Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund HECM Loans For Fiscal Year 2012

November 15 , 2012

Prepared for

U.S. Department of Housing and Urban Development

By

Integrated Financial Engineering, Inc.

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November 5, 2012

The Honorable Carol J. Galante
Acting 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 2012 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 2012 was *negative* $2.80 billion and the insurance in force was $78.21 billion. We also estimate that the economic value could be positive in FY 2012 and stay positive through FY 2019, under more favorable economic scenarios than those represented by the base-case assumptions.

The financial estimates presented in this Review require projections of events more than 35 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 2012

I have reviewed the "Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund, HECM Loans, for Fiscal Year 2012," dated November 5, 2012. 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 P. Boyle

Phelim Boyle, Ph.D., FIA, FCIA
Fellow of the Institute of Actuaries (UK)
Fellow of the Canadian Institute of Actuaries
November 5 2012

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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 a permanent program in 1998. Between 2003 and 2008, the number of HECM endorsements steadily 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 Fund (GI). 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 National Housing Act requires an independent annual actuarial study of FHA's MMI Fund.[2] Accordingly, an actuarial review must be conducted on HECM loans within the MMI Fund. This document reports the estimated economic values of the FY 2012 through FY 2019 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 capital resource balance, the economic value of a 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). Our projections indicate that, as of the end of FY 2012, the HECM portion of the MMI fund has an expected economic value of *negative* $2,799 million. Expected improvements in house price growth rates and recent increases in mortgage insurance premiums contribute to a steadily increasing economic value of the MMI HECM portfolio from FY 2012 through FY 2019.

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 June 30, 2012. 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 2012 to FY 2019 MMI HECM portfolios using various assumptions, including macroeconomic forecasts based on stochastic simulation of 100 possible future economic scenarios and the expected HECM portfolio characteristics provided by FHA.

Upon evaluating the loan performance of the HECM loans in the FY 2012 portfolio, we estimated the economic value of the HECM portion of the MMI fund to be *negative* $2.80

[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] 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).

billion. We estimated that the economic value of the HECM portfolio will subsequently improve over time with the addition of new endorsements. With the recent increase in annual insurance premiums and improvements in forecasted economic conditions, the newer books of business are estimated to contribute positive economic values to the Fund. The estimated economic value of the fund as of the end of FY 2019 is *negative* $426 million. Policy changes would be needed to increase the estimated value of future endorsements, so that the negative value of existing portfolio could be completely offset within a reasonable time period.

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 total of MCAs over the active portfolio. As new endorsements are added to the portfolio, projected HECM IIF increases from $78.21 billion in FY 2012 to $190.02 billion in FY 2019. Exhibit ES-1 provides the economic value, IIF and endorsements for FY 2012 through FY 2019.

Exhibit ES-1. Economic Value, Insurance-in-Force, and Endorsements for FY 2012-FY 2019 ($ 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
2012	-$2,799	$78,214	$13,899	-$385	
2013	-2,668	93,309	15,701	151	-22
2014	-2,226	105,106	17,504	480	-43
2015	-1,803	119,246	21,719	465	-48
2016	-1,306	135,834	27,472	543	-55
2017	-876	153,787	33,308	472	-53
2018	-541	171,150	37,512	368	-46
2019	-426	190,024	41,933	137	-37

*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 decreased by $4,157 million from the estimated FY 2011 economic value of positive $1,358 million estimated in the FY 2011 review. This change was primarily driven by three factors[3]:

- This year's Review re-estimated the base termination model. One primary result of this model update is a slower expected termination speed than had been estimated in the past years. The effect is especially large for loans still active after ten years, and for borrowers in comparatively older age brackets. For these loans, the longer loan life would lead to a greater

[3] Only major driving factors are listed here. Details of decomposition for changes of economic value are in Section II of this report.

chance that the loan balance would be higher than the property value. The total decrease of economic value caused by the model change is $2,369 million.

- FHA data show there has been a sharp increase in the rate at which properties are conveyed to FHA upon loan termination, as opposed to owners or estates engaging in direct sales. The upswing of conveyance rate appears to be related to current economic conditions. In the case of a conveyance, FHA assumes the expenses of managing and marketing the conveyed property. The higher expected conveyance rates on the outstanding portfolio yielded a reduction in economic value of $1,918 million.
- This year, we adopted a Monte Carlo simulation technique to generate the expected economic value. This method projects a number of equally likely paths of house price appreciation and interest rates, computes the net present value of the projected cash flows for each path and, since each path is equally likely, computes the average net present value over all the paths. The economic value is lower than that under the traditional approach. The use of the stochastic method leads to a $412 million decrease in the estimated economic value.

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. House price appreciation rates are generated by our stochastic simulation of economic conditions. Those rates are centered around Moody's July 2012 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 to the borrower at origination. Interest rate projections used are also based on stochastic simulation centered around Moody's July 2012 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 Draw-Down Rates: These represent the speed at which borrowers access the equity in their homes over time, which impacts the growth rate 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.

The realized economic value will vary from the Review's estimate if the actual drivers of loan performance deviate from the base case projections. Exhibit ES-2 presents the base case economic value from the Monte Carlo simulation and five alternative scenarios from our simulated paths. The base case of the Review is the mean of the economic value of the MMI HECM portfolio among the 100 simulated paths. Each alternative scenario estimates the performance of the Fund under the specific future interest rate and house price appreciation rates under the specific path with no uncertainty. The results indicate that there is approximately 50 percent chance that the economic value would fall in the range of *negative* $4.63 billion to positive $0.59 billion, and 80 percent chance to be within the range of *negative* $7.89 billion to positive $2.14 billion. Under the worst simulated scenario, the economic value could be negative $28.34 billion. This is a 99.5 percent stress test to 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
2012	-$2,799	$2,139	$592	-$4,633	-$7,892	-$28,343
2019	-$426	$13,432	$8,512	-$2,628	-$11,718	-$42,160

*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 same paths that generate the 10th or the 25th best and worst economic values to the forward loans in the MMI Fund. Some scenarios are very stressful for the forward mortgages in the MMI Fund, but are relatively mild in the HECM portfolio. Other scenarios that are stressful to the HECM portfolio could be mild in the forward portfolio. This is due to the substantial different risk drivers in the HECM loans. When HECM is combined with the forward mortgage in the same MMI Fund, there exist some natural diversification effects. As a result, the 25th best scenario of the HECM and forward combined portfolio will not equal to the sum of the 25th best HECM portfolio economic value and the 25th best forward portfolio economic value that is reported in the separate Actuarial Review of the forward portfolio.

Two other alternative scenarios were also tested in this Review. Under the most stressful scenario projected by Moody's, the protracted slump scenario, the FY 2012 economic value of the Fund is *negative* $5.73 billion. This is similar to the 17th worst path in our simulation. Thus, it is equivalent to an 83 percent stress test. If the interest rate remains low for extended time, then the economic value of the Fund in FY 2012 would be *negative* $1.76 billion, which is similar to the 36th best path in our simulation.

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.[4] FHA has conducted an actuarial review of the MMI Fund since 1990.

The FHA Modernization Act within the Housing and Economic Recovery Act of 2008 (HERA)[5] 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 FY 2012 through FY 2019 HECM MMI portfolios. This review also provides the HECM portion of the economic value and 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 senior homeowners to obtain additional income by accessing the equity in their homes. Since the inception of the HECM program in 1989, FHA has insured more than 768,000 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. They provide homeowners with cash payments or credit lines secured by their home's equity, and they require no repayment as long as the borrowers continue to live in the home and meet the HUD guidelines on 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 5. 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. When a loan terminates and the loan balance is 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

[4] 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).
[5] HERA was passed by the United States Congress on July 24, 2008 and signed by President George W. Bush on July 30, 2008.

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 can attempt to recover the loan balance including any interest accrued. Without the loss protection provided by FHA insurance, lenders would need to increase interest rates or reduce the amount of equity borrowers can access in order to cover the financial risks posed by reverse mortgages. Furthermore, FHA insurance protects borrowers from lenders' failure to advance contracted-for funds.

In 2010, FHA introduced the "Saver" alternative to the Standard HECM product. The HECM Saver program charges a lower upfront mortgage insurance premium but also lowers the amount of housing equity a borrower can access. Thus, the Saver's upfront mortgage insurance premium of one basis point is expected to attract borrowers who require less funds as an alternative to a Standard HECM that has a two percent upfront mortgage insurance premium. Appendix B provides information on the impact of the Saver initiative on HECM product demand and future HECM endorsement compositions.

We now provide details of several features of HECMs.

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 the 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 can access additional equity by refinancing. In the event of termination, the entire net sales proceeds[6] can be used to pay off the outstanding loan balance, regardless of whether the maximum claim amount was capped by the FHA HECM loan limit at origination.

2. Principal Limit and Principal Limit Factors (PLFs)

FHA manages its insurance risk by limiting the percentage of the initial equity available to HECM borrowers 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. For a given HECM applicant, a PLF is multiplied by the MCA that applies to that applicant. The result is the maximum HECM principal limit available to the applicant. The PLF increases with the borrower's age at origination[7] and decreases with the expected mortgage interest rate (with a floor of 3.0 percent).[8] The PLFs for the Saver program are 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. Over the course of the loan, the principal limit grows at a rate equal to the mortgage interest rate, the mortgage insurance premium and service fees. Once the HECM unpaid loan balance reaches the principal

[6] Net sales proceeds are the proceeds from selling the home minus transaction costs.
[7] For couples, the age of the younger borrower is used to determine the corresponding PLF.
[8] 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.

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[9]

Expected Mortgage Interest Rate	Borrower Age at Origination					
	65		75		85	
	Standard	Saver	Standard	Saver	Standard	Saver
5.50%	0.569	0.468	0.636	0.508	0.703	0.554
7.00%	0.428	0.316	0.516	0.376	0.606	0.443
8.50%	0.326	0.192	0.425	0.264	0.531	0.341

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.

4. Unpaid Principal Balance (UPB) and Loan Costs

HECM differs from other mortgage products as it requires no repayment as long as the borrowers continue to live in the home and follow the FHA guidelines on property maintenance, real estate taxes and insurance. In general, the loan balance continues to grow with borrower cash draws, interest, premiums, and service fees until the loan terminates.[10] Borrowers can choose between a fixed or adjustable interest rate, and the adjustable rate can be adjusted annually or monthly.

The 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, mortgage insurance premiums, and 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. From 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.

[9] 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

[10] 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.

5. Loan Terminations

HECM loans typically terminate because the borrowers die, 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 the details of the econometric model of tax and insurance defaults used in this Review.

When the HECM loan terminates, borrowers are required to pay back the current loan balance. If the net sale proceeds from the home sale exceed the loan balance, the borrower or their 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, capped by 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.

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.

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. Selected Principal Limit Factor Changes since FY 2009 for Standard HECMs

Borrower Age at Origination	Expected Mortgage Interest Rate	PLFs		
		FY 2009 and Prior	FY 2010	FY 2011 and onward
65	5.5%	0.649	0.584	0.569
65	7.0%	0.489	0.440	0.428
65	8.5%	0.369	0.332	0.326
75	5.5%	0.732	0.659	0.636
75	7.0%	0.609	0.548	0.516
75	8.5%	0.503	0.453	0.425
85	5.5%	0.819	0.737	0.703
85	7.0%	0.738	0.664	0.606
85	8.5%	0.660	0.594	0.531

In early 2009, the United States Congress passed the American Recovery and Reinvestment Act of 2009 (ARRA)[11] 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.[12] Mortgage Letters 2011-29 and 2011-39 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 program. Each path produces a possible future scenario for house prices and interest rates. This distribution is centered on Moody's July 2012 baseline forecasts in the sense that our projected values are just as likely to be above Moody's forecast values as below them. For simplicity we frame our discussion of future house price growth in Section 1 and future interest rates in Section 2 in terms of Moody's forecasts since our simulated distribution is centered around these forecasts.

1. House Price Growth Rate

The house price growth rate trend forecasts for the nation, states and MSAs were obtained from Moody's July 2012 forecast. Moody's state and MSA house price forecasts take into consideration local area economic environment forecasts including unemployment rates.

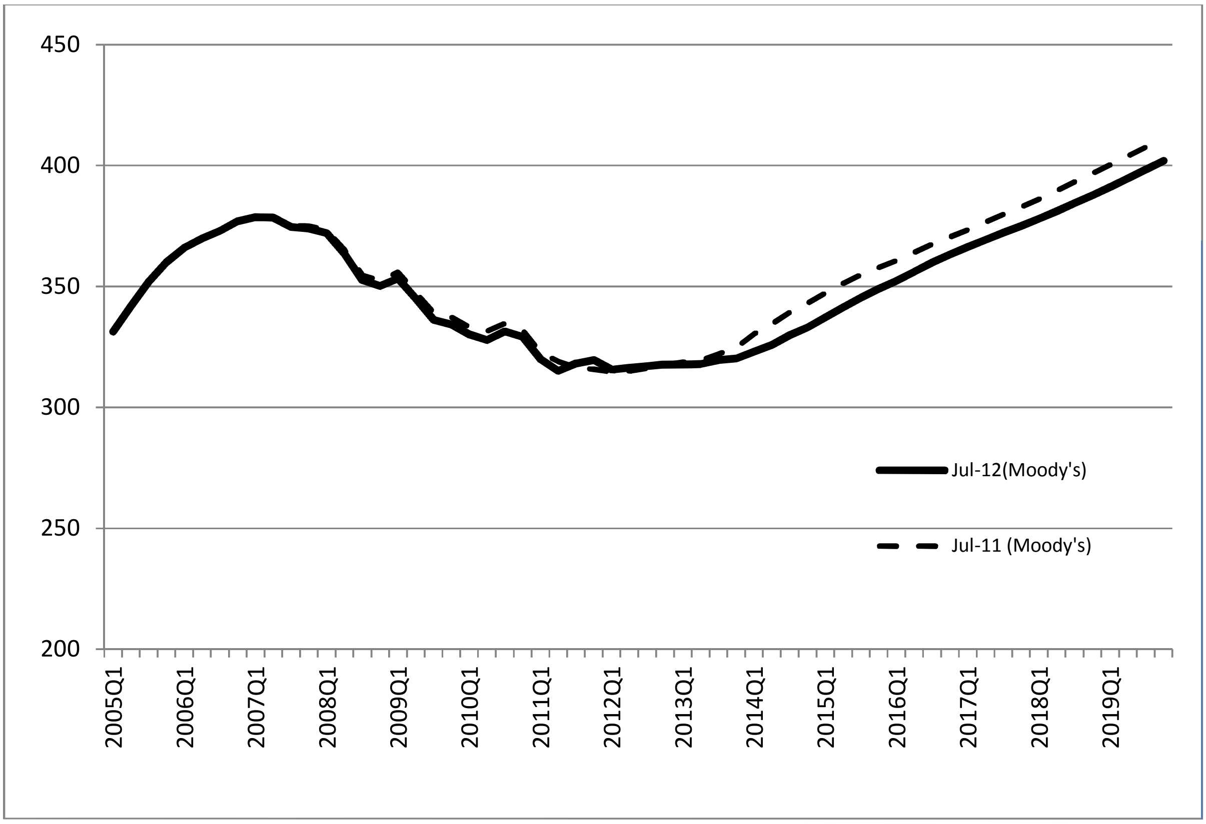
[11] ARRA was passed by the United States Congress on February 13, 2009 and signed by President Barack Obama on February 17, 2009.

[12] Department of the Interior, Environment, and Related Agencies Appropriations Act (H.R. 2996) was passed by the United States Congress on October 29, 2009 and signed by President Barrack Obama on October 30, 2009.

Moody's July 2012 forecast provides estimates from FY 2012Q2 to the end of FY 2042. We used the forecasts for FY 2042 as the basis for forecasts beyond that year.

Exhibit I-3a presents a brief summary of the July 2012 Moody's base-case national house price growth rate forecast as compared to those used in 2011 Review. According to this year's forecast, the annualized national house price growth rate during the remainder of FY 2012 will be negative 0.4 percent. National house prices will begin to experience positive growth starting in the second half of FY 2013. The forecast projects house price growth will rebound to positive 4.6 percent per annum by the second half of FY 2015 and gradually return to a long-run average of around 3.4 percent thereafter.

Exhibit I-3a. House Price Index Forecasts from 2008 to 2012



More importantly, the above Exhibit shows the continuous deterioration of the forecast of the nation's housing market conditions over the past two years. This year, the actual realized house price growth rates turned out to be worse than the previous year's forecast. Meanwhile, this year's forecast of future growth rates was lower than those of last year. This pattern reflects the fact that the housing market recession turned out to be deeper and longer than was expected. The realization of house price growth rates was worse than forecasted in the previous year, and the future house price growth rate forecasts from those of the previous year were downwardly revised. These changes led to decreasing economic values of the HECM portfolio during the past two years.

The house price projections at the state level are different from the national level. The HECM portfolio active at the end of FY 2012 is concentrated in California, Florida, New York and Texas. A near-term decline is forecasted for California and Florida, while an increase is forecasted for Texas and New York. Except for Florida, the long-term trend of house price growth for these states is lower than in last year's Moody's forecast. The differences compared to last year's Review are shown below in Exhibit I-3b for these critical states and nationally.

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

State	Percent of FY2012 Endorsements	House Price Growth Forecast		
		FY2012	Long Term Trend 2012	Long Term Trend 2011
California	12.6%	-2.2%	3.4%	3.7%
Texas	8.8%	1.1%	2.7%	2.9%
Florida	6.2%	-2.5%	4.0%	4.0%
New York	7.3%	0.1%	3.0%	3.4%
National Average		-0.39%	3.4%	3.4%

The continued deterioration in 2012 followed by a longer-term recovery in house price growth affects the HECM portfolio in two aspects. First, recoveries on terminations will be lower in a weak housing market. The low or negative house price growth rates in 2012 and the slower long-term house price growth projection reduce the recovery of HECM loans. Consequently, HECM insurance losses tend to increase accordingly.

Second, a near-term weak house price forecast reduces the additional equity available to a borrower through refinancing. This tends to lower the likelihood of refinance terminations in the near term, which tends to lead to more future assignments. Appendix A provides a detailed discussion of HECM termination analysis.

For future HECM endorsements under the baseline scenario, the eventual return to positive house price growth is likely to improve recoveries at termination, increase HECM loan demand and increase the available equity for borrowing.

2. Interest Rates

According to Federal Reserve Board statistics, the one-year U. S. Treasury rate declined steadily over the past several years and reached its lowest point since the 1950s in 2012. 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 has 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) rates reached historic lows in early 2009 and remained around one percent.

Exhibit I-4a. Comparison of Interest Rates

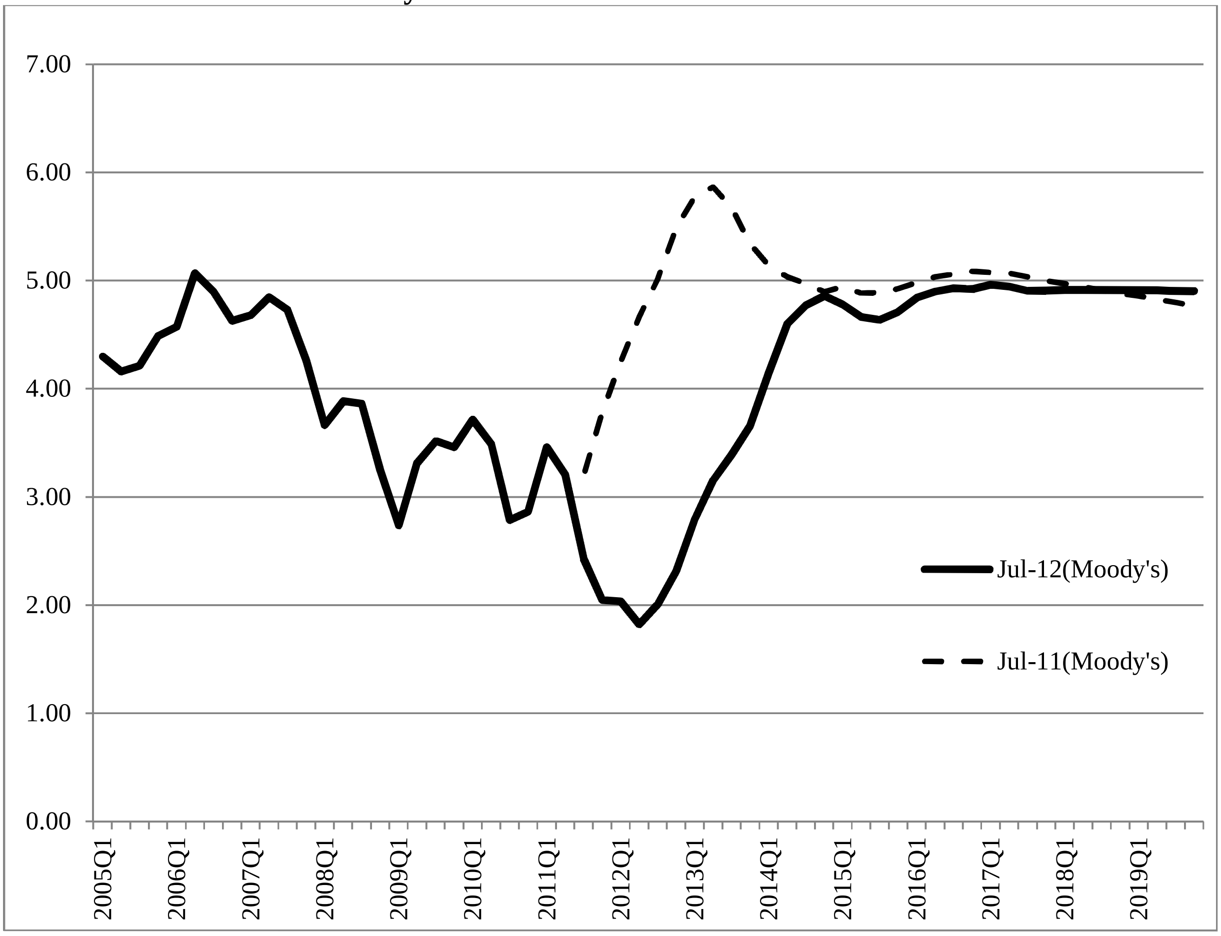
Rate type	Interest Rate		
	July-2010	**July-2011**	**July-2012**
1yr CMT	0.29%	0.26%	0.24%
10yr CMT	3.01%	3.18%	2.01%
1yr LIBOR	0.60%	0.79%	1.05%

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 4.9 percent by 2014 and then stabilize at around 5.0 percent by 2016.[13] The ten-year Treasury rate forecast implies a continued low interest rate environment, which enables borrowers to access a larger percentage of their home equity. However, even though the ten-year Treasury rates remain at low levels, 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. 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 two years. Similar to the case of house price growth rate forecasts, the realized 10-year Treasury rates since last years turned out to be much lower than what were forecasted last year. Also, the forecasts of future rates continue to be adjusted downward this year. This again is due to persistent national economic weakness and the quantitative easing monetary policy by the Federal Reserve. The continued decrease in interest rates tends to increase the probability of refinance of older books of business due to higher PLFs.

[13] At the time of the review, Moody does 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 32 percent of loans in the FY 2012 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 3.8 percent by FY 2016 and stabilize around 3.5 percent in the long run.

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 knowledge 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 114,000 endorsements in FY 2009, similar to the level in FY 2008. The Principal Limit Factor reductions listed in Exhibit I-2 and recent house price depreciation have contributed to a reduction in HECM demand growth since FY 2009. Exhibit I-5 shows the actual numbers and dollars of endorsements in FY 2009 through FY 2011 as well as the annualized values for FY 2012 (based on data as of June 30, 2012). The Exhibit also contains the baseline volume projections for FY 2013 through FY 2019 based on our updated HECM demand model described in Appendix E.

Exhibit I-5. Actual and Forecasted FY 2009 to FY 2019 Endorsements

Fiscal Year	Number of Endorsements	Average MCA per Endorsement	Total Endorsements ($millions)
2009	114,440	$ 262,763	$ 30,071
2010	79,078	$ 266,542	$ 21,078
2011	73,130	$ 249,119	$ 18,218
2012	57,519	$ 241,646	$ 13,899
2013	65,533	$ 242,690	$ 15,904
2014	73,923	$ 246,888	$ 18,251
2015	87,962	$ 256,132	$ 22,530
2016	101,389	$ 265,482	$ 26,917
2017	111,188	$ 273,528	$ 30,413
2018	118,349	$ 280,534	$ 33,201
2019	126,156	$ 288,173	$ 36,355

HECM borrowers represent about 0.9 percent of 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 improves, more seniors may have insufficient savings to sustain their financial needs in retirement, potentially increasing the demand for HECM.

Besides HECMs, there are several non-government reverse mortgage products. Typically, non-government products have higher loan limits but offer a lower percentage of home equity to borrowers. Their market share is less than 10 percent and will likely continue to shrink until the current stresses on lending institutions wane.

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 purchaser of HECM loans. As of 2012Q1, Fannie Mae held for investment $51 billion in HECM loans representing about 68 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 and the FY 2012 level has been tracking to around $9 billion.

The secondary market activities do not directly affect our actuarial projections, but a change in secondary market liquidity could 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 2009-2012 endorsement cohorts that were active at the end of FY 2012. All historical HECM data were used to analyze and better understand the performance of the program and to develop the termination model specifications. These data include loans that were endorsed under the General Insurance (GI) Fund between FY 1990 and FY 2008, as well as the loans endorsed under the MMI Fund since the start of FY 2009. Since the MMI fund was charged with covering the losses accruing in loans endorsed after FY 2008, the HECM "MMI portfolio" is defined to include only those more recent endorsements.

Borrower characteristics and loan features are based on loan-level data as of June 30, 2012. The actual endorsement volume is annualized for the remaining three months of the fiscal year. Historical economic data is obtained from Moody's economy.com website. These data include the one-year and ten-year Treasury rates, and one-year LIBOR rates, and the house price appreciation rates for the Federal Housing Finance Agency (FHFA) Conventional and Conforming loans. FHA provided estimates of borrower characteristics for future endorsements. FHA also provided the house price appreciation adjustment factors reflecting the home-maintenance risk for HECM borrowers. 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 2012 through FY 2019 MMI 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 2012.
- Section V. HECM Performance under Alternative Scenarios -- presents the HECM portfolio valuations using various alternative economic and scenarios.
- Section VI. Summary of Methodology -- presents the loan performance and cash flow models used to estimate the economic values included 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 IFE Group's updated tax and insurance default model development. 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 development and its implementation.
- Appendix F. Stochastic Forecast of Economic Variables -- presents the time series econometric model estimates of stochastic economic variables that drive the uncertainty of future economic conditions.

Section II. Summary of Findings

This section presents the economic values of the FY 2012 to FY 2019 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 endorsements from future fiscal years.

A. The FY 2012 Actuarial Review

The FY 2012 Actuarial Review assessed the actuarial soundness of the HECM portfolio in the MMI Fund as of the end of FY 2012 and projected the status of the portfolio through FY 2019. In this Review, we:

- Analyzed all HECM historical termination experience and the associated recoveries using loan-level HECM data maintained by FHA through June 2012.
- Developed loan termination models to estimate the relationship between loan termination cash flows and various economic, borrower and loan specific factors.
- Constructed a Monte Carlo stochastic simulation model for 100 possible economic scenarios of interest rates and house price index. These economic paths were calibrated to center around the baseline macroeconomic forecast published by Moody's Analytics.
- Estimated future cash flows associated with the FY 2012 to FY 2019 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 2012 through FY 2019, using expected cash flows from the Monte Carlo simulation and discount rates prescribed by OMB.
- Conducted scenario analysis using two of Moody's alternative scenarios, and a low interest rate scenario. Three scenarios from our Monte Carlo simulation paths were also included.

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 2012 was estimated to be *negative* $2,799 million.
- The economic value of the HECM MMI portfolio was projected to improve steadily over the next seven years and become *negative* $426 million by FY 2019.

- 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 $78.21 billion at the end of FY 2012 and was estimated to increase to $190.02 billion by the end of FY 2019.

Exhibit II-1. Economic Value, Insurance-In-Force, and Endorsements for FY 2012 through FY 2019 ($ Millions)

Fiscal Year*	Economic Value	Insurance in Force**	Volume of New Endorsements***	Economic Value of Each New Endorsement Book	Investment Earnings on Fund Balance
2012	-$2,799	$78,214	$13,899	-$385	
2013	-2,668	93,309	15,701	151	-22
2014	-2,226	105,106	17,504	480	-43
2015	-1,803	119,246	21,719	465	-48
2016	-1,306	135,834	27,472	543	-55
2017	-876	153,787	33,308	472	-53
2018	-541	171,150	37,512	368	-46
2019	-426	190,024	41,933	137	-37

* 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 count model in Appendix E multiplied by the average MCA.

B. Changes in the Economic Value

The FY 2011 HECM Review estimated that the HECM portfolio had an economic value of positive $1,358 million at the end of FY 2011 compared to the estimate of this year's Review of *negative* $2,799 million at the end of FY 2012. 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 $4.25 billion at the end of FY 2011. As measured and projected during FY 2012, the net insurance income, the net gains from investments, and the net change in value of properties in inventory increased the HECM capital resources to $4.79 billion. We estimated the net present value of future cash flows for surviving loans at the end of FY 2012 as *negative* $7.59 billion. The economic value at the end of FY 2012 was therefore estimated as *negative* $2.80 billion.

Exhibit II-2. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2012 ($ Millions)

Item	End of FY2011[1]	End of FY2012
Cash	$4,236	
Investments	0	
Properties and Mortgages	23	
Other Assets and Receivables	(1)	
Total Assets	$4,258	
Liabilities (Account Payables)	(12)	
Total Capital Resources	$4,246	
Net Gain from Investment[2]		$148
Net Insurance Income in FY 2012[3]		330
Net Change in Value of Property Inventory		77
Net Change in Accounts Payable		-14
Total Capital Resources as of EOY		**$4,787**
PV of Future Cash Flows on Outstanding Business		-7,586
Economic Value		**($2,799)**
Insurance-In-Force		**$78,214**

(1) Source: Audited Financial Statements for FY 2011
(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 2012
(3) Includes premium inflow and claim outflow during the fiscal year

C. Decomposition of the Differences in the FY 2012 Economic Value as Reported in the FY 2011 Review and the FY 2012 Review

The economic value of the HECM portfolio in the MMI fund changed from positive $1.36 billion in FY 2011 as estimated in the FY 2011 Review to *negative* $2.80 billion in FY 2012 as reported in this year's Review, representing a decrease in value of $4.16 billion. This change resulted from data changes, assumption changes and modeling changes.

In Exhibit II-3, we present the step-by-step changes in the economic value from the FY 2011 Review to the FY 2012 Review. A similar analysis for FY 2018 is also included. Note that FY 2018 is the last projected fiscal year common to both Reviews.

The FY 2012 HECM portfolio economic value presented in the FY 2011 Review was $2.11 billion. After updating three changes in the accounting statement item adjustments, as shown in the table, we describe the decomposition in more detail starting with the FY 2011 Fund valued at $2.17 billion.

Exhibit II-3. Sources of the Change in Economic Value for the HECM Portfolio in the MMI Fund between FY 2010 and FY 2011 ($ Millions)

Decomposition Steps	Change in FY 2012 Economic Value	FY2012 Economic Value	Change in FY 2018 Economic Value	FY 2018 Economic Value
FY 2011 Economic Value Presented in the FY 2011 Review(1)		$1,358		
FY 2012 Economic Value Presented in the FY 2011 Review Excluding the FY 2012 Book-of-Business	$7	$1,365		
Plus: Forecasted Value of FY 2012 Book-of-Business Presented in the FY 2011 Review	$742			
Equals: FY 2012 Economic Value Presented in the FY 2011 Review		$2,107		$10,033
Plus: Updated Capital Resources as the End of FY2011	-$2	$2,105	-$2	$10,031
Plus: Net Change in Value of Property Inventory	$77	$2,182	$88	$10,119
Plus: Net Change in Accounts Payable	-$14	$2,168	-$16	$10,103
Plus: (i) Updated Origination Volume in FY 2012	-$163	$2,005	-$2,226	$7,876
Plus: (ii) Updated Forecast of Composition	-$22	$1,983	$426	$8,302
Plus: (iii) Updated Valuation Model	-$2,369	-$386	-$1,498	$6,805
Plus: (iv) Updated Discount Factors	$179	-$207	$533	$7,338
Plus: (v) Updated Economic Forecast: HPI	-$462	-$669	-$2,378	$4,960
Plus: (vi) Updated Economic Forecast: Interest Rates	$200	-$469	$667	$5,627
Plus: (vii) Updated Loan Conveyance Projection	-$1,918	-$2,387	-$2,490	$3,137
Plus: (viii) Introduced Monte Carlo HPA Simulation	-$224	-$2,611	-$1,440	$1,696
Plus: (ix) Introduced Monte Carlo Interest Rate Simulation	-$188	-$2,799	-$2,237	-$541
Equals: Estimate of Economic Value	-$4,906	-$2,799	-$10,574	-$541

(1) Economic value as of the end of FY 2011.

(i) Updated Endorsement Volumes

In the 2012 Review, the volume of endorsements occurring in FY 2011 and FY 2012 was approximately $4.66 billion lower than the endorsement projections used in the 2011 Review. The lower volume translated to about $163 million in lower economic value. The lower volumes of projected future books reduce the economic value of the FY 2018 portfolio by $2,226 million.

(ii) Updated Forecast of Compositions

The FY 2011 Review assumed that the percentage of the endorsement volume of the Saver program will gradually increase from 10 percent in FY 2012 to 20 percent in 2017 and later. The actual endorsement volume of the Saver programs was 7 percent for the fiscal year through June 30, 2012. This year, it was assumed to be a constant 7.5 percent.

The realized and revised assumption of the Saver program share reduced the FY 2012 economic value by $22 million and increased FY 2018 economic values by $426 million.

(iii) Updated Valuation 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. The model update resulted in slower termination rates relative to last year's model, and hence prolonged the time until recoveries and yielded lower economic values.

Appendix D describes the tax and insurance default model that was implemented in this year's Review. The model estimates the timing, frequency and cash flow impacts of tax and insurance defaults. For example, a tax and insurance default can happen before or after a loan is assigned to FHA. If a borrower defaults from a tax and insurance delinquency, the amount of tax and insurance arrearage was added to the borrower's unpaid balance until a loan is disposed (two years after the occurrence of the default). Compared with last year, this updated model projects a higher tax and insurance default rate for the 2009 book of business and lower default rates for 2010 to 2012 books of business.

The combined effect of valuation model and assumption changes was to reduce the FY 2012 and FY 2018 economic values by $2,369 million and $1,498 million, respectively.

(iv) Updated FY 2012 Office of Management and Budget (OMB) Discount Factors

This decomposition step shows the effect of the updated discount factors. The latest OMB published discount factors are larger than the values used in last year's Reviews. (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 value of future positive cash flows such as insurance premiums and recovery revenue. As the result of these offsetting effects, the FY 2012 HECM economic value increased by $179 million, and the FY 2018 HECM economic value increased by $533 million.

(v) Updated Economic Forecast: House Price Growth Rates

The HECM portfolio is more concentrated in states that had lower long-term house price growth rates compared to last year's projection. As was illustrated in Exhibit I-3, the high-volume states of California, Texas, Florida and New York had an average decrease of 0.26 percentage points in the long-term house price growth rate in this year's Review compared to last year's Moody's forecast. As a result, this update has a negative impact on the FY 2012 and the FY 2018 economic values: they are estimated to decrease by $462 million and $2,378 million, respectively. 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.

(vi) 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 2018. Lower interest rates have offsetting effects: they increase loan endorsement volume and delay assignment dates, but 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—fixed-rate HECM balances accrue depending on the HECM's initial ten-year Treasury rate (which determines the HECM contract rate) whereas adjustable-rate HECM balances accrue depending on the one-year Treasury or LIBOR rates. Compared to last year, this year's Review used lower ten-year Treasury rates in the near term but higher ten-year Treasury rates after FY 2030. These offsetting factors resulted in an increase of economic values in FY 2012 and FY 2018 of $200 million and $667 million, respectively.

(vii) Updated Loan Conveyance Projection

The conveyance rate upon termination increased sharply during the last year. The projection of future conveyance rates was increased to take into account this recent phenomenon. Due to the higher expenses associated with the conveyance type termination, this assumption change led to a significant reduction in the economic value of the HECM portfolio. This higher projected conveyance rate reduces the economic value of the HECM portfolio by $1,918 million and $2,490 million for FY 2012 and FY 2018, respectively.

(viii) Introduced Monte Carlo Stochastic HPA Simulation

This year, economic value was based on 100 simulated economic paths using stochastic processes described in Appendix F. It is the average net present value under each equally likely path. Using these stochastic HPA paths and deterministic interest rates (Moody's baseline interest rates) resulted in a $224 million reduction of economic value in FY 2012 and a reduction of $1,440 million in FY 2018.

(ix) Introduced Monte Carlo Stochastic Interest Rate Simulation

When both HPA and interest rates are simulated through Monte Carlo Stochastic processes, the economic value further decreased by $188 million in FY 2012 and by $2,237 million in FY 2018.

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Section III. Current Status of HECMs in the MMI Fund

This section presents the components of the economic value in FY 2012 and also the projections through FY 2019. The HECM portion of the MMI Fund has an estimated economic value of *negative* $2,799 million at the end of FY 2012. 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

The components that constitute the MMI capital ratio are the economic value and the insurance-in-force. This section discusses each of these components.

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 component 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 2012. Exhibit III-1 presents the components of the economic value for FY 2012.[14] Data through June 2012 was annualized to estimate the total capital resources and the loan performance to the end of FY 2012. The total economic value consists of the following components:

- *Total Capital Resources* equals assets less liabilities in FY 2011 plus additional cash available from investments, fund transfers, and operational activities during FY 2012. We estimated the total capital resources to be $4,787 million at the end of FY 2012, 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 $4,258 million as of FY 2011.
  - *Total Liabilities* include the accounts payable. This is equal to $12 million as of the end of FY 2011.
  - *Net Gain from Investments* includes the estimated revenue from the investment of capital resources and the interest from the HECM Financing Account during FY 2012. The total investment gain is $148 million.

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

- *Net Insurance Income in FY 2012* includes the estimated premium, claims, and recoveries, derived by annualizing the year-to-date data for FY 2012. The net insurance income from the still-active FY 2009 to FY 2012 endorsements is $330 million.

- *Net Change in Value of Property Inventory* refers to the change in the value of the inventory of HECM-funded properties that are real estate held by HUD. The value of properties in inventory is projected to increase by $77 million by the end of FY 2012, largely due to the increase in the number of such properties.

- *Net Change in Accounts Payable* is the change of balance in Accounts Payable from the beginning to the end of FY 2012. It is *negative* $14 million.

- *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* $7,586 million as of the end of FY 2012.

Exhibit III-1. Projected Economic Value of the HECM Portfolio in the MMI Fund at the End of FY 2012 ($ Millions)

Item	End of FY2011[(1)]	End of FY2012
Cash	$4,236	
Investments	0	
Properties and Mortgages	23	
Other Assets and Receivables	(1)	
Total Assets	$4,258	
Liabilities (Account Payables)	(12)	
Total Capital Resources	$4,246	
Net Gain from Investment[(2)]		$148
Net Insurance Income in FY 2012[(3)]		330
Net Change in Value of Property Inventory		77
Net Change in Accounts Payable		-14
Total Capital Resources as of EOY		**$4,787**
PV of Future Cash Flows on Outstanding Business		-7,586
Economic Value		**($2,799)**
Insurance- In- Force		**$78,214**

(1) Source: Audited Financial Statements for FY 2011.
(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 2012.
(3) Includes premium inflow and claim outflow during the fiscal year.

2. Insurance-in-Force

Another major component of the capital ratio calculation is the insurance-in-force (IIF). According to NAHA, the IIF is defined as the “obligation on outstanding mortgages.” We estimate the current IIF as the total maximum claim amount (MCA) of all HECM loans remaining in the insurance portfolio as of the end of FY 2012. 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. MCA is the highest claim amount FHA can pay out at insurance termination (however, FHA may bear additional negative cash flows after a note assignment). Therefore, we use MCA as the measure of IIF.

At the end of FY 2012, the estimated IIF is $27.11 billion for the FY 2009 endorsements, $19.62 billion for the FY 2010 endorsements, $17.66 billion for the FY 2011 endorsements, and $13.82 billion for the FY 2012 endorsements for a total of $78.21 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.[15] 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 equally likely simulated paths. On this basis, we project the economic value of the MMI HECM portfolio to gradually recover from *negative* $2.80 billion in FY 2012 to *negative* $426 million in FY 2019, as shown in the first column of Exhibit III-2. This recovery is due to the projected positive economic value brought to the Fund by new endorsements. The higher annual insurance premiums and the return to positive house price appreciation starting FY 2013 makes these newer books profitable. However, their contribution is not large enough to offset the negative economic value contributed by the existing portfolio.

With the addition of new endorsements, the total insurance-in-force is estimated to increase from $78.21 billion at the end of FY 2012 to $190.02 billion in FY 2019. This represents an average increase of $19.75 billion per year.

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

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
2012	-$2,799	$78,214	$13,899	-$385	
2013	-2,668	93,309	15,701	151	-22
2014	-2,226	105,106	17,504	480	-43
2015	-1,803	119,246	21,719	465	-48
2016	-1,306	135,834	27,472	543	-55
2017	-876	153,787	33,308	472	-53
2018	-541	171,150	37,512	368	-46
2019	-426	190,024	41,933	137	-37

* 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.

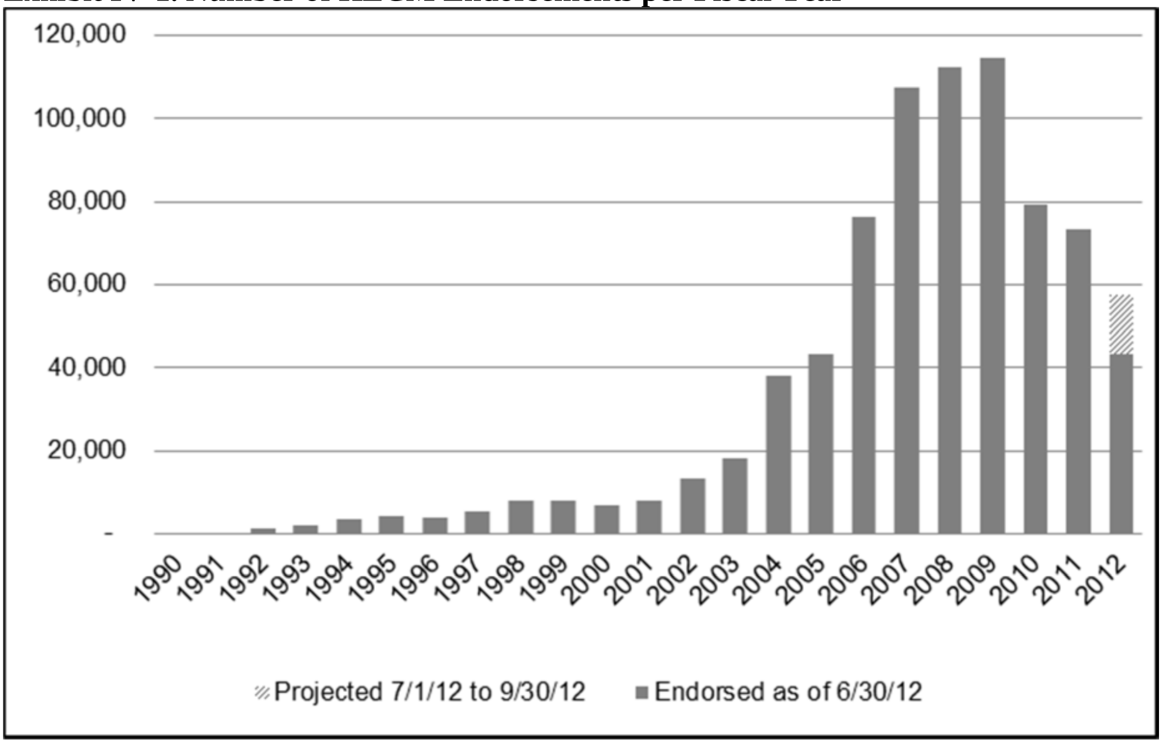
Section IV. Characteristics of the MMI HECM Books of Business

This section presents the characteristics of the FY 2009 through FY 2012 HECM endorsements. The HECMs from these books of business that have not terminated constitute the MMI HECM portfolio as of the end of FY 2012. 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 are shown for prior books as well, to indicate trends. All data used for this analysis were provided by FHA as of June 30, 2012.

A. Volume and Share of Mortgage Originations

FHA endorsed 43,139 HECM loans from October 1, 2011 to June 30, 2012, with a total dollar value, defined as the MCA, of $10.4 billion. The annualized number of endorsements in FY 2012 is thus 57,519 and the corresponding dollar value is $13.9 billion. The number of endorsements in FY 2009 was 114,440 and the corresponding dollar value was $30.1 billion. The number of endorsements in FY2010 was 79,078 and the corresponding dollar value was $21.1 billion. The number of endorsements in FY 2011 was 73,130 and the corresponding dollar value was $18.2 billion. Since the inception of the HECM program, this program has been the largest reverse mortgage product in the market, representing more than 90 percent of total reverse mortgages in the market. Exhibit IV-1 presents the count of HECM endorsements by fiscal years.

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



B. Payment Types

HECM borrowers receive loan proceeds by selecting from various payment plans, *i.e.*, term, line of credit, tenure, lump sum, or their combinations. Exhibit IV-2 presents the distributions of HECM endorsement between FYs 2009 and 2012 by payment plan. As of June 30, 2012, the majority of HECM borrowers selected either the line of credit or the lump sum option. These two options accounted for 94 percent of the FY 2012 endorsements.

Exhibit IV-2. Distribution of FY 2009-FY2012 HECM Loans by Payment Type

FY	Loan Type	Term	Line of Credit	Tenure	Term + Line of Credit	Tenure + Line of Credit	Lump Sum	Total
2009	Number of Loans	1,188	101,894	2,192	4,208	2,618	2,340	114,440
	Percentage	1.04%	89.04%	1.92%	3.68%	2.29%	2.04%	100%
2010	Number of Loans	484	65,855	1,125	2,096	1,356	8,162	79,078
	Percentage	0.61%	83.28%	1.42%	2.65%	1.71%	10.32%	100%
2011	Number of Loans	413	32,215	1,212	1,938	1,177	36,175	73,130
	Percentage	0.56%	44.05%	1.66%	2.65%	1.61%	49.47%	100%
2012	Number of Loans	212	14,486	698	1,060	717	25,966	43,139
	Percentage	0.49%	33.58%	1.62%	2.46%	1.66%	60.19%	100%

C. Interest Rate Type

HECM borrowers can select fixed or adjustable rate mortgages. Exhibits IV-3 shows the distribution of HECM endorsements between FYs 2009 and 2012 by interest rate type. The majority of HECM borrowers (88 percent) selected monthly or annually adjustable rate mortgages in FY 2009. The percentage of fixed-rate endorsements increased sharply from 12 percent in FY 2009 to 69 percent in FY 2010 and stabilized at 68 percent of endorsements in FY 2011 and FY 2012.

The LIBOR-indexed loans constituted 37 percent, 60 percent, 61 percent and 68 percent of the FY 2009 through FY 2012 HECM endorsements, respectively. FHA introduced LIBOR as a HECM index option on October 12, 2007. LIBOR-indexed endorsements have steadily increased since then due to changes in market environment, one of which was that Fannie Mae, the major HECM purchaser, discontinued purchasing U. S. Treasury-indexed HECMs as of September 1, 2009.[16]

[16] See Fannie Mae Selling and Servicing Guides Announcement 09-16, published on June 1, 2009.

Exhibit IV-3. Distribution of FY 2009-FY2012 HECM Loans by Interest Rate Type

FY	Index Type	Libor Indexed			Treasury Indexed			Total
	Rate Type	Annually Adjustable	Monthly Adjustable	Fixed	Annually Adjustable	Monthly Adjustable	Fixed	
2009	Number of Loans	24	39,672	2,512	828	60,610	10,794	114,440
	Percentage	0.02%	34.67%	2.20%	0.72%	52.96%	9.43%	100%
2010	Number of Loans	8	24,175	23,211	11	405	31,268	79,078
	Percentage	0.01%	30.57%	29.35%	0.01%	0.51%	39.54%	100%
2011	Number of Loans	10	23,319	21,007	4	49	28,741	73,130
	Percentage	0.01%	31.89%	28.73%	0.01%	0.07%	39.30%	100%
2012	Number of Loans	9	13,676	15,477	2	79	13,896	43,139
	Percentage	0.02%	31.70%	35.88%	0.00%	0.18%	32.21%	100%

D. Product Type

Almost all of the loans endorsed in FY 2009 through FY 2012 are "traditional" HECMs, whereby 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 within a single transaction.

Among the HECM-for-Purchase loans, during FYs 2009- 2012, 15 to 30 percent of borrowers drew at least 90 percent of their maximum available equity within the first month of loan endorsement. However, these HECM-for-Purchase loans represent a small portion of the total FYs 2009 through 2012 HECM endorsements as seen in Exhibit IV-4.

Exhibit IV-4. Distribution of FY 2009-FY 2012 HECM Loans by Product Type

FY	Product Type	Traditional HECMs	HECM for Purchase: First Month Cash Draw >= 90% of Initial Principal Limit	HECM for Purchase: First Month Cash Draw < 90% of Initial Principal Limit	Total
2009	Number of Loans	113,881	86	473	114,440
	Percentage	99.51%	0.08%	0.41%	100%
2010	Number of Loans	77,689	200	1,189	79,078
	Percentage	98.24%	0.25%	1.50%	100%
2011	Number of Loans	71,591	328	1,211	73,130
	Percentage	97.90%	0.45%	1.66%	100%
2012	Number of Loans	41,906	368	865	43,139
	Percentage	97.14%	0.85%	2.01%	10%

E. Endorsement Loan Counts by State

Of all endorsements between FY 2009 and FY 2012, approximately 37 percent originated in California, Florida, Texas, and New York as measured by loan counts. California had the highest endorsement volume in FYs 2009, 2010, 2011 and 2012 at 13.7 percent, 14 percent, 13.5 percent and 12.6 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 to 9.0 percent. Its volume continued to drop to 6.8 percent in FY 2011 and 6.2 percent in FY 2012. The endorsement volume in Texas increased steadily from FY 2009 to 2012 and has been the second highest state of endorsement volume since FY 2011. The breakdown of these top four states is shown in Exhibit IV-5.

Exhibit IV-5. Percentage of Endorsements by State for FY 2009-FY2012 HECM Loans

FY	State	California	Florida	New York	Texas	Total
2009	Number of Loans	15,661	15,091	6,085	7,591	114,440
	Percentage	13.7%	13.2%	5.3%	6.6%	
2010	Number of Loans	11,061	7,110	4,624	6,312	79,078
	Percentage	14.0%	9.0%	5.8%	8.0%	
2011	Number of Loans	9,852	4,970	4,341	6,674	73,130
	Percentage	13.5%	6.8%	5.9%	9.1%	
2012	Number of Loans	5,431	2,688	3,164	3,783	43,139
	Percentage	12.6%	6.2%	7.3%	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 2012 by MCA. Approximately 69 percent of loans endorsed in FY 2009 have an MCA less than $300,000 and this percentage is approximately 66 percent for FY 2010. The number of loans with MCA less than $300,000 increased to 70 percent in FY 2011 and 71.5 percent in FY 2012.

The percentage of endorsements with an MCA between $300,000 and $417,000 dropped from 19 percent to 14 percent from FY 2009 to FY 2010, as the percentage of endorsements with an MCA greater than $417,000 increased from 12 percent in 2009 to 20 percent in 2010. 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. 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.

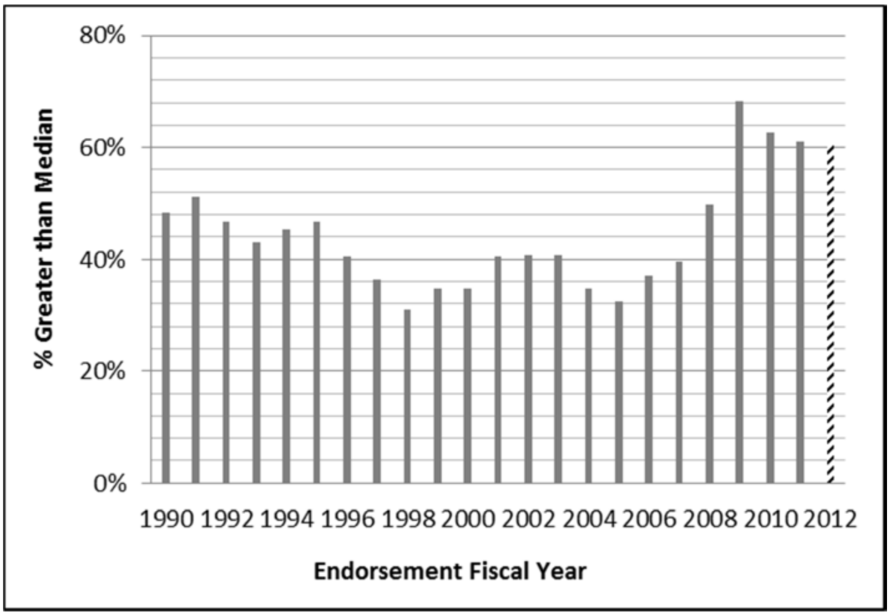
Exhibit IV-6. Distribution of FY 2009-FY2012 HECM Loans by MCA Level

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	12.2%	34.0%	20.0%	13.8%	20.1%	100%
2011	14.9%	35.7%	19.4%	12.9%	17.1%	100%
2012	16.1%	36.6%	18.8%	12.7%	15.8%	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 in the FY 2005 book of business, there began 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 remained at 61 percent of all endorsements in FY 2012.

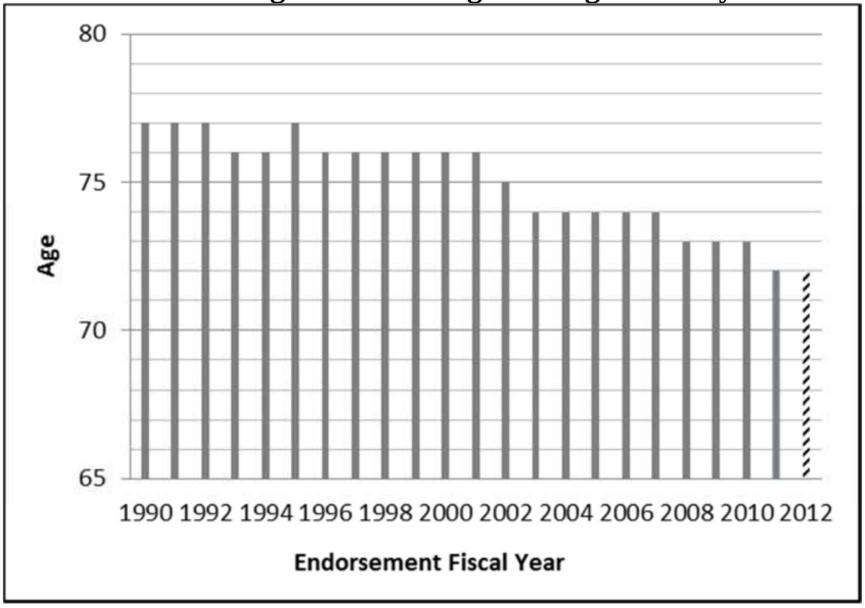
Exhibit IV-7. Percentage of Borrowers with Appraised House Value Greater than Area Median Value



H. Borrower Age Distribution

The borrower age profile of an endorsement year book of business 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 2012 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 are lower for younger borrowers, limiting them to a smaller portion of their equity. The average borrower age of the FYs 2009-2010 endorsements was about 73 years, and 72 years for FYs 2011-2012 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 2012. 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. Females also comprise the largest gender cohort of the FY 2010 endorsements at 42 percent, followed by couples at 35 percent, and males at 21 percent. A similar distribution pattern is observed for FY 2011 and FY 2012 endorsements.

Exhibit IV-9. Distribution of FY 2009-2012 HECM Endorsements by Gender

Endorsement Fiscal Year	Male	Female	Couple	Missing
2009	21.7%	40.9%	36.8%	0.6%
2010	21.5%	42.0%	35.2%	1.4%
2011	20.9%	40.4%	37.1%	1.7%
2012	21.1%	39.4%	37.2%	2.3%

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 2012.

Younger borrowers tend to draw a higher percentage of the initial amount of equity available than older borrowers. In FY 2009, 64 percent of the 62-65 age group drew over 80 percent of the initial principal limit, compared to 44 percent for the greater-than-85 years-old age group. In FY 2010, 84 percent of the 62-65 age group drew over 80 percent of the initial principal limit, compared to 53 percent for the greater-than-85 years-old age group. Similarly, in FY 2011, 83 percent of the 62-65 age group drew over 80 percent of the initial principal limit compared to 51 percent for greater-than-85 years-old age group. In FY 2012, 78 percent of the 62-65 age group drew over 80 percent of the initial principal limit compared to 51 percent for greater-than-85 years-old age group.

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 2012 HECM Endorsements as a Percentage of the Initial Principal Limit

Endorse-ment 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	23,713	11.9%	23.7%	50.9%	0.3%	13.3%
	66-70	28,217	14.5%	24.3%	48.1%	0.2%	12.9%
	71-75	24,935	18.9%	24.4%	45.3%	0.1%	11.3%
	76-85	28,906	24.7%	24.0%	41.3%	0.1%	9.8%
	85+	8,669	35.2%	20.1%	36.8%	0.1%	7.7%
	Total	114,440	19.1%	23.8%	45.5%	0.2%	11.4%
2010	62-65	17649	7.4%	8.1%	4.4%	1.3%	79.5%
	66-70	18,824	9.3%	9.8%	5.2%	1.1%	75.2%
	71-75	16,653	13.5%	11.5%	5.9%	0.8%	68.9%
	76-85	19,456	19.9%	14.1%	6.8%	0.8%	58.9%
	85+	6,496	31.7%	14.7%	8.6%	0.5%	44.8%
	Total	79,078	14.2%	11.2%	5.8%	0.9%	67.8%
2011	62-65	18,804	8.6%	10.2%	5.1%	1.1%	77.7%
	66-70	18,017	11.0%	10.8%	5.0%	1.1%	74.8%
	71-75	14,802	15.7%	11.9%	5.0%	0.9%	68.8%
	76-85	16,051	22.6%	13.9%	5.3%	0.9%	59.1%
	85+	5,456	36.2%	13.2%	5.6%	0.5%	45.5%
	Total	73,130	15.8%	11.7%	5.1%	0.9%	66.3%
2012	62-65	11,928	9.2%	10.6%	5.5%	2.9%	72.5%
	66-70	10,584	11.9%	10.7%	4.7%	2.7%	70.7%
	71-75	8,319	15.5%	11.9%	4.6%	2.4%	66.2%
	76-85	9,029	21.5%	12.6%	5.2%	2.8%	58.3%
	85+	3,279	34.3%	13.3%	5.1%	2.1%	45.8%
	Total	43,139	15.6%	11.5%	5.0%	2.7%	65.2%

Section V. HECM Performance under Alternative Scenarios

The realized economic value of HECM will vary from the Review's estimate if the actual drivers of loan performance deviate from the base case projections. In this section, we present the base case economic value from the Monte Carlo simulation and seven alternative scenarios. The base case of the Review is the mean of the economic value of the MMI HECM portfolio among the 100 simulated paths. Each alternative scenario estimates the performance of the Fund under the specific future interest rate and house price appreciation rates under the specific path with no uncertainty.

The first five alternative economic scenarios were based on our 100 simulated paths, corresponding to the paths that yield the 10th best, 25th best, 25th worst, 10th worst and the worst projected economic values. The sixth path is the most stressful scenario among Moody's Analytics alternative forecasts published in July 2012. The last scenario assumes the current low interest rate environment will extend for two more years. The seven alternative scenarios are[17]:

- 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 2012.
- Low Interest Rate Scenario, representing a continuation of the historically very low interest rate environment prevailing at the end of FY 2012.

Under Moody's protracted slump scenario, the levels of the house price indices converge to similar long-term index level of its baseline forecast. As a result, this scenario shows low house price growth rate in the short-term, followed by higher growth after cyclical bottoms. 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 indices converging to their long-term levels. This adjustment avoids having the stress scenarios show rosy 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 forecast. Appendix B provides more details about this adjustment.

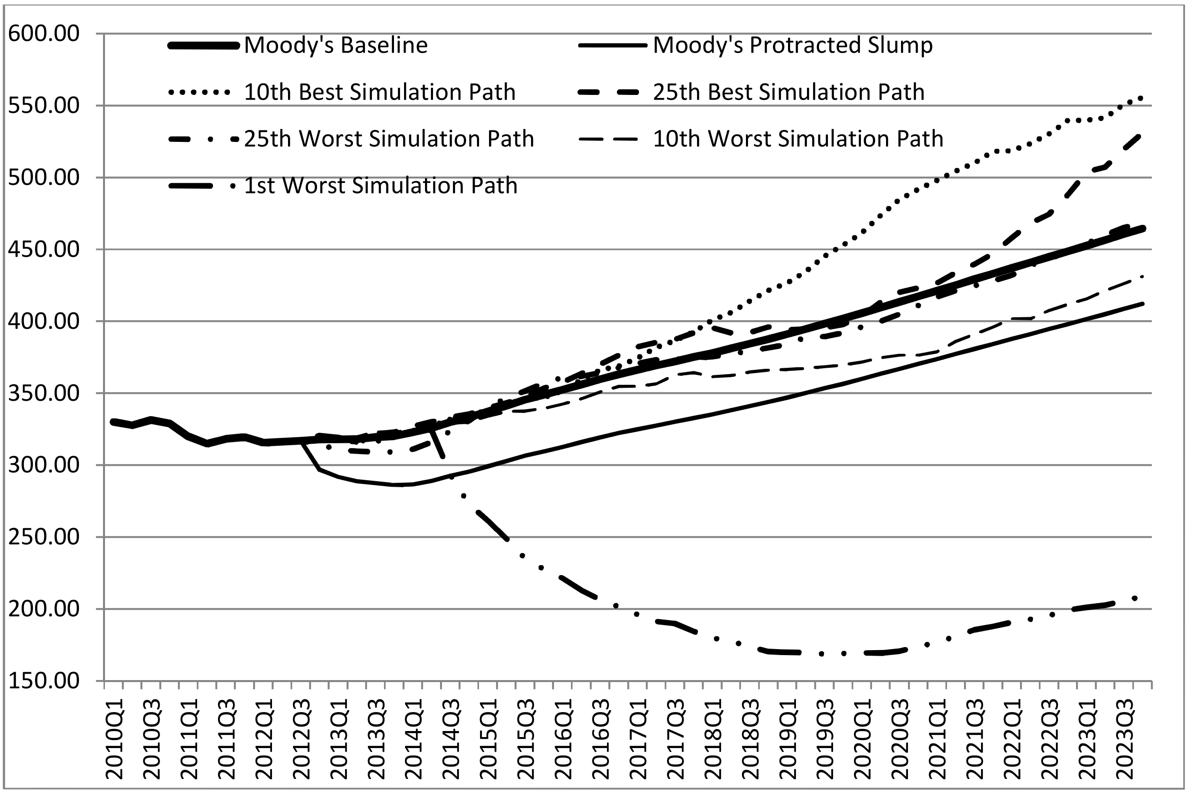
In a press release during August of 2011, the Federal Reserve Board announced its intention to keep the federal funds rate low for the next two years. On September 13, 2012 the Federal Reserve Board announced that "……the Committee also decided today to keep the target range

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

for the federal funds rate at 0 to 1/4 percent and currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015." To recognize this position, for the seventh alternative scenario we coupled Moody's July 2012 baseline house price forecast with an interest rate path that extends the current very low level for two more years and then linearly converges to Moody's July 2012 forecast path by the end of FY 2016.

Exhibit V-1 shows the future movements of the national-level House Price Index under Moody's baseline (which is the index for the low interest rate scenario) and five of the alternative economic scenarios used in our analysis (low interest rate scenario follows Moody's baseline house price forecast).

Exhibit V-1. Future National House Price Index 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 Exhibit 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 the different borrower composition provided by FHA.

Exhibit V-2 reproduces the projected expected economic value from FY 2012 through FY 2019 from our Monte Carlo simulation. This is our baseline case. Recall that this involves taking the expectation over 100 randomly sampled paths.[18] The estimated economic value of the HECM portfolio in the MMI Fund at the end of FY 2012 is *negative* $2.80 billion, and its economic value is projected to steadily grow to *negative* $426 million by the end of FY 2019.

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
2012	-$2,799	$78,214	$13,899	-$385	
2013	-2,668	93,309	15,701	151	-22
2014	-2,226	105,106	17,504	480	-43
2015	-1,803	119,246	21,719	465	-48
2016	-1,306	135,834	27,472	543	-55
2017	-876	153,787	33,308	472	-53
2018	-541	171,150	37,512	368	-46
2019	-426	190,024	41,933	137	-37

* 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 provided by 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 condition and the corresponding prepayments and claims. In addition to the estimation of the "expected" economic value of HECM, 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 among these scenarios allowed us to gain more insight into the volatility of the Fund with respect to the strength of future economic.

Exhibit V-3 presents the projected economic values for FY 2012 to FY 2019 under five different simulated future economic paths. The 10th best economic value at the end of FY 2012 is estimated to be $2.14 billion. Compared with the baseline result (the mean across the 100 paths), the estimated economic values increases by $4.94 billion in this scenario. There is approximately 10 percent chance the economic condition can be even more favorable and yield higher economic value than $2.14 billion. The projected economic value for FY 2012 under the 10th worst simulated path is *negative* $7.89 billion. There is approximately 10 percent probability that the actual realized economic value can be even more stressful than this path, and result in an

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

economic value worse than negative $7.89 billion. These two alternative scenarios suggest that there is 80 percent chance that the economic value of HECM would be between *negative* $7.89 to positive $2.13 billion in FY 2012. From these two scenarios, we found that the down side risk of HECM economic value is almost equal to the upside potential. This indicates that HECM revenue is very sensitive to the economic condition. When market condition deteriorates, claim severity increases and recoveries decrease; on the other hand, when market condition improves, claim severity decreases and recoveries increase. The impact size of downward trend on the economic value is almost the same as the upward trend.

Under the 25th best scenario, the HECM economic value is projected to be positive $592 million in FY 2012, whereas the economic value under the 25th worst scenario is projected to be *negative* $4.63 billion. These two alternative scenarios suggest that there is 50 percent chance that the economic value of HECM would be between *negative* $4.63 billion to positive $592 million in FY 2012. Under the worst scenario, the economic value of HECM is *negative* $28.34 billion in FY 2012. This is an extremely depressed scenario, with very low probability to occur. However, if such a situation occurs, it would be a national or even global disaster.

Exhibit V-3. Fund Performance 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
2012	-$2,799	$2,139	$592	-$4,633	-$7,892	-$28,343
2013	-2,668	3,146	1,240	-4,257	-9,412	-33,307
2014	-2,226	4,232	2,161	-3,893	-9,781	-36,500
2015	-1,803	5,535	3,311	-4,444	-10,032	-37,021
2016	-1,306	7,069	4,569	-4,289	-10,249	-37,899
2017	-876	8,892	5,224	-3,856	-10,676	-39,071
2018	-541	11,131	6,981	-3,259	-11,159	-40,497
2019	-426	13,432	8,512	-2,628	-11,718	-42,160

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. Fund Performance: 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
2012	$2,139	$78,214	$13,899	$393	
2013	3,146	93,276	15,062	992	15
2014	4,232	104,398	16,734	1,041	45
2015	5,535	117,491	20,699	1,224	80
2016	7,069	131,141	25,404	1,391	142
2017	8,892	147,548	31,922	1,598	226
2018	11,131	166,904	39,769	1,909	330
2019	13,432	194,546	51,877	1,840	461

Exhibit V-4 presents the projected economic values for FY 2012 through FY 2019 under the 10th best simulated path. This scenario results in the highest economic value among all alternative paths presented in this section from FY 2012 to FY 2019. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be positive $2.14 billion and positive $13.43 billion, respectively. The high economic value in this alternative path is generated by a stable and moderate house price appreciation rate before FY 2018 and a high house price appreciation rate after FY 2018. This creates a low claim loss and high recoveries. As a result, it led to the highest economic value among all scenarios through FY 2019.

Exhibit V-5. Fund Performance: 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
2012	$592	$78,214	$13,899	$72	
2013	1,240	94,713	16,498	644	4
2014	2,161	107,187	19,170	904	18
2015	3,311	123,062	23,725	1,109	41
2016	4,569	141,220	29,769	1,173	85
2017	5,224	163,599	39,079	509	146
2018	6,981	184,329	43,691	1,564	194
2019	8,512	201,894	40,765	1,242	289

Exhibit V-5 presents the projected economic values for FY 2012 through FY 2019 under the 25th best simulated path. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be positive $592 million and positive $8.51 billion, respectively. It is $1.55 billion less than the 10th best scenario. This alternative path has a fast house price appreciation before FY 2015 and a mild house price appreciation rate afterwards. This also creates a relatively low claim loss and high recoveries.

Exhibit V-6: Fund Performance: 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
2012	-$4,633	$78,214	$13,899	-$607	
2013	-4,257	92,245	14,031	408	-33
2014	-3,893	100,283	13,606	425	-61
2015	-4,444	110,772	18,338	-478	-74
2016	-4,289	122,522	24,254	270	-114
2017	-3,856	132,133	26,575	570	-137
2018	-3,259	136,800	26,270	740	-143
2019	-2,628	140,185	25,335	766	-135

Exhibit V-6 presents the projected economic values for FY 2012 through FY 2019 under the 25th worst simulated path. Under this path, the house price continues to drops through FY 2013. After FY 2013, there is a four-year period of fast house price appreciation, and then the appreciation rate slows down again. In FY 2028, a big drop of house price occurs. Consequently, this path projects a relatively low economic value through FY 2019. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be *negative* $4.63 billion and *negative* $2.63 billion, respectively.

Exhibit V-7: Fund Performance: 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
2012	-$7,892	$78,214	$13,899	-$1,317	
2013	-9,412	93,902	15,687	-1,464	-55
2014	-9,781	106,054	17,514	-234	-135
2015	-10,032	118,243	19,436	-67	-185
2016	-10,249	129,757	22,121	41	-258
2017	-10,676	138,724	24,531	-99	-327
2018	-11,159	142,363	25,005	-87	-396
2019	-11,718	142,229	24,382	-98	-462

Exhibit V-7 presents the projected economic values for FY 2012 through FY 2019 under the 10th worst simulated path. Under this path, the house price appreciates slowly until FY 2020. In 2026, the house price drops further and stays 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 2019. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be *negative* $7.89 billion and *negative* $11.72 billion, respectively.

Exhibit V-8. Fund Performance: 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
2012	-$28,343	$78,214	$13,899	-$4,731	
2013	-33,307	95,202	16,987	-4,765	-199
2014	-36,500	107,599	17,702	-2,717	-476
2015	-37,021	111,281	9,484	171	-691
2016	-37,899	105,764	4,011	72	-950
2017	-39,071	93,315	2,183	39	-1,211
2018	-40,497	75,154	1,244	22	-1,449
2019	-42,160	59,802	768	14	-1,677

Exhibit V-8 presents the projected economic values as for FY 2012 through FY 2019 under the worst simulated path. This stress path has a long protracted house price decrease and a very slow house price growth rate afterwards. This creates a severe claim loss and very low recoveries. As a result, it led to the lowest economic value by far among all scenarios for all books of business. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be *negative* $28.34 billion and *negative* $42.16 billion, respectively.

B. Other Alternative Scenarios

Exhibit V-9 and V-10 present the estimated economic value of HECM based on Moody's protracted slump economic forecasts and our low interest rate scenario. These scenarios provide a reasonableness check of the range of results obtained from the Monte Carlo simulation.

Exhibit V-9. Fund Performance: 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
2012	-$5,731	$78,214	$13,899	-$870	
2013	-5,876	89,740	11,526	-105	-40
2014	-6,079	94,382	10,603	-119	-84
2015	-5,944	101,787	13,822	251	-115
2016	-5,481	111,793	18,639	616	-153
2017	-4,882	122,343	22,873	774	-175
2018	-4,239	131,122	25,732	824	-181
2019	-3,558	138,529	28,429	856	-176

Exhibit V-9 presents the projected economic values for FY 2012 through FY 2019 under the protracted slump scenario. The economic value at the end of FY 2012 decreases from the base case *negative* $2.80 billion to *negative* $5.73 billion under this alternative scenario. This is primarily due to the higher near-term house price depreciation which reduces the amount of recovery at termination. The FY 2019 value is about $3.13 billion lower than in the base case scenario. The protracted slump scenario projects an economic value that is similar to the 18nd worst economic value in our simulation.

Exhibit V-10. Fund Performance: Low Interest Rates ($ 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
2012	-$1,760	$78,214	$13,899	-$227	
2013	-1,910	94,160	15,945	-138	-12
2014	-2,118	105,937	18,522	-180	-27
2015	-1,887	120,305	23,537	271	-40
2016	-1,001	138,134	28,605	935	-48
2017	54	155,206	32,263	1,087	-32
2018	1,177	170,102	35,101	1,120	2
2019	2,376	183,547	38,312	1,151	49

Exhibit V-10 presents the projected economic values of the FY 2012 through FY 2019 MMI HECM portfolio under the low interest rates scenario. This scenario results in higher economic values than the baseline for all years from FY2012 to FY2019. The economic values at the end of FY 2012 and at the end of FY 2019 are estimated to be *negative* $1.76 billion and *positive* $2.38 billion, respectively. The low interest rate scenario projects an economic value that is similar to that of the 36th best path in our simulation.

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 sections below 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, refinance, and mobility. A multinomial logistic regression modeling approach is adopted to capture the competing-risk structure of the different termination events. This is consistent with the approach used for the FHA single-family forward mortgage Actuarial Review.

The termination model adopts 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 and the estimated ratio of property value to the local area's median home values at time of origination.
- Dynamic variables based entirely on loan/borrower characteristics: loan age (i.e., policy year and termination rates.)
- Dynamic variables derived by combining loan characteristics with external macroeconomic data: interest rates, house price indices (determines the cumulative house price growth), the amount of additional equity available to the borrower through refinancing, and the probability of negative equity.

For each termination event, a separate binomial logistic model is estimated based on loan-level historical HECM 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 probability of negative equity over time to model the impact of potential gains from resale on the likelihood of move-out. The refinance model includes a first-month cash draw variable that acts as an indicator of the borrowers' behavioral pattern drawing cash. 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 book as of the end of FY 2012. For future books' economic value, we used projections of the composition and the level of future endorsements. Each loan creates an annual observation from its origin to the policy year when the loan reaches 35 years old, the maximum assumed duration of a HECM loan. The future HECM endorsements for FY 2013 through FY 2019 were cloned from FY 2012 endorsements. The characteristics of the future loans followed assumptions provided by FHA.

C. HECM Cash Flow Analysis (Appendix C)

The cash flow model estimates the HECM economic values for the FY 2012 through FY 2019 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 assignment, note holding expenses (post-assignment), and recoveries on assigned notes in inventory. The cash flows are discounted according to the most recent Federal credit subsidy present value conversion factors.[19]

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

In this year's Review, we used an econometric model to estimate HECM tax and insurance defaults. The specification is binomial logistic, estimating the probability that a borrower defaults on their 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 to HUD. The HECM portfolio of active loans as of June 30, 2012 has a base-case projected cumulative tax and insurance default rate of 4.2%.

E. HECM Demand Model (Appendix E)

We updated the HECM demand volume model that was introduced in last year's Review. This is a quarterly time series econometric model built on data for HECM loan counts, house price growth rates at the national level, the change in the senior population, and 1-year Treasury rates. The model predicts the number of HECM loans that will be endorsed in FY 2013 through FY 2019. Different economic scenarios or simulations for house prices and interest rates will 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 for July 2012. 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 rate and house price growth rate are the fundamental economic factors that drive future

[19] At the time of this Review, the latest annual discount factors published by the Office of Management Budget (OMB) were in November 2011.

termination rates, HECM tax and insurance default rates and the HECM demand volume in each of the stochastic simulation paths and the prescribed 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 markets that will naturally change over time in response to economic and institutional factors.

A. Basic Data Limitations

The quality of any model built on historical data will be 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. This year we have developed stochastic models to project the future distribution of house prices and interest rates using Monte Carlo simulation. Our stochastic models have been calibrated so that they are centered on Moody's July 2012 base case economic forecasts. 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 more severe 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 PLFs. 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 draw 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.

This review has not explicitly modeled the impact of future possible changes in 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 2012 actuarial analysis, we updated the methodology and the model specification from the FY 2011 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 hazard 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 HUD owns the loan and in essence self-insures) but the HECM loan itself does not terminate at this time. Hence, note assignments were not modeled as HECM loan terminations. Also note that the HECM model is an annual model, whereas the models used for FHA forward mortgage Reviews are quarterly.

The available FHA historical HECM termination and survivorship 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 2012. Only the loans endorsed under the MMI fund, however, are included to determine their economic value 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 forward and HECM loans (IFE Group 2011), a competing-risk multinomial logistic model was used to estimate the probabilities of HECM loan termination events (not including 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:

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

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

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

The probability of remaining active during the period is simply one minus the sum of these three probabilities, so the current-to-current transition is not estimated directly. The constant terms α_D , α_R, and α_M as well as the coefficient vectors β_D, β_R and β_M are the 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 were done with 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,[20] 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 2012 Actuarial Review (IFE Group 2012) 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 for HECM borrowers. The IFE Group received updated mortality data in March of 2012. Death dates were aligned with termination dates to determine which loans terminated due to 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.

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

The *Mortality* variable is used as the baseline of the mortality model. It corresponds to the gender-specific mortality rates from the 1999-2001 U.S. Decennial Life Table from the Center for Disease Control and Prevention, shifted by two years to account for the time lag between the dates of the recorded termination and the actual death. For loans with co-borrowers (couples), the likelihood of both borrowers not surviving up to the period was used to estimate the loan's overall mortality rate. *Equation 4* depicts the *Mortality* [*M(t)*] calculation.

$$M(t) = \begin{cases} m_{female}(t-2) & \text{if gender} = \text{female} \\ m_{male}(t-2) & \text{if gender} = \text{male} \\ 1-[1-m_{male}(t-2)]*[1-m_{female}(t-2)] & \text{if gender} = \text{couple} \end{cases} \qquad \{Equation\ 4\}$$

where $M(t)$ represents the gender-specific mortality for borrower with attained age t
$m_g(t)$ represents the mortality rate of gender g for borrower with attained age t based on the U.S. Decennial Life Table

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

Two additional variables specific to couples were included to capture the unique characteristics for loans with more than one borrower. Past data show that mortality-related termination rates for couples tend to be lower than the joint mortality rate estimated in Equation 4. However, the rate of increase per attained age tends to be greater than the joint mortality as the borrowers' attained ages increase. The dummy variable *Gender(Couple)*, which equals 1 if a couple and 0 otherwise, and the interaction term *Gender(Couple) x M(t)* were designed to account for this experience.

Prior HECM experience also indicates that the likelihood of death terminations increases with policy year while the death termination in the first policy year tends to be low. The time-dependent variable *PolicyYear* and the dummy variable *FirstYear* capture these factors. The former has a value equal to the number of years the loan has been active and the latter has the value 1 in the first policy year and 0 otherwise. We also include a function *Duration0* that equals the age of a loan in years, but with a limit of 4.[21] As the majority of HECM loans have been endorsed in the past seven years, we have a limited number of loans that have been in the HECM program for more than 10 years. Due to the limited number of loan termination, we restrict our sample to observations that are within policy year 10.

Historical HECM experience also suggests that different borrowers select into the HECM program which leads to differences in the borrowers' probability of death. The percentage of the first-month cash draw was found to be correlated with this borrower difference. Therefore in this year's Review, we added the variable *CashDraw* to capture the self-selection of borrowers into the HECM program.

21 The functional form of *Duration0* is specified below in A1.2.1.

A1.2. Refinance Model

The refinance model was constructed to estimate the probability a HECM loan will terminate due to the borrower refinancing the loan. The model consists of three types of explanatory variables: duration, borrower-related, and economic variables.

A1.2.1. Duration 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 *FirstYear* is the same as defined in the mortality model; variables *Duration0-Duration3* are a series of piece-wise linear functions for loan age defined as follows22:

$$\text{Duration0} = \begin{cases} \text{Loan Age} & \text{if Loan Age} \le k_1 \\ k_1 & \text{if Loan Age} > k_1 \end{cases}$$

$$\text{Duration1} = \begin{cases} 0 & \text{if Loan Age} \le k_1 \\ \text{Loan Age - } k_1 & \text{if } k_1 < \text{Loan Age} \le k_2 \\ k_2 - k_1 & \text{if Loan Age} > k_2 \end{cases}$$

$$\text{Duration2} = \begin{cases} 0 & \text{if Loan Age} \le k_2 \\ \text{Loan Age - } k_2 & \text{if } k_2 < \text{Loan Age} \le k_3 \\ k_3 - k_2 & \text{if Loan Age} > k_3 \end{cases}$$

$$\text{Duration3} = \begin{cases} 0 & \text{if Loan Age} \le k_4 \\ \text{Loan Age - } k_4 & \text{if Loan Age} > k_4 \end{cases}$$

where $k_1 = 4$, $k_2 = 9$, $k_3 = 11$ and $k_4 = 35$ years.

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

The variables *Age1-Age3*, *Gender* and *Children* are three borrower characteristics in the refinance model. *Age1-Age3* are piece-wise linear functions for the borrower's age at endorsement, whose value was held constant for the life of the loan. Historical experience suggests that older borrowers are less likely to refinance. Similarly, borrowers of different genders also refinance at differing rates. *Gender* refers to categorical variables representing female, male, and couple; with female as the baseline in this model. That is, it is not included in the equation to avoid multi-collinearity, and the coefficients of the related included variables reflect the differences from this baseline gender. Historical experience

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

suggests that couples are less likely to refinance than females, and males are more likely to refinance than females. *Children* measures the number of children of the HECM borrower. Borrowers with more children were found to be less likely to refinance in the HECM program.

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-CashDraw3*) predicted the likelihood of future refinances. Specifically, borrowers who drew large amounts of cash initially were more likely to refinance than borrowers who did not. We used piece-wise linear functions of the variable cash draw.

We used *state_CA, state_FL, state_NY* and *state_TX* as indicators for whether a HECM borrower's property is located in California, Florida, New York and Texas respectively. These four states have the largest endorsement volume of HECM loans. We used these four indicator variables to capture program awareness, which affects the 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 5 is the refinance incentive measure we used:

$$rfi_t\_new = \frac{\min\left(MCA_0 \times \Delta H, LoanLimit_t\right) \times PLF_t - C - PL_t}{C} \qquad \text{\{Equation 5\}}$$

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 included another variable *rfi* that equals the absolute value of *refi_new* to capture the slope change when the refinance incentive is positive. We also used piece-wise functions of the period-by-period interest rate change and the HPI change (*CMT10Change1-CMT10Change3*, *margin_hpa1-margin_hpa3*) to measure the periodical refinance incentive. As fixed-rate mortgage borrowers' probability of refinancing is more sensitive to interest rate changes, we interacted interest rate change with *frm*, which is a dummy variable with a value of 1 if a HECM loan is fixed-rate and 0 otherwise.

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 vs. Area Median as an indicator for whether the property value was above the median house price in the region, which has a value of 1 if property value was above the median and 0 otherwise. The local median house price data was obtained from Moody's 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 such as borrower characteristics, economic conditions, and loan-specific variables were used to define this last sub-model specification.

A1.3.1. Duration Variables for the Mobility Model

As before, the *FirstYear Dummy* variable has a value of 1 if it is the first year of the loan and zero for all other years of the loan. This variable was included in the model to reflect the limited number of loans terminating in the first policy year.

Historical experience shows that mobility begins to taper off starting in the tenth year. To model this experience, the same series of duration functions (*Duration0-Duration3*) as in refinance model were used for the mobility model.

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

Borrower-specific characteristics are also key drivers of the move-out likelihood. Historical experience suggests that gender and gender-specific mortality rates are two major determining factors.

The *Gender_Couple* categorical values are single and couple. Results show that couples are less likely to move out. *Children* indicates that borrowers with children are more likely to move out, which is consistent with the notion that these borrowers are able to move in with their children as an alternative to an assisted-living facility.

The *Mortality1-Mortality2* are piece-wise gender-specific mortality functions that are designed to capture the borrower's mobility based on health reasons, such as moving to a nursing home or assisted-living facility, or to live with their children.

We also included an 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

Historical experience suggests that higher house price appreciation increases the likelihood of move-outs. Moreover, moving out is more likely when the loan interest rate rises, which increases the outstanding loan balance due to higher accruals. Quarterly house price appreciation rates and one-year Treasury rates were obtained from Moody's economy.com website as of July 2011. *CumulativeHPA1-CumulativeHPA4* are piece-wise functions that captured the expected change in the resale value of the home. The *OneYearCMTChange* variable captured changes in interest rates.

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 was designed to capture the implicit differences in move-out behavior of borrowers whose homes have higher relative values than that of borrowers whose homes have lower relative values.

The *Probability of Positive Equity1-3* is a series of piece-wise functions based on the probability of positive equity. The probability of positive equity represents the likelihood of the estimated home value increasing above the projected loan balance during the period of observation. Historical experience indicated that HECM borrowers with a higher probability of positive equity tend to move out of their homes earlier than borrowers with a lower probability of positive equity.

The distributions of individual home values were estimated based on the house price drift and volatility parameters as computed during construction of the house price indexes. The parameters α and β below represent the variability of home values within a geographical area, which are specific to MSAs and states; i.e., they reflect the "cross-sectional" variation. The parameter c represents the variability of home values over time, which is also specific to MSAs and states. The parameters α and β were provided by FHA and sourced from the financial regulator FHFA.

Equation 7 defines the components of the diffusion volatility of an individual property based on the time elapsed since origination. Equation 8 shows the calculation of the probability of positive equity.

$$\sigma(t) = \sqrt{\alpha * t + \beta * t^2} \qquad \textit{\{Equation 7\}}$$

$$\Pr\{PositiveEquity\}(t) = 1 - \Phi\left\{\frac{\ln(UPB(t)) - \ln(HomePrice(t))}{\sigma(t)}\right\} \qquad \textit{\{Equation 8\}}$$

where *Φ(x)* is the standard normal cumulative distribution function evaluated at x.

UPB(t) is the projected unpaid loan balance at time *t*

HomePrice(t) is the projected median home value at time *t*, estimated as the multiple of the house price at origination and the change in the house price index for the MSA/State

A1.4. Combining the Three Risks

The joint termination hazard rate can be defined as

$$P(t) = \sum_{j=1}^{3} P_j(t) \qquad \textit{\{Equation 9\}}$$

where P_j is defined in Equations 1, 2, and 3; and were 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 were 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 poor. Experience with elderly homeowners has shown that as the borrower ages, the likelihood of move-outs (mobility) and refinancings decreases and hence mortality tends to dominate as the cause of terminations.

A2. Model Estimation Results

Exhibits A2-1, A2-2, and A2-3 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 A2-1. Mortality Termination Model Estimation Results

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.728	0.037	392.9	<.0001
FirstYear	1	-0.222	0.019	141.4	<.0001
Duration0	1	-0.116	0.010	134.7	<.0001
PolicyYear	1	0.086	0.004	420.1	<.0001
Couple	1	-0.375	0.128	8.6	0.0033
Mortality(-∞,-2.2)	1	0.731	0.009	6175.2	<.0001
Mortality[-2.2,+∞)	1	1.296	0.026	2504.7	<.0001
Couple*Mortality(<-2.2)	1	0.716	0.050	203.6	<.0001
Couple*Mortality(≥-2.2)	1	0.259	0.042	37.6	<.0001
CashDraw%	1	-1.053	0.015	4980.9	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	76.1	**Somers' D**	0.546
Percent Discordant	21.5	**Gamma**	0.560
Percent Tied	2.4	**Tau-a**	0.021
Pairs	112665321694	**c**	0.773

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

Exhibit A2-2. Refinance Termination Model Estimation Results

Parameter	Boundary Values	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.796	0.082	2159.7	<.0001
FirstYear		1	-0.420	0.019	517.7	<.0001
Duration0	**(0,4)**	1	0.041	0.008	28.3	<.0001
Duration1	**(4,9)**	1	-0.122	0.006	394.2	<.0001
Duration2	**(9,11)**	1	-0.324	0.031	107.6	<.0001
Duration3	**(11, 35)**	1	-0.360	0.040	81.0	<.0001
Age1	**(62,80)**	1	-0.002	0.001	4.8	0.03
Age2	**(80,90)**	1	0.013	0.003	15.1	0.00
Age3	**(90,109)**	1	0.114	0.011	101.7	<.0001
RFI		1	0.026	0.005	30.3	<.0001
RFI_new		1	0.184	0.002	8948.7	<.0001
CashDraw1	**(0,0.8)**	1	1.590	0.031	2669.2	<.0001
CashDraw 2	**(0.8,0.9)**	1	-0.979	0.174	31.5	<.0001
CashDraw 3	**(0.9,+∞)**	1	5.942	0.233	649.1	<.0001
CMT10Change1	**(-∞,-0.5)**	1	0.635	0.028	503.0	<.0001
CMT10Change 2	**(-0.5,0.5)**	1	0.570	0.022	685.1	<.0001
CMT10Change 3	**(0.5,+∞)**	1	-0.238	0.042	31.6	<.0001
Home Value > Area Median		1	0.375	0.010	1361.5	<.0001
Couple		1	-0.113	0.007	249.5	<.0001
Male		1	0.124	0.008	218.2	<.0001
Children		1	-0.114	0.012	93.9	<.0001
Cmt10Cha1*frm		1	1.782	0.051	1214.8	<.0001
Cmt10Cha 2*frm		1	0.957	0.136	49.7	<.0001
Cmt10Cha 3*frm		1	-0.251	0.383	0.4	0.51

Parameter	Boundary Values	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
LOC		1	-0.147	0.016	85.5	<.0001
State_CA		1	0.959	0.012	6285.0	<.0001
State_FL		1	-0.028	0.020	2.0	0.16
State_NY		1	0.314	0.021	232.7	<.0001
State_TX		1	-0.707	0.033	468.7	<.0001
Margin_hpa1	**(-∞,-0.05)**	1	-0.003	0.002	1.9	0.17
Margin_hpa2	**(-0.05,0.05)**	1	-0.149	0.003	1906.5	<.0001
Margin_hpa3	**(0.05,+∞)**	1	-0.013	0.002	64.2	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	74.2	**Somers' D**	0.518
Percent Discordant	22.4	**Gamma**	0.536
Percent Tied	3.3	**Tau-a**	0.019
Pairs	107352222600	**C**	0.759

Exhibit A2-3. Mobility Termination Model Estimation Results

Parameter	Boundary Value	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-4.044	0.058	4862.2	<.0001
FirstYear		1	-0.112	0.019	36.6	<.0001
Duration0	**(0,4)**	1	0.149	0.008	391.6	<.0001
Duration1	**(4,9)**	1	0.030	0.005	35.4	<.0001
Duration2	**(9,11)**	1	-0.085	0.020	18.2	<.0001
Duration3	**(11,35)**	1	-0.039	0.016	5.5	0.0187
Couple		1	-0.334	0.010	1102.9	<.0001
Children		1	0.050	0.006	72.3	<.0001
CumulativeHPA1	**(-∞,-0.1)**	1	0.004	0.001	14.2	0.0002
CumulativeHPA2	**(-0.1,0)**	1	0.033	0.002	209.4	<.0001
CumulativeHPA3	**(0,0.1)**	1	0.064	0.002	1220.3	<.0001
CumulativeHPA4	**(0.1,+∞)**	1	0.002	0.000	67.3	<.0001

Parameter	Boundary Value	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
1Year CMT Change<-0.1		1	-0.295	0.008	1407.6	<.0001
1Year CMT Change>0.1		1	0.091	0.008	126.0	<.0001
Mortality1	**(-∞,-1)**	1	0.447	0.007	4241.4	<.0001
Mortality2	**(1,+∞)**	1	0.283	0.037	58.3	<.0001
LOC		1	0.065	0.012	32.2	<.0001
Home Value > Area Median		1	0.069	0.009	56.0	<.0001
Prob(postiveEq)1	**(0,0.9)**	1	0.128	0.053	5.8	0.0164
Prob(postiveEq)2	**(0.9,0.995)**	1	3.765	0.297	161.2	<.0001
Prob(postiveEq)3	**(0.995,1)**	1	129.000	3.661	1240.4	<.0001

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	73.1	**Somers' D**	0.493
Percent Discordant	23.9	**Gamma**	0.508
Percent Tied	3.0	**Tau-a**	0.021
Pairs	124432667520	**C**	0.746

A3. Base Termination Model Implementation

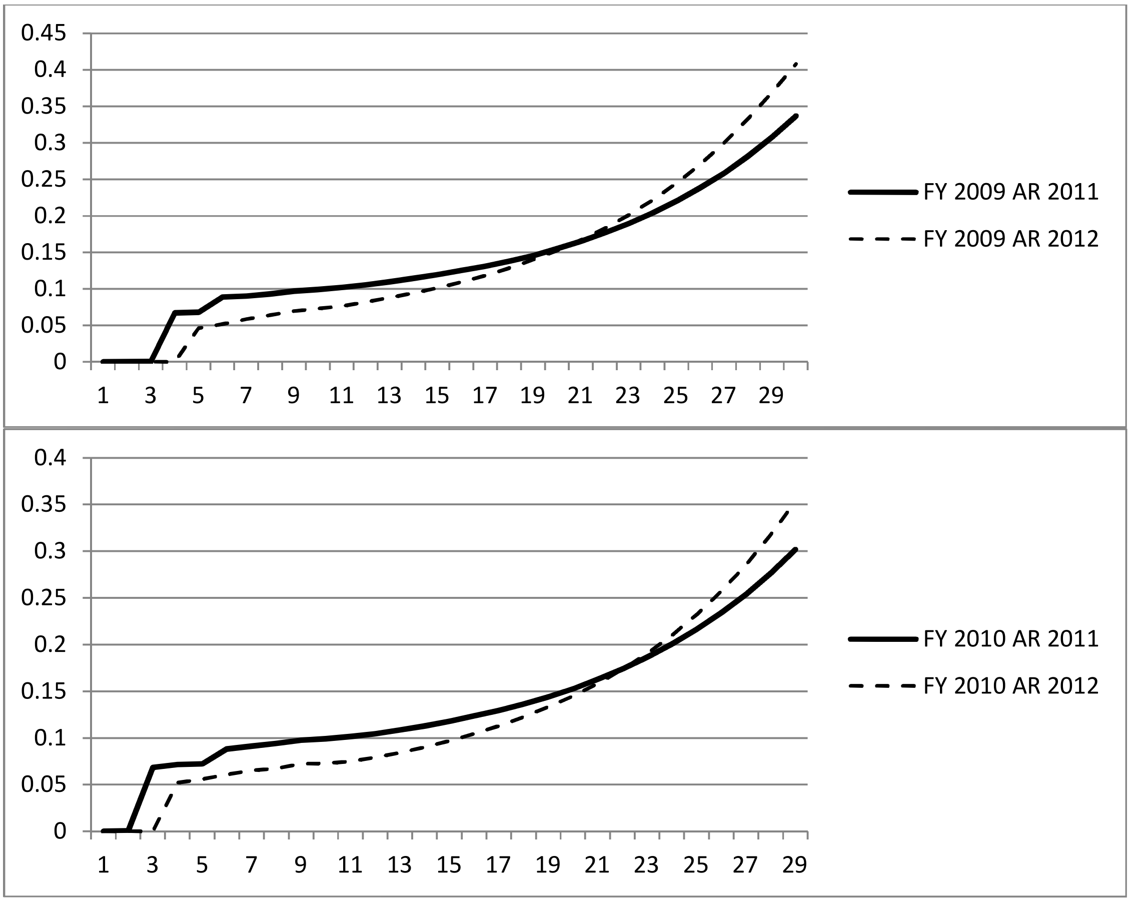
Representing the joint hazard, Exhibit A3-1 below shows the average conditional HECM termination rates among Monte Carlo simulation paths for standard loans by policy year (loan age) and the fiscal years that loans were endorsed.

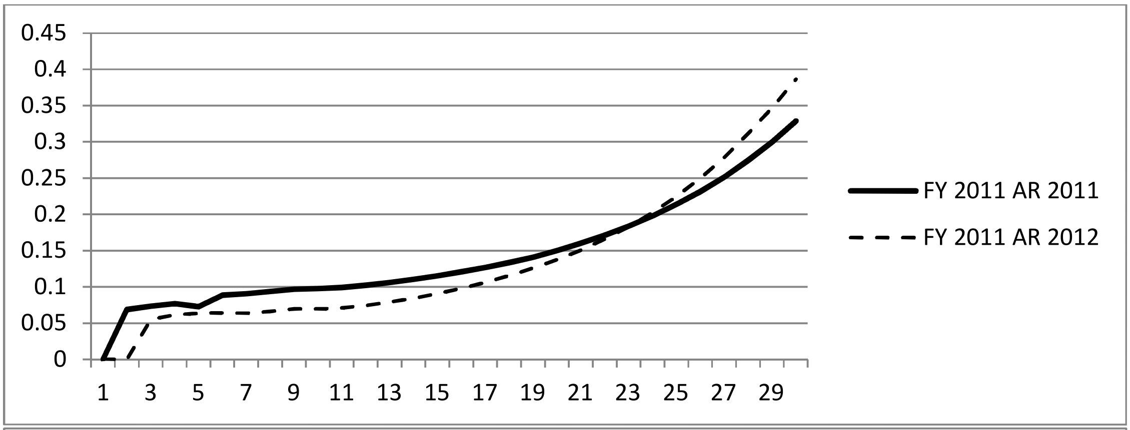
Exhibit A3-1. HECM Termination Rates Conditional on Surviving to the Beginning of the Policy Year

Policy Year	Endorsement Fiscal Year										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	.	.	.	.	4.55%	5.54%	5.99%	5.33%	5.25%	5.26%	5.23%
2	.	.	.	5.30%	6.50%	8.44%	7.81%	7.58%	7.71%	7.68%	7.68%
3	.	.	5.41%	5.88%	7.48%	8.39%	8.45%	8.54%	8.65%	8.64%	8.61%
4	.	5.14%	6.04%	6.38%	7.20%	8.81%	9.16%	9.31%	9.42%	9.35%	9.31%
5	4.52%	5.48%	6.29%	6.43%	6.78%	8.59%	8.93%	9.16%	9.26%	9.20%	9.16%
6	5.05%	5.96%	6.32%	6.15%	6.65%	8.32%	8.70%	8.99%	9.08%	9.03%	9.00%
7	5.71%	6.38%	6.26%	6.31%	6.63%	8.11%	8.49%	8.79%	8.89%	8.86%	8.83%
8	6.25%	6.60%	6.51%	6.52%	6.72%	7.99%	8.32%	8.63%	8.75%	8.71%	8.73%
9	6.78%	7.03%	6.81%	6.81%	6.91%	7.98%	8.26%	8.57%	8.67%	8.68%	8.66%
10	7.07%	7.07%	6.77%	6.75%	6.76%	7.55%	7.77%	8.00%	8.11%	8.09%	8.06%
11	7.38%	7.22%	6.86%	6.81%	6.78%	7.35%	7.51%	7.71%	7.77%	7.75%	7.73%
12	7.87%	7.59%	7.17%	7.11%	7.06%	7.48%	7.61%	7.74%	7.78%	7.76%	7.74%
13	8.39%	8.03%	7.57%	7.50%	7.44%	7.76%	7.85%	7.92%	7.95%	7.93%	7.92%
14	8.96%	8.55%	8.05%	7.97%	7.91%	8.14%	8.22%	8.25%	8.27%	8.25%	8.23%
15	9.60%	9.15%	8.61%	8.52%	8.46%	8.64%	8.70%	8.70%	8.71%	8.69%	8.68%
16	10.32%	9.83%	9.25%	9.15%	9.09%	9.23%	9.28%	9.26%	9.27%	9.25%	9.23%
17	11.12%	10.59%	9.98%	9.87%	9.81%	9.93%	9.97%	9.93%	9.93%	9.91%	9.90%
18	12.02%	11.43%	10.79%	10.67%	10.62%	10.72%	10.75%	10.70%	10.70%	10.68%	10.67%
19	13.01%	12.36%	11.70%	11.57%	11.52%	11.61%	11.64%	11.58%	11.57%	11.56%	11.55%
20	14.11%	13.40%	12.72%	12.58%	12.54%	12.61%	12.64%	12.58%	12.57%	12.56%	12.54%
21	15.33%	14.56%	13.86%	13.72%	13.68%	13.74%	13.77%	13.70%	13.70%	13.68%	13.67%
22	16.69%	15.84%	15.13%	14.99%	14.95%	15.01%	15.03%	14.97%	14.97%	14.95%	14.94%
23	18.21%	17.28%	16.56%	16.42%	16.39%	16.44%	16.46%	16.40%	16.39%	16.38%	16.37%
24	19.90%	18.88%	18.16%	18.02%	17.99%	18.04%	18.05%	18.00%	18.00%	17.98%	17.97%
25	21.81%	20.70%	19.97%	19.85%	19.81%	19.86%	19.87%	19.82%	19.81%	19.79%	19.79%
26	23.92%	22.71%	22.00%	21.89%	21.86%	21.90%	21.91%	21.87%	21.86%	21.84%	21.84%
27	26.29%	24.99%	24.30%	24.19%	24.17%	24.21%	24.21%	24.17%	24.17%	24.15%	24.15%
28	28.98%	27.59%	26.91%	26.83%	26.81%	26.84%	26.85%	26.81%	26.80%	26.78%	26.79%
29	31.88%	30.40%	29.74%	29.67%	29.66%	29.69%	29.69%	29.66%	29.65%	29.63%	29.63%
30	35.13%	33.56%	32.93%	32.87%	32.85%	32.88%	32.88%	32.85%	32.85%	32.83%	32.83%
31	38.70%	37.08%	36.47%	36.42%	36.41%	36.44%	36.43%	36.41%	36.41%	36.39%	36.39%
32	42.61%	40.97%	40.39%	40.36%	40.34%	40.37%	40.36%	40.34%	40.34%	40.32%	40.32%
33	46.84%	45.22%	44.67%	44.64%	44.62%	44.64%	44.63%	44.62%	44.61%	44.60%	44.60%
34	51.32%	49.74%	49.22%	49.21%	49.19%	49.20%	49.20%	49.18%	49.18%	49.17%	49.17%
35	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

The graphs below compare the 2011 Actuarial Review's conditional total termination rates (AR 2011) to these new results (AR 2012) for loans endorsed from FY 2009 through FY 2012. The update to the model parameters and economic conditions indicates a lower termination rate before policy year 23, compared with AR 2011. The difference of termination rates between two AR models diminishes as the loans season. The FY 2012 endorsed loans were actual loans in this year's Review but hypothetical loans in last year's Review.

Exhibit A3-2

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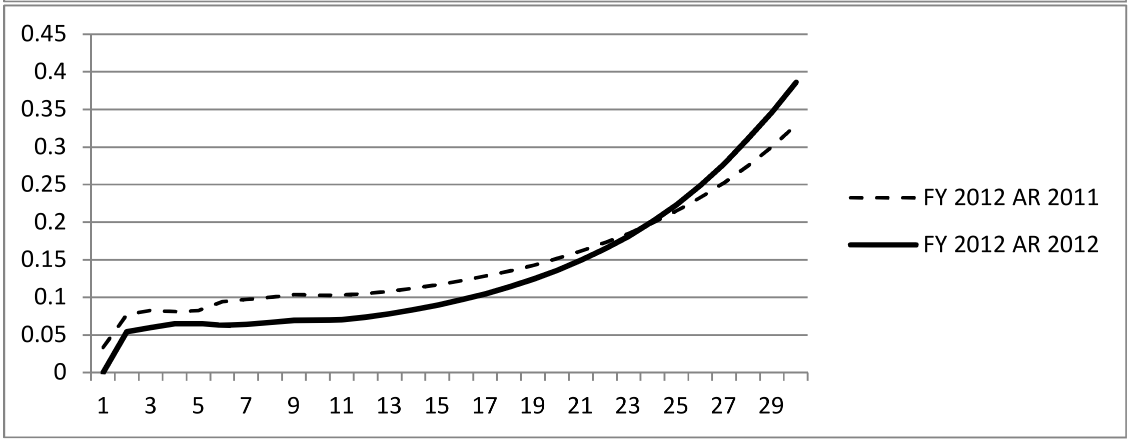
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
FY 2011 AR 2011
FY 2011 AR 2012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FY 2012 AR 2011
FY 2012 AR 2012

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 growth rates to account for deferred maintenance risk follow last year's assumptions and are also recapped 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 2013-2019.

B1. General Approach to Loan Termination Projections

HECM loan termination rates are estimated for all future policy years for each surviving (active) loan. Policy year is the annual loan age and by assumption all HECM loans will terminate no later than 35 years of life. To illustrate the initial conditions of the forecast, a loan endorsed in FY 2009, that is still active in FY2012, has its first termination rate estimated in policy year five since the first four policy years have already elapsed by the end of FY 2012 (the starting date of the forecast). Active loans are distinguished by the fiscal year of endorsement over FY 2009 through FY 2012. In addition to surviving loans from past cohorts, future endorsements are created for FY 2013 to FY 2019 as described in Section B4 below.

The variables used in the analysis are derived from loan characteristics and economic forecasts. Moody's July 2012 forecasts of interest rates and house price indices are combined with the loan data to simulate the stochastic economic paths and create all required 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 and future policy year, the derived loan variables serve as inputs to the logistic termination models described in Appendix A. The HECM model is an annual simulation model. The termination projections by type of termination are combined to generate a single conditional termination rate per policy year, representing the (joint) probability the loan will terminate in a policy year given that it survived to the end of the prior policy year. The HECM cash flow model uses these forecasted termination rates and projects the associated cash flows at termination.

B2. Economic Scenarios

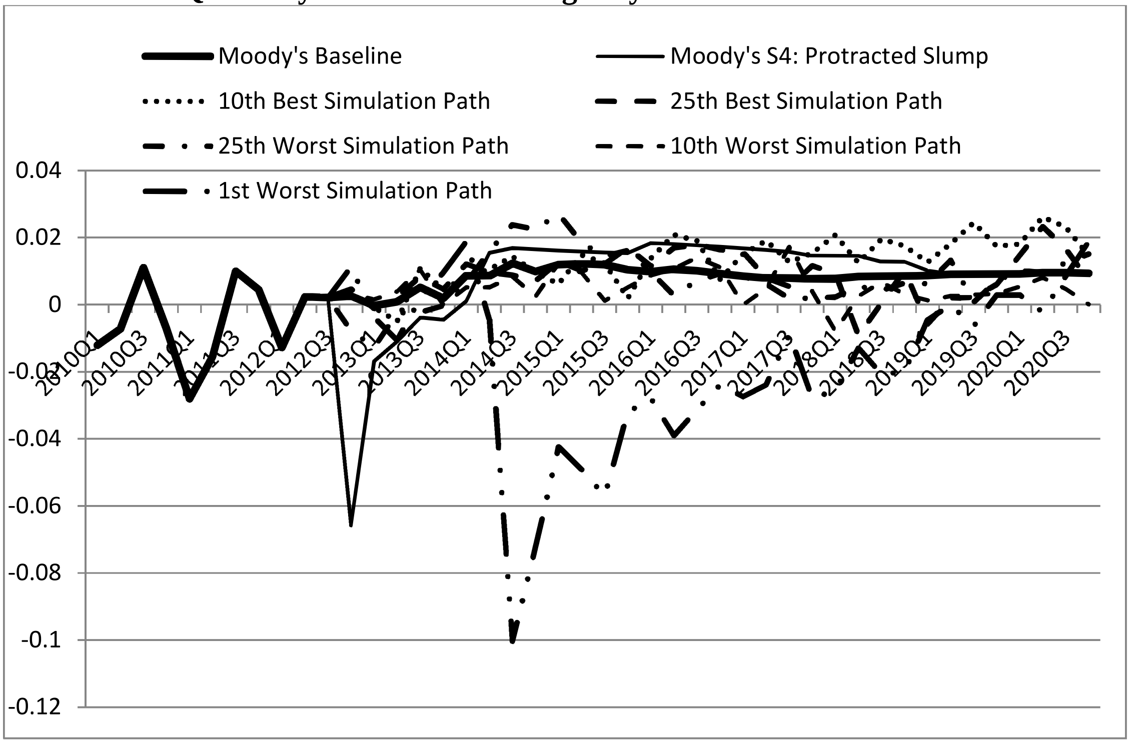
We used 100 simulated stochastic economic paths calibrated to center around Moody's baseline scenario as of July 2012 to generate our benchmark result. We also include seven alternative economic scenarios for sensitivity analysis, including five economic paths from our stochastic simulation, one economic scenario reported by Moody's economy.com website as of July 2012 and a continued low interest rates scenario. The economic factors include the FHFA national, state and MSA housing price indices, the ten-year Treasury rate, the one-year Treasury rate and the one-year LIBOR rate.

The seven alternative scenarios are:

- 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.
- Low Interest Rate Scenario, representing a continuation of the historically very low interest rate environment prevailing at the end of FY 2012.

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 inordinate faster house price growth after cyclical bottoms. As has been done in the actuarial reviews for forward mortgages (IFE Group (2012)), we used an adjustment to this methodology where the growth rates converge to long-run *growth* rates instead of converging to the base-case levels of the indices. This adjustment avoids having the stress scenarios show this faster growth after cyclical bottoms. Based on quarterly data, the graph below depicts the quarterly national home price changes historically. Moody's baseline scenario is used in the low interest rate path.

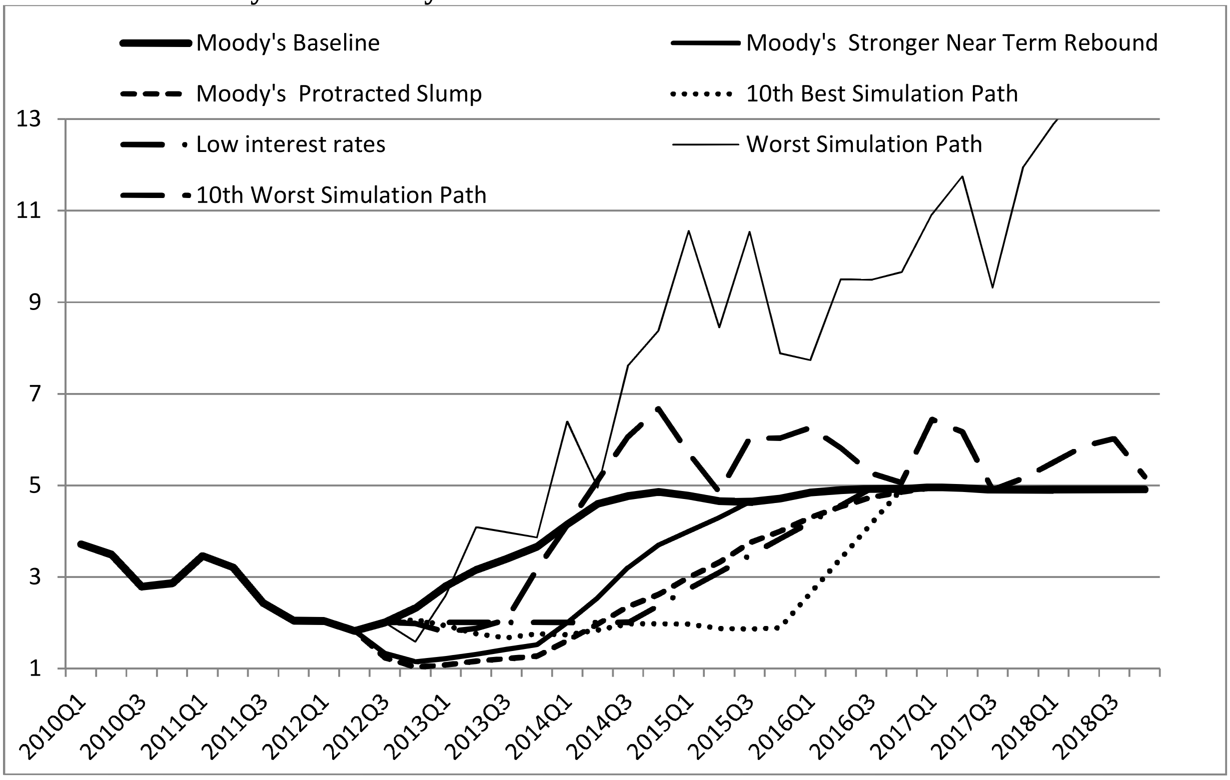
Exhibit B2-1. Quarterly House Price Changes by Six Scenarios



A similar chart for the 10-year constant maturity Treasury (CMT) rates appears below. In Moody's alternative economic scenarios, the future paths of interest rates all rise rapidly in the near term, while in a press release during August 2011, the Federal Reserve Board announced its intention to keep the federal funds rate low for the next two years. On September 13, 2012the Federal Reserve Board announced that "……the Committee also decided today to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015." To recognize this policy and the still weak economy, for the sixth alternative scenario we coupled Moody's baseline home price scenario with an interest rate path that remains at the current very low level for two more years; rates then gradually rise toward the long-term stable levels of the baseline scenario.

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 series are not shown for brevity.

Exhibit B2-2. Ten-year Treasury Rates for Six 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. Based on the work of Shiller and Weiss (2000) and Capone et al. (2010), the effect of maintenance risk is measured by the spread between the market-level house price growth rate and the HECM portfolio's house price growth rate. The research found that HECM properties with a higher value than the area's median value appreciate at higher rates than those with a value lower than the area's median value.

Exhibit B3-1. Maintenance Risk Adjustment Factors

	Annual HPA Adjustment	
Loan Age Bucket	**Loans with Property Value Above the Local Area's Median Value at Origination**	**Loans with Property Value Below the Local Area's Median Value at Origination**
1 to 2 Years	+ 2000 bps	+ 600 bps
3 to 4 Years	+ 350 bps	0 bps
5 to 6 Years	+ 160 bps	- 10 bps
7 to 8 Years	+ 100 bps	- 125 bps
9 to 10 Years	+ 0 bps	- 140 bps
11 to 12+ Years	-80 bps	- 170 bps

Thus, FHA estimated the maintenance risk adjustment factors as listed in the above Exhibit B3-1. These values remain the same as the values used in the 2011 Actuarial Review. Letting HPI denote the level of the house price index, these adjustment factors enter through the formula for the adjusted home price change multiplier "HPM":

HPM = Exponential{Natural Log (HPI at time t /HPI at origination) +
(adjustment factor from Exhibit B3-1)(loan age in years)},*

so that:

Adjusted Property Revenue Recovery = HPM*Original Property Value.

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

B4. Forecasted Endorsement Volume and Portfolio Composition

Based on HECM loan data observed through June of 2012, on the Moody's baseline economic forecast, and on the HECM total demand count model in Appendix E, Exhibit B4-1 shows forecasted HECM endorsement volumes and MCAs for FY 2012 through FY 2019. FHA recently introduced the Saver product, which has a lower upfront insurance premium and lower principal limits in comparison to the original Standard product. FHA estimated that the Saver share of HECM originations will stay constant at 7.5 percent from FY 2013 through FY 2019.

Exhibit B4-1. HECM Volume and MCA Projections

FY	Saver Average MCA	Saver Total Volume	Standard Average MCA	Standard Total Volume	Total Average MCA (Stnd & Saver)	Total Count Volume (Stnd & Saver)	Total Dollar Volume ($m, Stnd & Saver)
2012*	$353,769	4,167	$232,889	53,352	$241,646	57,519	$13,899
2013	$354,622	4,915	$233,614	60,618	$242,690	65,533	$15,904
2014	$359,925	5,544	$237,723	68,379	$246,888	73,923	$18,251
2015	$371,395	6,597	$246,787	81,365	$256,132	87,962	$22,530
2016	$382,707	7,604	$255,977	93,785	$265,482	101,389	$26,917
2017	$392,301	8,339	$263,898	102,849	$273,528	111,188	$30,413
2018	$400,539	8,876	$270,804	109,473	$280,534	118,349	$33,201
2019	$409,367	9,462	$278,346	116,694	$288,173	126,156	$36,355

* 2012 data has been annualized by multiplying actual 2012 data as of 6/30/12 by (4/3)

The assumptions on the age and gender distribution for FY 2013-2019 were based on 2012 data and are shown in Exhibit B4-2 separately for the standard and saver programs.

Exhibit B4-2. Future Endorsement Age and Gender Distribution

Standard FY 2013-19				
Age Group	Male	Female	Couple	Row Totals
62 to 65	24%	34%	43%	100%
66 to 70	21%	34%	45%	100%
71 to 75	19%	40%	41%	100%
76 to 85	21%	49%	29%	100%
85+	22%	68%	10%	100%
All Ages	**22%**	**40%**	**38%**	**100%**

Saver FY 2013-19				
Age Group	Male	Female	Couple	Row Totals
62 to 65	28%	32%	41%	100%
66 to 70	20%	33%	47%	100%
71 to 75	16%	36%	48%	100%
76 to 85	19%	51%	30%	100%
85+	15%	77%	8%	100%
All Ages	**20%**	**44%**	**36%**	**100%**

Based on recent data and expected market changes, assumptions about the future market shares of loan amortization types were projected by FHA as in Exhibit B4-3.

Exhibit B4-3. Future Distribution of Loan Amortization Types

FY	**Standard fixed rate loan %**	**Standard variable rate loan %**	**Saver fixed rate loan %**	**Saver variable rate loan %**
2012	75%	25%	11%	89%
2013-2015	75%	25%	10%	90%
2016-2019	50%	50%	10%	90%

Additional assumptions about future cash draws and related variables were also provided by FHA based on historical averages. All of these assumptions form the basis for generating loan-level data representing future HECM endorsements for FY 2013 to FY 2019. The technique clones recent endorsement records and updates the loan variables according to the various assumptions above made about 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 projected 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. HECM cash flows are discounted according to the latest discount factors published by the Office of Management and Budget (OMB). All these elements of cash flow and 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 2012).

  Insurance-In-Force (IIF): Refers to the active loans in the HUD 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 amount of time from note assignment to loan termination. During this period, HUD takes possession of the loan, now called an assigned note, and services it until loan termination.

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

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 for the HECM program. Recoveries after assignment, a cash inflow, represent cash recovered from the sale or property disposition once the loan has terminated. Claim type 1 payments are a cash outflow 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 service fees. Future borrower draws are estimated by assigning draw patterns to loans based upon the first-month draw. 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 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 source of FHA revenue for 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 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. We assume that it remains the same throughout our projection period. For FY 2011 and onward, the upfront premium rate for the recently introduced Saver option is 0.01 percent (1 basis point) of the MCA.

Typically, the upfront premium is financed by the HECM loan and hence added to the loan balance.

C2.2.2. Annual Premiums

The annual premium is calculated as a percentage of the current loan balance. For FY 2009 and FY 2010 endorsement books of business, the annual premium was 0.5 percent of the UPB. From FY 2011 and onward, the annual premium is set to 1.25 percent of the UPB for both the Standard and Saver options. Typically, the annual premium is paid by the servicer to FHA and added to the accruing loan balance.

C2.3. Claims

HECM claims consist of claim type 1s and claim type 2s.

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

Claim type 1s factor into 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 1s can be expressed as:

Indicator of pre-assignment termination × CC1R defined above × historical severity rate for claim type 1 × unpaid balance, where indicator = 1 if unpaid balance < 98% × MCA and 0 otherwise.

C.2.3.2. Claim Type 2 (Assignment)

Lenders can assign the loan to HUD when the UPB reaches 98 percent of the MCA. HUD acquires the note resulting in acquisition costs equal to the loan balance (up to the MCA). The majority of HECM lenders require the loans to be assigned to HUD when 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 equals 99 percent of the MCA. The net losses from claim type 2s also depend on the next two factors.

C2.4. Note Holding Expenses after Assignment

The note holding expenses equal the additional borrower cash draws that occur under the historically-based cash drawdown assumptions.

C2.5. Recoveries from Assigned Loans

At note termination for assigned loans, the HECM loan is due and payable to HUD. The timing of loan terminations after assignment (when UPB reaches 98% of MCA) depends on the base 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 property selling expenses. For tax and insurance 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 modeling convention, T&I arrearage thus functions like an additional property selling expense.

C3. Net Future Cash Flows

The portfolio cash flow for a book-of-business can be computed by aggregating the individual components:

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

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 loan cohort according to the latest Federal discount factors. At the time of this review, the latest discount factors published by the Office of Management and Budget (OMB) were released in November 2011 and are shown below in Exhibit C-2. For this year's Actuarial Review of HECM, we used end-of-year factors whereas last year's HECM review used middle-of-the-year values. 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 were referenced in Appendix B and F. The OMB is expected to update the discount factors in November 2012.

Exhibit C-2. OMB Discount Factors as of November 2011

Fiscal Year	Discount Factor	Fiscal Year	Discount Factor
2013	0.9930	2032	0.4432
2014	0.9790	2033	0.4204
2015	0.9609	2034	0.3986
2016	0.9368	2035	0.3779
2017	0.9078	2036	0.3581
2018	0.8753	2037	0.3393
2019	0.8405	2038	0.3213
2020	0.8050	2039	0.3043
2021	0.7693	2040	0.2880
2022	0.7339	2041	0.2726
2023	0.6995	2042	0.2579
2024	0.6662	2043	0.2440
2025	0.6341	2044	0.2309
2026	0.6033	2045	0.2184
2027	0.5737	2046	0.2066
2028	0.5453	2047	0.1955
2029	0.5180	2048	0.1850
2030	0.4920	2049	0.1750
2031	0.4670	2050	0.1656

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Appendix D

HECM Tax and Insurance Default Model

Appendix D: HECM Tax and Insurance 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 some summary descriptive statistics. Section D3 outlines the model and provides parameter estimates and other statistics. Section D4 describes some aspects of model implementation. Section D5 reports the projected cumulative lifetime T&I default rate 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 servicer guidance has the potential to impact the economic value of the HECM program. IFE Group developed a new methodology for treating HECM tax and insurance defaults in the 2011 Actuarial Review. The 2012 tax and insurance default model is enhanced upon the 2011 methodology.

D2. Data

FHA's data systems identify which HECM loans have had episodes of T&I delinquency. Some of these loans will terminate through foreclosure pursuant to ML 2011-01, some will cure, and some will terminate for other reasons. For purposes of this analysis, "default" is defined as a T&I delinquent loan not making any partial repayment in the next 12 months. 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 as 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 more repayments until month 20, this HECM loan will be considered in default during month 6 through 8. Starting from month 9, because another payment is made in month 20, the loan is not classified as in default status. As described below, 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 much more strict than that used in previous Reviews, in which a default is considered permanently cured after making any one time payment.

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 that has been used for several years. 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, 2012: 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)

CashDraw% = the percentage of cash drawdown to the maximum allowed amount in the first month of loan origination.

CashDraw90+ = 1 if CashDraw% >= 90 percent of maximum; 0 otherwise.

OrigAge = borrower age at origination.

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

FirstYear = 1 if current loan age = 1; 0 otherwise.

SecondYear = 1 if current loan age = 2; 0 otherwise.

Single Female = 1 if single female borrower; 0 otherwise

Single Male = 1 if single male borrower; 0 otherwise

stateFL = 1 if collateral property in Florida; 0 otherwise.

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

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

FRM = 1 if product is Fixed Rate; 0 otherwise.

House Price > Area Median = 1 if HECM home value at origination is above area median value; 0 otherwise.

PolicyYear = current loan age.

D2.2. Descriptive Statistics

Exhibit D-1 shows selected statistics for the estimation dataset. The data indicate that 7.7% of HECM loans have had a T&I delinquency history, among which 40% are currently in default.

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

Variable	Number of Observations	Mean	Standard Deviation
Ever Default	40,600	0.403	0.491
Default Policy Year	16,366	3.156	1.471
Cashdraw %	524,697	0.683	0.298
CashDraw90+	525,382	0.396	0.489
OrigAge	525,382	72.305	7.061
Line of Credit	525,382	0.837	0.369
Single Male	525,382	0.183	0.387
Single Female	525,382	0.428	0.495
State FL	525,382	0.131	0.337
State CA	525,382	0.168	0.374
State TX	525,382	0.066	0.248
FRM	525,382	0.175	0.380
House Price > Area Median	525,382	0.495	0.500

D3. T&I Default Model

In estimating the T&I default model, we used active loans as of 3/31/2012. Endorsements prior to FY 2000 are excluded because of data limitation. Regression results are provided below in Exhibits D-2-D-5.

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

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-6.42	0.12	2,882.42	<.0001
CashDraw%	1	3.45	0.06	3,234.09	<.0001
CashDraw90+	1	-0.22	0.02	110.72	<.0001
OrigAge	1	-0.02	0.00	168.70	<.0001
Line of Credit	1	1.07	0.06	354.60	<.0001
FirstYear	1	-0.15	0.04	17.31	<.0001
SecondYear	1	0.26	0.03	89.02	<.0001
Single Female	1	0.29	0.01	739.82	<.0001
Single Male	1	0.27	0.01	430.88	<.0001
stateFL	1	0.06	0.02	6.42	0.0113
stateCA	1	-0.39	0.03	234.00	<.0001
stateTX	1	0.61	0.02	656.81	<.0001
FRM	1	-2.52	0.07	1,302.18	<.0001
House Price > Area Median	1	-0.43	0.02	615.74	<.0001
Policy Year	1	-0.21	0.01	412.63	<.0001

Exhibit D-3. Odds Ratio Estimates

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
CashDraw%	31.642	28.090	35.642
CashDraw90+	0.804	0.772	0.838
OrigAge	0.985	0.982	0.987
Line of Credit	2.913	2.607	3.256
FirstYear	0.863	0.805	0.925
SecondYear	1.292	1.225	1.362
Single Female	2.334	2.244	2.429
Single Male	2.274	2.171	2.381
stateFL	1.060	1.013	1.108
stateCA	0.676	0.643	0.711
stateTX	1.841	1.757	1.929
FRM	0.080	0.070	0.092
House Price > Area Median	0.647	0.625	0.670
Policy Year	0.813	0.797	0.830

Exhibit D-4. Partition for the Hosmer and Lemeshow Test

Partition for the Hosmer and Lemeshow Test					
		timeDfltAny = 1		timeDfltAny = 0	
Group	Total	Observed	Expected	Observed	Expected
1	192,501	46	55.88	192,455	192,445.1
2	192,552	171	142.91	192,381	192,409.1
3	192,348	323	260.43	192,025	192,087.6
4	192,411	416	430.95	191,995	191,980.0
5	192,442	727	707.77	191,715	191,734.2
6	192,397	1,095	1,130.58	191,302	191,266.4
7	192,405	1,590	1,680.21	190,815	190,724.8
8	192,408	2,277	2,424.97	190,131	189,983.0
9	192,417	3,577	3,548.90	188,840	188,868.1
10	192,271	6,137	5,975.60	186,134	186,295.4

Exhibit D-5. Association of Predicted Probabilities and Observed Responses

Percent Concordant	76.2	**Somers' D**	0.573
Percent Discordant	19.0	**Gamma**	0.602
Percent Tied	4.8	**Tau-a**	0.010
Pairs	31,209,585,687	**c**	0.786

Based on the regression results in Exhibit D2, borrowers with a large initial cash draw exhibit a significantly higher default propensity than those with a low initial cash draw, as expected. Default risk shows an inverse relationship with original borrower age. Default risk is greater in Florida and 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 fixed-rate borrowers (vs. ARMs) and those with home prices above the area median, as expected. Single borrowers of either gender are more likely to default compared to the omitted category representing borrower and co-borrower couples.

D4. T&I Default Model Implementation

We forecast T&I default behavior using the T&I binomial logistic default model described above. A T&I default can happen in a future year only if a 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 estimated property value and that an assumed 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 16,000 such loans as of March 31, 2012. In view of the two-year disposition time assumption, these defaulted loans were treated as if default occurred in FY 2012 and the disposition will occur in FY 2014. Thus, during model implementation, the T&I default model was not applied to these loans.

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

Active delinquent loans meeting the cure definition, uncured active delinquencies with less than one year of delinquency history, active loans with no delinquency history, and future endorsements will all be 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 assigned a random number between zero and one each year as a benchmark. A loan is tagged as a T&I default in the fiscal year if the probability of default exceeds the random number benchmark. Once a loan is flagged as a default, we set the effective date of property disposition 24 months 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 incidence might diminish in the future. Incoming empirical evidence of borrower and servicer responses to ML 2011-01 should be used to reconsider 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, 2012 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-6 below. The results include loans meeting the default definition as of the forecast start date (July 1, 2012). The projected T&I default rate indicates a lower default rate for recent cohorts.

Exhibit D-6 Lifetime Tax and Insurance Default Rates by Endorsement Year

Fiscal Year of endorsements	HECM loan count	Lifetime T&I default rate
1990	9	0
1991	23	0
1992	76	0
1993	159	1.3%
1994	375	0.1%
1995	395	0.3%
1996	426	0.2%
1997	620	1.3%
1998	1,076	4.5%
1999	1,412	5.0%
2000	1,150	5.0%
2001	1,690	8.8%
2002	3,835	8.5%
2003	7,627	8.2%
2004	17,682	8.9%
2005	26,442	7.7%
2006	55,805	6.6%
2007	88,079	6.2%
2008	98,419	5.6%
2009	103,369	3.5%
2010	73,755	0.9%
2011	70,902	0.8%
2012*	42,911	1.0%
Total	**596,237**	**4.20%**

*2012 endorsements through 6/30/2012

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 2013-2019 in order to project future overall MMI economic values. The HECM demand forecasting model was designed to respond appropriately to the different economic forecast scenarios for interest rates and home prices. While the HECM analysis uses an annual periodicity, the demand model uses a quarterly periodicity that is then aggregated to an annual basis.

E2. Data

Data for the number of new HECM endorsements by quarters were compiled from FHA data files. The HECM demand model predicts loan counts, not dollar volumes. Quarterly historical and forecast data for home price indices and interest rates were obtained from Moody's economy.com website as of the end of July 2012.

HECM demand depends on the number of eligible senior homeowners who might choose the product. 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 72 (CYs 1994 Q2-2012 Q1), reflecting data availability and taking into account the lags used in connection with the explanatory variables. The forecasted data cover CYs 2012 Q2 through 2019 Q3 to encompass the FYs 2012-2019. Forecasts for 2012 Q2 and 2012 Q3 are needed to update the base for the 2012 Q4 and beyond forecast. Exhibit E-1 summarizes the input data for the demand regression.

Exhibit E-1. Input Data for the Demand Model

Period	HECM Loan Count	US. Pop>= 62years Old	1-year Treasury Rate	HPI Index
1994Q1	756	38,938,452	3.910	180.40
1994Q3	1,295	39,035,124	5.600	182.20
1995Q1	1,249	39,200,444	6.727	182.68
1995Q3	969	39,424,388	5.653	188.66
1996Q1	917	39,587,624	5.123	192.44
1996Q3	1,061	39,682,600	5.783	193.35
1997Q1	1,386	39,816,000	5.647	196.62
1997Q3	1,437	39,926,648	5.540	200.99
1998Q1	1,470	40,065,052	5.313	206.81
1998Q3	2,377	40,240,384	5.093	211.50
1999Q1	1,868	40,386,276	4.663	216.33
1999Q3	2,172	40,515,796	5.160	221.97
2000Q1	1,766	40,785,720	6.187	228.55
2000Q3	1,094	41,450,780	6.130	236.39
2001Q1	1,942	41,753,388	4.597	246.34
2001Q3	2,142	41,740,848	3.303	254.26
2002Q1	3,666	41,960,512	2.320	261.24
2002Q3	3,459	42,245,780	1.813	270.96
2003Q1	3,677	42,543,076	1.300	278.26
2003Q3	5,877	43,006,256	1.223	285.87
2004Q1	9,899	43,338,700	1.223	298.44
2004Q3	10,982	43,599,840	2.080	316.98
2005Q1	11,795	43,923,080	3.063	331.32
2005Q3	12,702	44,284,368	3.787	352.00
2006Q1	18,345	44,628,464	4.633	366.01
2006Q3	20,607	44,989,424	5.090	373.06
2007Q1	29,011	45,491,776	5.010	378.65
2007Q3	27,114	46,457,912	4.523	374.61
2008Q1	30,484	47,113,548	2.100	372.04
2008Q3	28,259	47,731,396	2.123	352.61
2009Q1	30,087	48,355,036	0.567	353.37
2009Q3	28,166	48,891,692	0.447	336.23
2010Q1	20,436	49,480,656	0.367	330.21
2010Q3	18,506	50,030,044	0.270	331.47
2011Q1	20,663	50,669,320	0.273	319.99
2011Q3	16,909	51,363,783	0.133	318.24
2012Q1	14,982	52,137,181	0.157	315.60

E3. Quarterly Time Series Model of HECM Demand

The HECM demand model specifies the natural log of the number of HECM loans endorsed in a quarter as the dependent variable. The explanatory variables include the first and second lags of the dependent variable, the contemporaneous level of the one-year Treasury rate, the year-over-year change in home prices, and the quarter-over-quarter change in the senior population size.

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

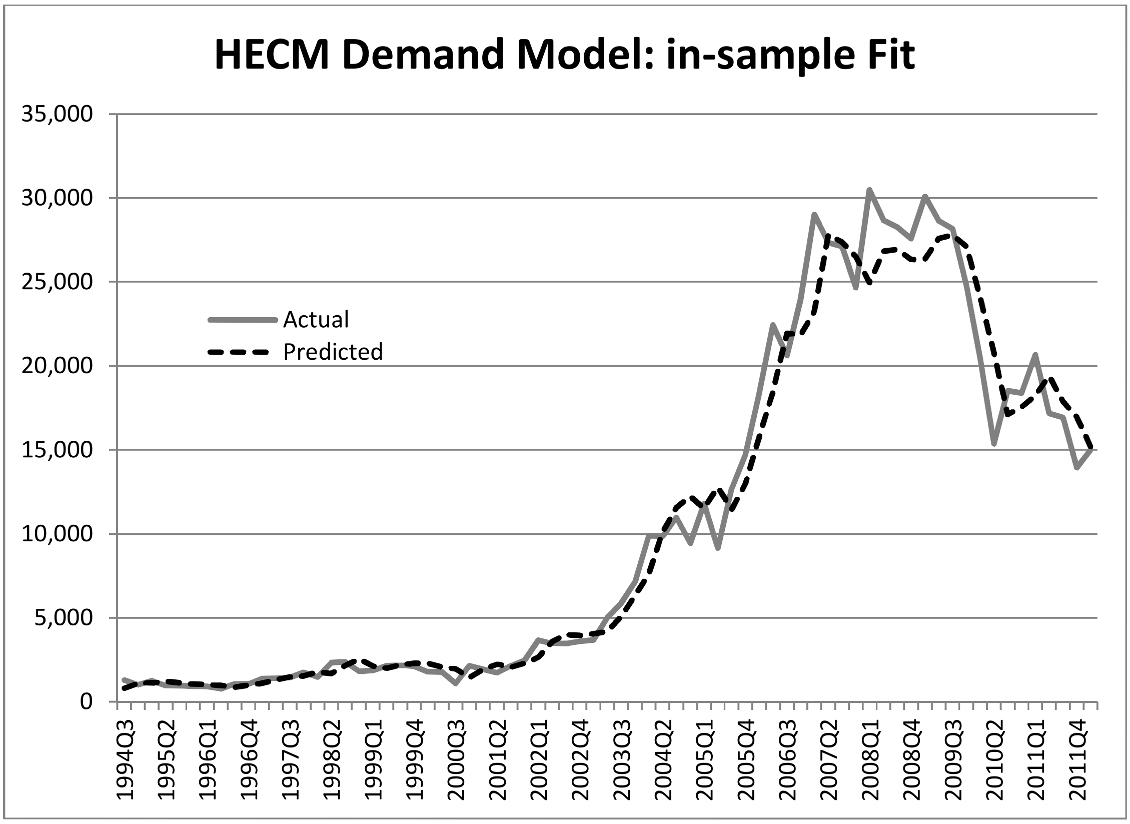
Exhibit E-2. OLS Regression of Log of HECM Loan Count

	Parameter Estimate	**Standard Error**	**t-stat value**	**Pr > |t|**
Intercept	0.2084	0.2656	0.78	0.4354
1-quarter lag of log of loan count	0.6497	0.1135	5.72	<.0001
2-quarter lag of log of loan count	0.3307	0.1148	2.88	0.0053
1-year Treasury rate at quarter t	-0.0118	0.0147	-0.80	0.4249
log (HPI at t / HPI at t - 4)	1.3899	0.5651	2.46	0.0165
log(Pop >= 62 yr at t/ Pop >= 62 yr at t - 1)	2.9184	12.5764	0.23	0.78172
Adj R-Sq = 0.9775 Durbin-Watson = 1.934 Number of Observations = 72				

Retaining the two insignificant variables—the one-year Treasury rate and the senior population growth rate—was necessary to endow the forecast implementation with more responsiveness to macro factors.

The model's in-sample fit is shown in Exhibit E-3.

Exhibit E-3. HECM Demand Model



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

The implemented HECM demand model takes as inputs scenario forecasts of interest rates, 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, the HECM volume model's 0.2084 intercept was reduced by 5 percent in the model implementation to calibrate to FHA's projection of demand volumes. We applied the model to project demand under alternative economic scenarios and individual paths in the Monte Carlo simulation.

Exhibit E-4 and E-5 represent the demand forecasts based on our base case (which corresponds to the average of our 100 stochastic simulation paths) and the future demand forecasts based on alternative scenarios used in the 2012 Actuarial Review for HECM.

Exhibit E-4. 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
2013	65,533	64,087	66,343	58,700	66,749	65,433
2014	73,923	70,913	76,780	56,690	74,217	67,922
2015	87,963	82,974	90,012	72,320	77,969	34,570
2016	101,390	94,363	104,892	88,723	82,465	13,639
2017	111,188	111,401	129,658	91,452	86,222	7,019
2018	118,349	135,357	141,464	88,223	85,827	3,911
2019	126,156	173,406	129,673	83,613	82,246	2,377

Exhibit E-5. Forecasts of HECM Loan Counts for Other Economic Scenarios

Fiscal Year	Mean Stochastic Simulation	Moody's Protracted Slump	Low Interest Rates Scenario
2013	65,533	51,875	65,701
2014	73,923	48,147	75,021
2015	87,963	60,188	91,895
2016	101,390	77,703	107,746
2017	111,188	92,281	117,950
2018	118,349	101,066	125,121
2019	126,156	108,519	132,949

It is instructive to examine the FY 2019 demand for the seven alternative scenarios. Among these seven scenarios, we see that demand is the highest under the 10th best simulated scenario. The FY2019 demand is second highest based on Low Interest Rates Scenario, followed by the 25th best path, Moody's protracted slump, the 25th worst simulation path, the 10th worst simulation path and lastly the worst path in our simulation. The volatility of demand response highlights the modeled sensitivity of HECM demand to macro factors.

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Appendix F

Stochastic Processes of Economic Variables

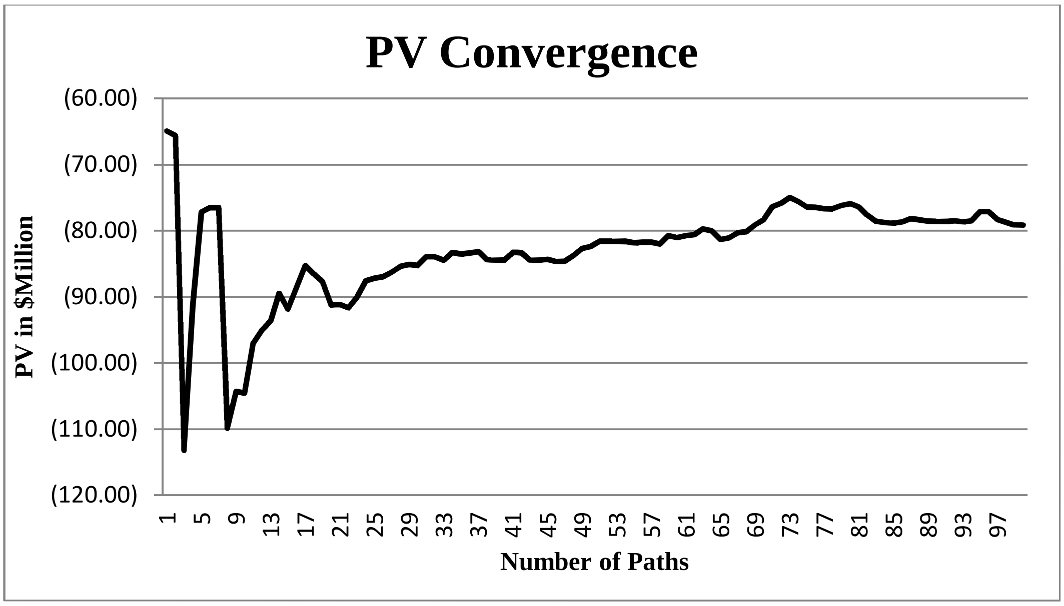
Appendix F: Stochastic Processes of Economic Variables

This appendix describes the stochastic processes assumed for the economic variables used in the Monte Carlo simulations of the HECM Actuarial Review 2012. In past Reviews, the economic value of the HECM was estimated by computing the net present value (NPV) of the portfolio's future cash flows along a single baseline deterministic path of house price appreciation (HPA) and interest rates. In this year's Review, we computed the present value of expected cash flows from 100 possible paths of 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 paths of HPA and interest rates, compute the NPV 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.

If the NPV-generating function is "concave," meaning that when the separate NPVs are arranged from lowest to highest, they increase at a decreasing rate, then the expected present value (the average of the individual-path NPVs) will be less than the single NPV computed for the expected path. (This is known as "Jensen's Inequality.") For mortgages, the NPV generating function is typically concave, because when HPA goes negative, default losses increase at an increasing rate as HPA falls, but when HPA goes positive and keeps increasing, default losses can only go as low as zero and premium income does not increase. This is what we observed for HECMs.

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 by the 100 paths. Exhibit F-1 shows the convergence of the Monte Carlo simulation: after about the 80th path the NPV of future cash flows does not deviate measurably.

Exhibit F-1. PV Convergence in Monte Carlo Simulation



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

- 1-year Treasury rates,
- 10-year Treasury rates,
- 1-year London interbank overnight rates (LIBOR),
- 30-year fixed rate mortgage (FRM) rates, and
- FHFA national house price index (HPI).

These stochastic processes have been modeled using the "real world" or "physical" measure and hence estimated using historical data23. 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 is consistent with this approach.

[23] 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.

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. 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.

Exhibit F-2. Historical Interest Rates

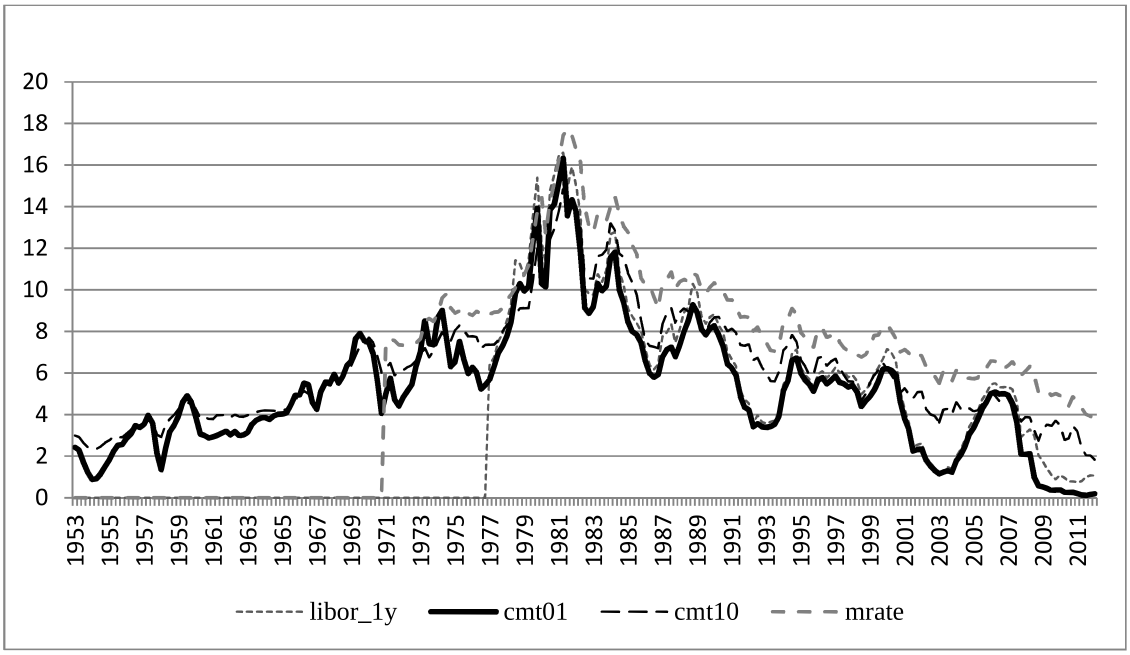
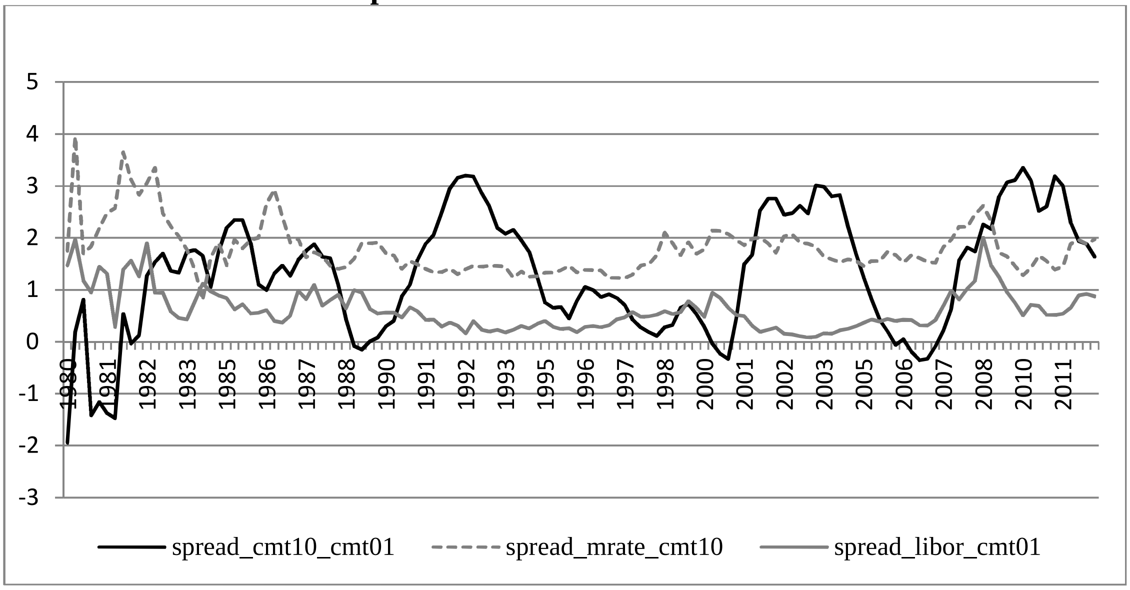


Exhibit F-3 shows historical interest rate spreads, including the spread between the 10-year and the 1-year Treasury rates, the spread between the 30-year mortgage rate and the 10-year Treasury rate, and the spread between the 1-year LIBOR and the 1-year Treasury rate. The spread between the 10-year and 1-year Treasury rates appears to be a mean-reverting process 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 (HPI) of all transactions. Due to methodological limits and the thin data at the beginning of the sample period, HPIs prior to 1980 tend to be unreliable indicators of the actual appreciation rate. We used the HPI data from 1980 Q1 to 2012 Q1 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 1980 Q1 to 2012 Q1. The long-term average quarterly HPA is around 1.00%.

The HPI increased steadily from 1980 to 2004, and the quarterly appreciation rate was around 1.15%, close to the long-term average. Then house prices rose sharply starting from around 2004. The average quarterly house price appreciation rate was 2.09% during the subprime mortgage expansion period, from 2004 to 2006, and reached the peak of 3.61% in 2004 Q3. After 2006, the average growth rate became negative. Exhibit F-4 shows the average quarterly HPA by selected historical time spans.

Exhibit F-4. National HPI and HPA

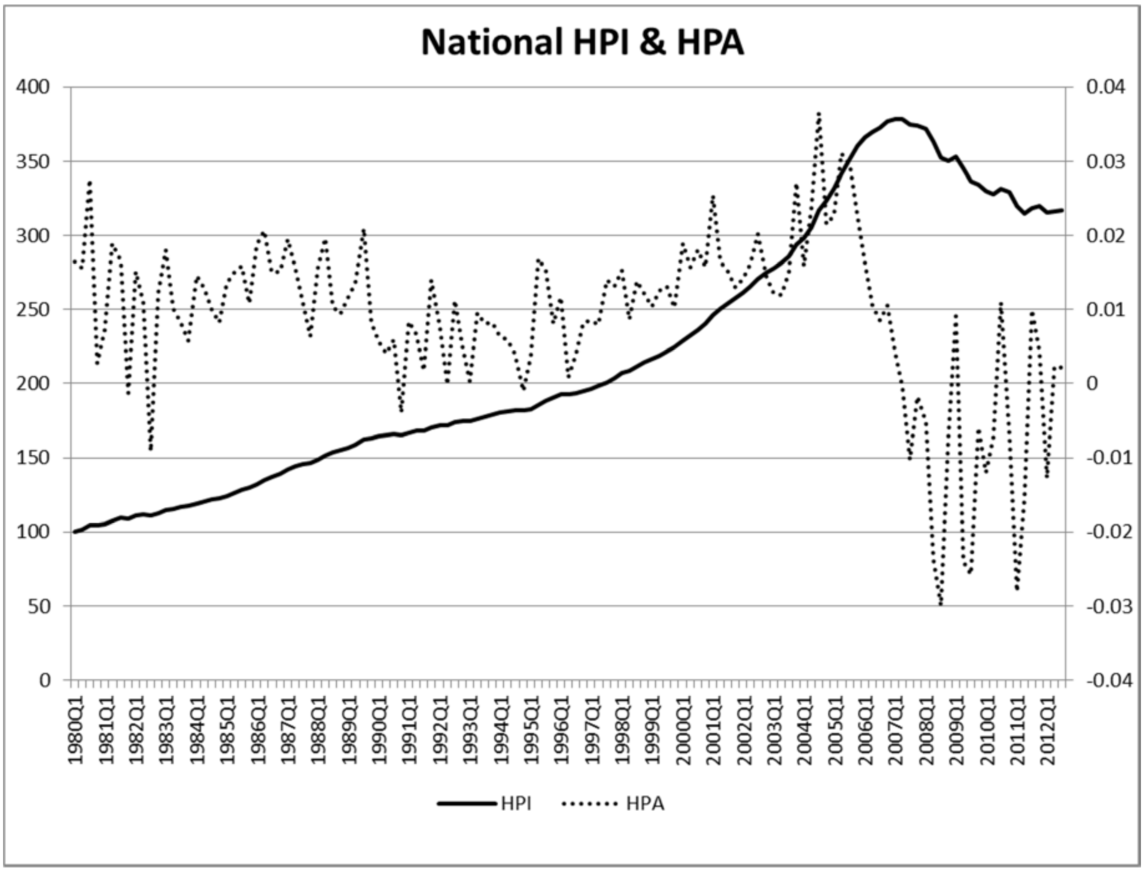


Exhibit F-5. Average Quarterly HPA by Time Span

Period	Average Quarterly HPA
1980 – 2010	1.00%
1980 – 2003	1.15%
2004 – 2006	2.09%
2007 – 2010	-0.69%

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 historical time periods, one started in 1953 and the other started in 1982.

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

Statistics	Since 1980	Since 1953
Mean	5.59%	5.29%
Standard Deviation	3.67%	3.13%
Max	16.32%	16.32%
95- Percentile	13.55%	10.15%
90- Percentile	10.18%	8.86%
50- Percentile	5.41%	4.99%
10- Percentile	0.52%	1.30%
5- Percentile	0.26%	0.38%
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[24]. The process takes the following form:

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

where Z 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.

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

Parameter	Estimate	Std Dev	t Value	Prob>t
A[25]	(0.0002)			
B	0.993	0.020	0.339	0.735
β_0	3.65E-06	2.13E-06	1.701	0.089
β_1	0.417	0.199	2.097	0.038
β_2	0.549	0.122	4.482	1.67E-05
Adjusted R2	0.9501			

The model based on these parameters is used to simulate FY2013 Q1 and future 1-year Treasury rates.

[24] Example of using GARCH model for fixed income analysis includes Heston and Nandi (2003).
[25] The interception term A is calibrated each time period, so that the median of our simulated paths match the baseline scenario from Moody's forecast as of July 2012.

The constant terms are used to calibrate the series such that the median value among 100 simulations matches Moody's July 2012 baseline forecast of the 1-year Treasury rates quarter by quarter. However, Moody's July forecast only covers the period until 2042 Q4. After 2043, we repeated Moody's last 4 quarter forecasts for all remaining terms. All the other interest rates and HPA series are expanded to year 2050 using the same methodology. A lower bound of 0.01 percent is applied to the simulated future 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 α_{10} and β_{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
$\alpha_{10,t}$[26]	(0.004)			
β_{10}	-0.022	0.017	-1.296	0.197
γ_{10}	0.840	0.048	17.511	3.33E-35
β_0	1.39E-05	3.67E-06	3.772	0.000
β_1	0.530	0.345	1.536	0.127
Adjusted R2	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 2012 base forecast of the 10-year Treasury rates quarter by quarter (with the same logic of expanding the forecast

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

series to year 2080). We also set a floor value at 0.01 percent to the simulated 10-year Treasury rates to eliminate negative rates.

F4. Mortgage Rate

We modelled the mortgage rate by first modelling the spread between the mortgage rate and the 10-year rate and then adding the spread back to the 10-year rate. The process for the spread is assumed to be:

$$s_{m,t} = \alpha_{m,t} + \beta_{1m} r_{1,t} + \beta_{2m} r_{1,t-1} + \beta_{3m} s_{10,t} + \beta_{4m} s_{m,t-1} + \varepsilon_{m,t} \quad (5)$$

where $s_{m,t}$ is the spread between the mortgage rate at time *t* and 10-year Treasury rate, $r_{1,t}$ is 1-year Treasury rate at time *t* , and $s_{10,t}$ is the spread between the 10-year and 1-year Treasury rate at time *t* . The variance of the residual term follows a GARCH (1,1) process:

$$\sigma_t{}^2 = \beta_0 + \beta_1 \varepsilon_{m,t-1}^2 + \beta_2 \sigma_{t-1}^2 \qquad (6)$$

FIML was used to estimate the parameters in equations (5) and (6). The estimated parameters are shown in Exhibit F-9.

Exhibit F-9. Estimation Results for the Mortgage to 10-Year Treasury Rate Spread Model

Parameter	Estimate	Std Dev	tValue	Prob>t
$\alpha_{m,t}$[27]	(0.005)			
β_{1m}	-0.179	0.032	-5.666	1.02E-07
β_{2m}	0.169	0.031	5.471	2.49E-07
β_{3m}	-0.053	0.018	-2.995	0.003
β_{4m}	0.742	0.050	14.695	1.35E-28
β_0	2.35E-07	1.29E-07	1.821	0.071
β_1	0.128	0.064	1.988	0.049
β_2	0.795	0.067	11.931	4.08E-22
Adjusted R2	0.6047			

We used the estimated parameters to simulate the spread between the mortgage rate and 10-year Treasury rates, and added the simulated spread to the simulated 10-year Treasury rate to obtain the mortgage rate. Then we adjusted the constant term $\alpha_{m,t}$ to calibrate the series such that the median value among 100 simulated paths will match Moody's July 2012 base forecast of the mortgage rates quarter by quarter. As with the other interest rates, we also set a floor value at 0.01 percent to the simulated mortgage rate.

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

F5. 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:

$$r_{L,t} = \alpha_{L,t} + \beta_L r_{1,t} + \varepsilon_{L,t}$$

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 α_L and β_L. The estimated parameters are shown in ExhibitF-10.

Exhibit F-10. Estimation Results for the LIBOR Rate Model

Parameter	Estimate	Std Dev	tValue	Prob>t
α_L[28]	(0.0036)			
β_L	1.0457	0.0086	120.9669	5.1E-133
Adjusted R^2	0.9913			

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 2012 base forecast of the LIBOR rates quarter by quarter.

F6. House Price Appreciation Rate (HPA)

F6.1. National HPA

We specified the 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

$$HPA_t = \mu_t + \alpha_1 D_{spring} + \alpha_2 D_{summer} + \alpha_3 D_{fall} + \beta_1 HPA_{t-1} + \beta_2 HPA_{t-2} + \beta_3 HPA_{t-3} + \beta_4 r_{1,t} + \beta_5 r_{1,t-1} + \beta_6 s_{10,t} + \beta_7 s_{10,t-1} + \beta_8 s_{m,t} + \beta_9 s_{m,t-1} + \sigma_{h,t} dZ_h \quad (7)$$

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 is independent Wiener random process with distribution N(0,1)

The variance of the residual term follows an ARCH (1) process:

[28] The intercept term is calibrated each time period so that the median of simulated rates matches Moody's July baseline forecast.

$$\sigma_{h,t}{}^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 \quad (8)$$

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 (7) and (8). The results are shown in Exhibit F-11.

Exhibit F-11. Estimation Results the National HPA Model

Parameter	Estimate	Std Dev	tValue	Prob>t
μ_t	(-0.001)	Matched with Moody's Forecast		
α_1	0.005	0.001	4.033	0.000
α_2	0.005	0.001	4.405	2.45E-05
α_3	0.005	0.001	5.196	9.34E-07
β_1	0.613	0.058	10.610	1.4E-18
β_2	-0.153	0.060	-2.534	0.012677
β_3	0.398	0.046	8.606	5.63E-14
β_4	-0.596	0.089	-6.737	7.49E-10
β_5	0.600	0.088	6.836	4.62E-10
β_6	-0.770	0.142	-5.427	3.4E-07
β_7	0.748	0.143	5.243	7.63E-07
β_8	-0.649	0.177	-3.656	0.000
β_9	0.581	0.160	3.633	0.000
γ_0	1.2E-05	3.19E-06	3.759	0.000
γ_1	0.955	0.264	3.619	0.000
Adjusted R2	0.6242			

We used these parameters to simulate future HPAs from 2012 Q2. Also, we calibrated the mean of HPA (μ_t in the equation) by matching the median value across 100 simulated paths to Moody's July base forecast. Moody's July forecast extends only to year 2042 Q4, so again we repeat the last four quarters for the remaining terms.

F6.2. 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.[29] We understand this approach is equivalent to assuming perfect correlation of dispersions among different locations across simulated national HPA paths, which creates a large systematic house price decrease during economic downturn and vice versa during the boom. Due to Jensen's Inequality, this tends to generate a more conservative estimate of claim losses of the Fund.

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

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References

References

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

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

Glasserman, P., (2003), *Monte Carlo Methods in Financial Engineering*, Springer.

Heston, Steven L and Saikat Nandi (2003). *A Two-Factor Term Structure Model under GARCH Volatility.* The Journal of Fix Income(13),1,87-95.

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

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

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

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

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

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

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

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

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

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