |
| 2001Q3 | 2,133 | 41,740,848 | 151.46 |
| 2002Q1 | 3,661 | 41,960,512 | 156.44 |
| 2002Q3 | 3,449 | 42,245,780 | 162.38 |
| 2003Q1 | 3,663 | 42,543,076 | 168.58 |
| 2003Q3 | 5,844 | 43,006,256 | 174.68 |
| 2004Q1 | 9,883 | 43,338,700 | 182.69 |
| 2004Q3 | 10,955 | 43,599,840 | 192.12 |
| 2005Q1 | 11,781 | 43,923,080 | 201.71 |
| 2005Q3 | 12,706 | 44,284,368 | 212.45 |
| 2006Q1 | 18,336 | 44,628,464 | 220.35 |
| 2006Q3 | 20,597 | 44,989,424 | 222.52 |
| 2007Q1 | 29,007 | 45,491,776 | 225.19 |
| 2007Q3 | 27,111 | 46,457,912 | 222.03 |
| 2008Q1 | 30,480 | 47,113,548 | 213.60 |
| 2008Q3 | 28,255 | 47,731,396 | 203.04 |
| 2009Q1 | 30,074 | 48,355,036 | 196.56 |
| 2009Q3 | 28,163 | 48,891,692 | 192.99 |
| 2010Q1 | 20,433 | 49,480,656 | 190.87 |
| 2010Q3 | 18,496 | 50,030,044 | 186.91 |
| 2011Q1 | 20,658 | 50,669,320 | 180.62 |
| 2011Q3 | 16,904 | 51,363,783 | 180.32 |
| 2012Q1 | 14,979 | 52,137,181 | 181.82 |
| 2012Q3 | 11,690 | 52,910,578 | 187.52 |
| 2013Q1 | 15,825 | 53,666,194 | 194.05 |

## 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 | 0.812 | 0.165 | 4.910 | <.0001 |
| 2-quarter lag of log of loan count | 0.095 | 0.162 | 0.590 | 0.559 |
| log (HPI at t / HPI at t - 4) | 0.433 | 0.583 | 0.740 | 0.462 |
| log(Pop >= 62 yr at t) | 0.052 | 0.036 | 1.470 | 0.150 |
| Adj R-Sq = 0.9997<br>Durbin-Watson = 1.955<br>Number of Observations = 41 | | | | |

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

The HECM demand model takes as input scenarios: forecasts of home prices and the senior population, as well as lagged values of the dependent variable. The steady growth in the future senior population and general autoregressive momentum produced forecasts that somewhat exceeded expectations. Consequently, we calibrate the HECM volume from the model to FHA's projection of demand volumes. We applied this calibration to project demand under alternative economic scenarios and individual paths in the Monte Carlo simulation.

Exhibit E-3 and E-4 present the demand forecasts based on the base case (which corresponds to the average of 100 stochastic simulation paths) and the future demand forecasts based on alternative scenarios used in the 2013 Actuarial Review for HECM.

**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 |
|---|---|---|---|---|---|---|
| **2014** | 54,687 | 55,039 | 54,712 | 54,679 | 54,398 | 53,857 |
| **2015** | 62,469 | 63,979 | 63,595 | 62,322 | 61,537 | 58,641 |
| **2016** | 66,906 | 69,993 | 68,662 | 66,816 | 65,457 | 58,047 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2017** | 69,380 | 74,762 | 70,988 | 68,919 | 67,139 | 56,037 |
| **2018** | 72,040 | 79,159 | 73,581 | 71,151 | 69,027 | 56,888 |
| **2019** | 75,128 | 82,455 | 76,310 | 73,985 | 71,780 | 59,646 |
| **2020** | 78,170 | 84,680 | 78,995 | 76,613 | 74,042 | 62,048 |

**Exhibit E-4. Forecasts of HECM Loan Counts for Other Economic Scenarios**

| Fiscal Year | Mean Stochastic Simulation | Moody's Protracted Slump |
|---|---|---|
| **2014** | 54,687 | 52,200 |
| **2015** | 62,469 | 48,567 |
| **2016** | 66,906 | 50,815 |
| **2017** | 69,380 | 56,748 |
| **2018** | 72,040 | 62,409 |
| **2019** | 75,128 | 67,716 |
| **2020** | 78,170 | 72,436 |

It is instructive to examine the FY 2020 demand for the six alternative scenarios. From the highest to the lowest, they are $10^{th}$ best path, $25^{th}$ best path, $25^{th}$ worst path, $10^{th}$ worst path, Moody's protracted slump, and the worst path.

The volatility of demand demonstrates the model's sensitivity to macro factors.

# Appendix F

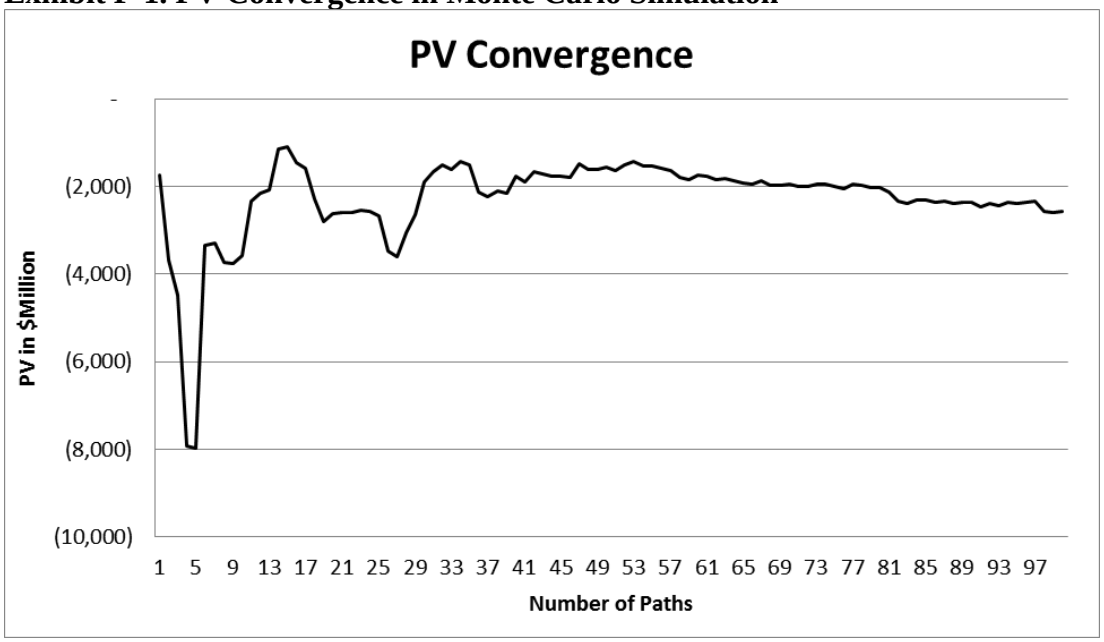
# Stochastic Processes of Economic Variables

## Appendix F: Stochastic Processes of Economic Variables

This appendix describes the stochastic processes assumed for the economic variables used in the Monte Carlo simulations of the HECM Actuarial Review 2013. Starting from 2012 Review, we computed the present value of expected cash flows from 100 possible paths of house price appreciation (HPA) and interest rates. This interpretation is consistent with the industry best practice for pricing and measuring risks of mortgage portfolios. The concept (in terms on the "Monte Carlo" technique that we use in this Review) is to project a number of equally likely future paths of HPA and interest rates, compute the PV of the projected cash flows for each path and, since each path is equally likely, compute the average PV over all the paths as the expected present value.

We selected 100 simulated paths for the Monte Carlo simulations because we observed that the present value of the future cash flows converged to a constant value when used 100 paths. This converged value is the expected present value of future cash flows. So if we were to randomly draw a number of sets of 100 paths, we infer that the results will be essentially the same expected PV of the future cash flows for each such set. We obtain the economic value of the HECM portfolio by adding this expected present value to the capital resources of the HECM. Using more paths would increase the computation time required to conduct simulations with little additional precision. Exhibit F-1 shows the convergence of the Monte Carlo simulation: after about the 82th path the PV of future cash flows does not deviate measurably.

**Exhibit F-1. PV Convergence in Monte Carlo Simulation**




The economic variables modeled herein as stochastic for computing expected 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-PO), and
- Unemployment rates.

These stochastic variables have been modeled to project the "real world" or "physical" measure and hence were estimated using historical data[30]. 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 rate and house price appreciation rates, estimating the interest rates and other economic variables using the real-world measure, versus risk-neutral measures used for security trading purposes, is consistent with this approach.

## 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. Interest rates generally decreased since this policy shift. Exhibit F-2 shows historical interest rates since 1953. The 1-year Treasury rate was around 2% in 1953 and increased steadily to its peak of 16.32% in 1981 Q1. After that, it followed a decreasing trend and reached an all-time low of 0.11% in 2011 Q4. Also shown are the 10-year Treasury rate (cmt10), the 30-year fixed rate mortgage rate (mrate) and the 1-year LIBOR rate (LIBOR_1y).

[30] For valuing options, "theoretical" or "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 need not resemble actual historical movements in interest rates.

**Exhibit F-2. Historical Interest Rates (%)**

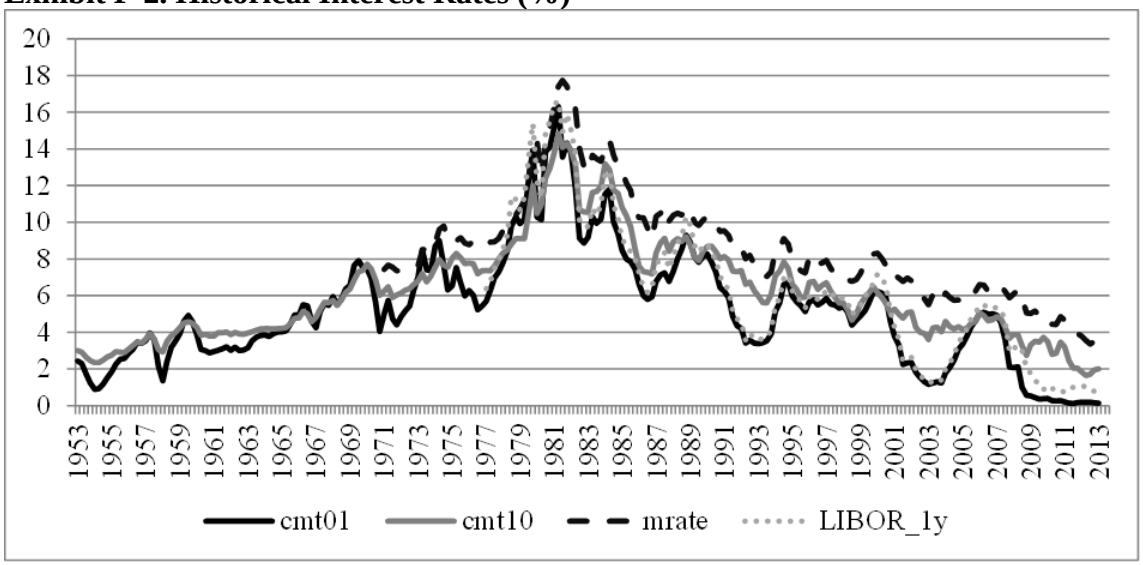
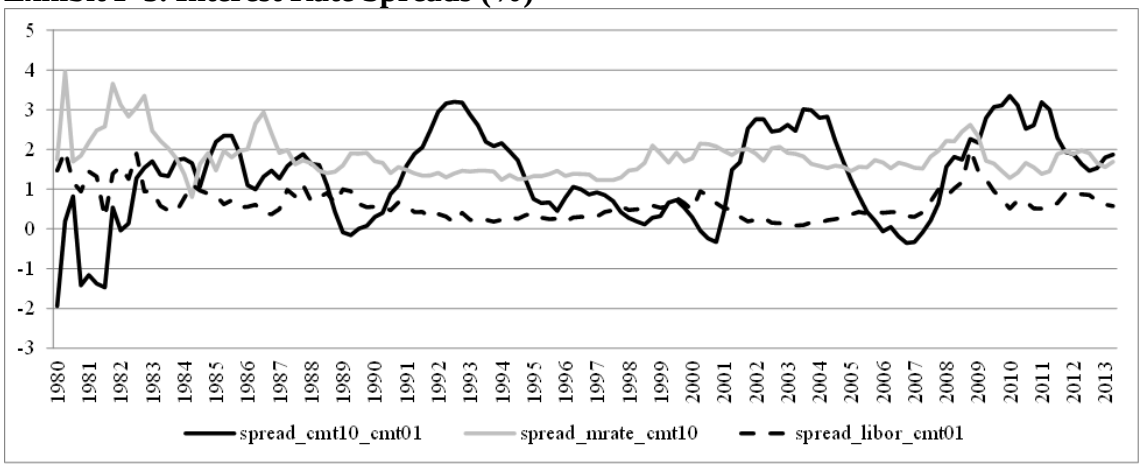



Exhibit F-3 shows historical interest rate spreads, including the spread between the 10-year and the 1-year Treasury rates, the spread between the 30-year mortgage rate and the 10-year Treasury rate, and the spread between the 1-year LIBOR and the 1-year Treasury rate. The spread between the 10-year and 1-year Treasury rates appears to have long cycles and the spread is not always positive. However, the spread of the mortgage rate over the 10-year Treasury rate and the spread of LIBOR over the 1-year Treasury rate are always positive, reflecting the premium for credit risk.

**Exhibit F-3. 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. Previous Reviews used the all-inclusive HPA, which includes refinanced mortgages. The PO Index provides a more reliable measure of housing market conditions, since it is based on repeat sales at market prices and does not use any appraised values.

Since PO HPI index started from 1991, we used the HPI data from 1991 Q1 through 2013 Q2 to build our model. The HPA series being modeled is defined as

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

Exhibit F-4 shows the National HPI and quarterly HPA from 1991 Q1 to 2013 Q2. The long-term average quarterly HPA is around 1.00% (at annual rates).

The PO HPI increased steadily before 2004, and the quarterly appreciation rate was around 1.14%, close to the long-term average. Then house prices rose sharply starting from around 2004. The average quarterly house price appreciation rate was 1.90% during the subprime mortgage expansion period from 2004 to 2006, and reached its peak of 2.63% in 2005 Q2. After 2006, the average growth rate became negative. Exhibit F-4 shows the average quarterly HPA (at annual rates) by selected historical time periods.

**Exhibit F-4. National HPI and HPA**

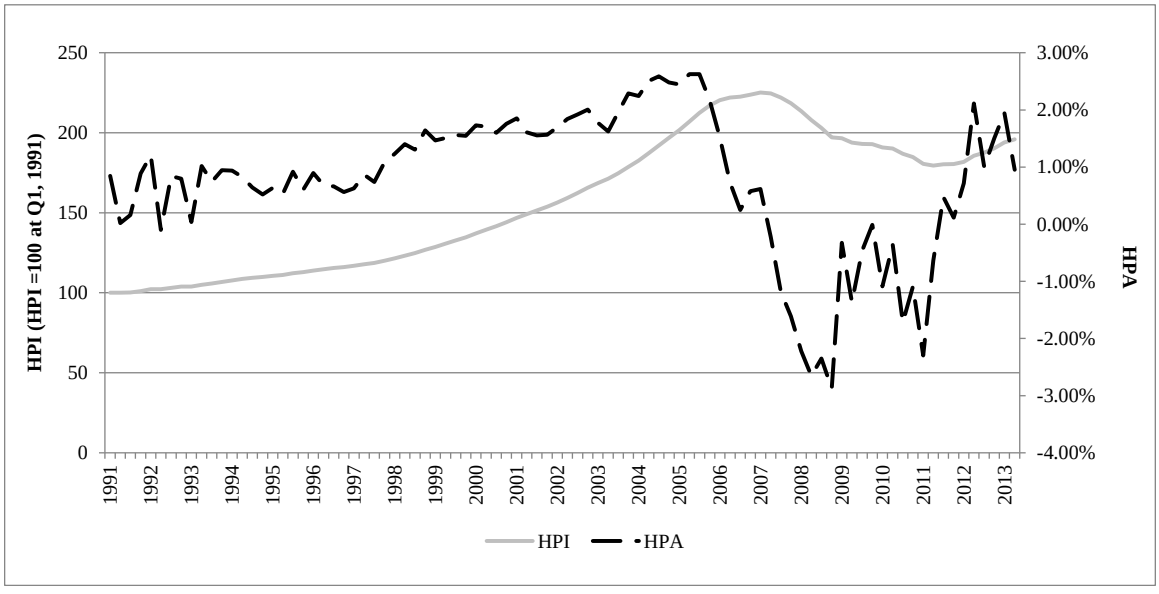


**Exhibit F-5. Average Quarterly HPA by Time Span**

| Period | Average Quarterly HPA |
|---|---|
| 1991 – 2003 | 1.14% |
| 2004 – 2006 | 1.90% |
| 2007 – 2010 | -1.18% |
| 2011 – 2012 | 0.59% |

## F2. 1-Year Treasury Rate

In this section, we present some historical statistics on the one-year Treasury rate, and then describe the model we used in our simulations, and finally report the parameter estimates and their standard errors. Exhibit F-6 shows the summary statistics of the historical 1-year Treasury rates since for two periods, one started in 1953 and the other started in 1980.

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

| Statistics | Since 1980 | Since 1953 |
|---|---|---|
| **Mean** | 5.43% | 5.20% |
| **Standard Deviation** | 3.73% | 3.18% |
| **Max** | 16.32% | 16.32% |
| **95- Percentile** | 13.63% | 10.30% |
| **90- Percentile** | 10.16% | 9.18% |
| **50- Percentile** | 5.24% | 5.01% |
| **10- Percentile** | 0.37% | 1.22% |
| **5- Percentile** | 0.19% | 0.35% |
| **Min** | 0.11% | 0.11% |

We used a GARCH(1,1) parameterization to model the 1-Year Treasury rate ($r_1$) and estimated it using data from 1980 Q1 to 2012 Q1[31]. 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) of the residual term follows a GARCH (1,1) process:

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

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

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.

[31] Example of using GARCH model for fixed income analysis includes Heston and Nandi (2003).

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

| Parameter | Estimate | Std Dev | t Value | Prob>t |
|---|---|---|---|---|
| A | (0.0002) | | | |
| B | 0.993 | 0.020 | 0.339 | 0.735 |
| $\beta_0$ | 3.65E-06 | 2.13E-06 | 1.701 | 0.089 |
| $\beta_1$ | 0.417 | 0.199 | 2.097 | 0.038 |
| $\beta_2$ | 0.549 | 0.122 | 4.482 | 1.67E-05 |
| Adjusted $R^2$ | 0.9501 | | | |

The model based on these parameters is used to simulate FY2013 Q3 and future 1-year Treasury rates. The "constant" term A is actually a different value during each quarter of the simulation. The values were chosen so that the median value among 100 simulations matches Moody's July 2013 baseline forecast of the 1-year Treasury rate quarter by quarter. We applied the same procedure for the "constant" terms in the interest rate and HPA equations below.

Note that Moody's July forecast only covers the period until 2043 Q4. After 2043, we repeated Moody's last 4-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 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 follows an ARCH (1) process:

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

FIML was used to estimate the parameters $\alpha_{10}$ and $\beta_{10}$. The estimated parameters are the following Exhibit F-8.

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

| Parameter | Estimate | Std Dev | tValue | Prob>t |
|---|---|---|---|---|
| $\alpha_{10,t}$[32] | (0.004) | Matched with Moody's Forecast | | |
| $\beta_{10}$ | -0.022 | 0.017 | -1.296 | 0.197 |
| $\gamma_{10}$ | 0.840 | 0.048 | 17.511 | 3.33E-35 |
| $\beta_0$ | 1.39E-05 | 3.67E-06 | 3.772 | 0.000 |
| $\beta_1$ | 0.530 | 0.345 | 1.536 | 0.127 |
| Adjusted $R^2$ | 0.8277 | | | |

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 2013 base forecast of the 10-year Treasury rates quarter by quarter (with the same logic of expanding the forecast series to year 2100). 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 parameter $\alpha_L$ and $\beta_L$. The estimated parameters are shown in ExhibitF-9.

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

| Parameter | Estimate | Std Dev | tValue | Prob>t |
|---|---|---|---|---|
| $\alpha_L$[33] | (0.004) | | | |
| $\beta_L$ | 1.046 | 0.009 | 120.967 | 5.1E-133 |
| Adjusted $R^2$ | 0.991 | | | |

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

[33] The intercept term is calibrated each time period so that the median of simulated rates matches Moody's July 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 2013 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. After considerable experimentation the model we adopted was

$$HPA_t = \mu_t + \alpha_1 D_{spring} + \alpha_2 D_{summer} + \alpha_3 D_{fall} + \beta_1 HPA_{t-1} + \beta_2 HPA_{t-2} + \beta_3 HPA_{t-3} + \beta_4 r_{1,t} + \beta_5 r_{1,t-1} + \beta_6 s_{10,t} + \beta_7 s_{10,t-1} + \beta_8 s_{m,t} + \beta_9 s_{m,t-1} + \sigma_{h,t} dZ_h \quad (6)$$

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 | tValue | Prob>t |
|---|---|---|---|---|
| $\mu_t$ | (-0.001) | Matched with Moody's Forecast | | |
| $\beta_1$ | 0.538 | 0.002 | 1.641 | 0.103 |
| $\beta_2$ | 0.141 | 0.090 | 5.959 | 0.000 |
| $\beta_3$ | 0.208 | 0.109 | 1.302 | 0.196 |
| $\beta_4$ | -0.126 | 0.089 | 2.347 | 0.021 |
| $\beta_5$ | 0.094 | 0.068 | -1.855 | 0.066 |
| $\beta_6$ | -0.182 | 0.069 | 1.371 | 0.173 |
| $\beta_7$ | 0.154 | 0.094 | -1.927 | 0.056 |
| $\beta_8$ | -0.073 | 0.095 | 1.610 | 0.110 |
| $\beta_9$ | 0.111 | 0.159 | -0.458 | 0.648 |
| $\gamma_0$ | 0.000 | 0.155 | 0.716 | 0.476 |

| | | | | |
|---|---|---|---|---|
| $\gamma_1$ | 0.403 | 0.000 | 0.816 | 0.416 |
| $\gamma_2$ | 0.648 | 0.131 | 3.080 | 0.003 |
| Adjusted $R^2$ | 0.640 | | | |

We used these parameters to simulate future HPAs from 2013 Q3. Also, we calibrated the mean of HPA ($\mu_t$ 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 2043 Q4, so again we repeat the last four quarters for the remaining terms.

### 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.[34] 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. Due to Jensen's Inequality, this tends to generate a more conservative estimate of claim losses of the Fund.

## F6. Unemployment Rate

### F6.1. National Unemployment Rate

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

This year we added the unemployment rate in the conveyance and payoff models. 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 2012 to estimate the national unemployment rate. The model we adopted was:

$$ue_t = \mu_t + \beta_1 ue_{t-1} + \beta_2 ue_{t-2} + \beta_4 r_{1,t} + \beta_5 r_{m,t} + \beta_6 HPA_t + \varepsilon_t \quad (8)$$

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**

| Variable | Parameter Estimate | Standard Dev | t Value | Pr > \|t\| |
|---|---|---|---|---|
| **Intercept** | 0.186 | 0.096 | 1.95 | 0.0537 |
| **unemployment rate, lag1** | 1.508 | 0.065 | 23.19 | <.0001 |
| **unemployment rate, lag2** | -0.579 | 0.061 | -9.45 | <.0001 |
| **National annual house price growth rate at time t** | -1.497 | 0.476 | -3.15 | 0.0020 |
| **1-year Treasury rate at time t** | -0.048 | 0.020 | -2.39 | 0.0180 |
| **30-year mortgage rate at time t** | 0.071 | 0.023 | 3.06 | 0.0027 |
| **Adjusted $R^2$** | 0.9809 | | | |
| **Durbin-Watson Statistics** | 2.020 | | | |

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 percent with a floor at 2%.

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