## Appendix B: Cash Flow Analysis

### I. Introduction

The calculation of the economic value of the MMI Fund involves the estimation of the present value of future cash flows generated by the existing portfolio and future books of business. This requires the projection of future prepayment and claim incidences and cash flow items associated with each type of outcome. This appendix explains the details related to the attribution of cash flows by source.

The evaluation of the Fund's economic value is done similarly to corporate valuation. An investor would estimate the value of a firm as the present value of net assets plus the present value of new business expected to be undertaken. Assuming FHA continues to insure loans, the economic value of the MMI Fund would be determined by valuing both its current portfolio of loans and its future books of business.

In order to analyze future changes in the Fund's economic value, we developed a model that incorporates projections of the loan performance and information about the existing portfolio composition to project the Fund's various cash flow sources. The actuarial model used the projections from the econometric models discussed in Appendix A. We estimated econometric models for conditional claim and prepayment probabilities for each individual loan depending on its origination year, age, interest rate, initial LTV ratio, credit history, refinancing incentive, probability of negative equity, loan term, burnout, and other characteristics. Using detailed loan-level characteristics, we were able to estimate more accurately the prepayment and claim probabilities and then generate respective cash flows to each loan.

**Exhibit B-1**

| Cash Flow Components | | |
|---|---|---|
| **Cash Flow Components** | **Cash Inflow** | **Cash Outflow** |
| Upfront Premiums | √ | |
| Annual Premiums | √ | |
| Net Claim Payments | | √ |
| Refunded Upfront Premiums | | √ |
| Administrative Expenses[a] | | √ |
| Distributive Shares[b] | | √ |

[a] The administrative expense was discontinued since the FY 2002 Actuarial Review according to the Federal credit reform requirement.

[b] The distributive share has been suspended since 1990. There is no indication that it would be resumed in the foreseeable future.

Based on the mortgage termination rates projected by the econometric model, the major components of cash flows are projected into the future. Future interest income is included in the present value discounting process. The relevant cash flow components are listed in Exhibit B-1. These components were projected for each loan on a probabilistic basis and then aggregated according to the product type, origination year, and policy year for reporting purposes. Below, we discuss the derivation of each of these cash flows.

## II. Background Information

The following definitions and background information help clarify our discussion of the cash flow components:

- **Insurance-in-force (IIF):** the nominal value of the unamortized original mortgage loan balances of the surviving mortgages insured by FHA. This is distinct from the conventional notion of amortized insurance-in-force, which includes only the current outstanding balances on surviving loans.

- **Conditional Claim Rate (ccr):** the number of loans that become claims during a time period divided by the number of surviving loans-in-force at the beginning of that period for a specific pool of loans.

- **Conditional Prepayment Rate (cpr):** the number of loans being completely prepaid during a time period divided by the number of surviving loans-in-force at the beginning of that period for a specific pool of loans.

- **Policy Year:** a single Federal fiscal year. The year in which the mortgage is originated is assigned as fiscal policy year one, even though it may not be a complete year. The MMI Fund's policy year follows the definition of the Federal fiscal year, which runs from October 1$^{st}$ of the previous calendar year to September 30$^{th}$ of the specific calendar year. For example, the time frame from October 1, 2006 to September 30, 2007 is considered as Fiscal Policy Year 2007, or FY 2007.

- **Termination Year:** the fiscal year in which a mortgage terminates through a claim, prepayment or other reasons.

**Unpaid Principle Balance (UPB) Factor:** the principal balance outstanding divided by the original mortgage amount. The UPB factor is calculated based on the amortization term, the type of mortgage, and the mortgage contract rate. For FRMs, the UPB factor for each quarter in the future can be directly computed with the initial contract rate and the amortization term. For ARMs, the UPB factor decreases at different rates depending on the interest rate of the particular

loan, updated according to the contractual rate-adjustment rule. In this model, the contract interest rate of ARM loans are updated by using changes in the one-year Treasury rate as an approximation for changes in the underlying index, subject to limits implied by standard annual and lifetime rate-adjustment caps.

## III. Cash Flow Components

### A. Premiums

#### 1. Premium Structure

The primary source of revenue to the Fund is the insurance premium. If the Fund's mortgage insurance is priced to be premium-sufficient, the insurance premiums collected and interest earned on them will cover all costs associated with insuring pools of specific mortgage loans. According to current and past FHA mortgage insurance policy, the insurance premium has been structured in different ways over time:

- For loans originated through September 1, 1983 the mortgage premium was collected on a monthly basis at an annualized rate of 0.50 percent of the outstanding principal balance for the period. To align this change with fiscal quarters, we assumed for this analysis that the annual premium policy was in effect through September 30, 1983.

- Between September 1, 1983 and June 30, 1991 the mortgage premium was based on a percentage of the original mortgage amount at the time of origination. This amount was 3.80 percent for 30-year mortgages and 2.40 percent for 15-year mortgages.

- Effective July 1, 1991, the NAHA specified a new premium structure. This structure specified an upfront premium of 3.80 percent for all product types except for 15-year non-streamline refinance loans (for which the upfront premium was set at 2.00 percent) and an annual renewal premium of 0.50 percent per year on the outstanding balance. The annual premium would cease at different mortgage ages depending on the initial LTV of the loan.

- On October 1, 1992, the upfront premium was reduced from 3.80 percent to 3.00 percent. The annual premium of 15-year mortgages was lowered to 0.25 percent or completely waived if the initial LTV ratio was less than 90 percent.

- As of April 17, 1994, FHA lowered the upfront premium rate on 30-year mortgages from 3.00 percent to 2.25 percent. To align this change with fiscal quarters, we started applying this policy change on April 1, 1994.

- Starting from October 1, 1996, FHA lowered the upfront premium rate on 30-year mortgages for first-time homebuyers who receive homeowner counseling from 2.25 percent to 2.00 percent. This rate was further reduced to 1.75 percent for mortgages executed on or after September 22, 1997. This favorable treatment for borrowers with homeownership counseling was terminated shortly thereafter.
- Effective January 1, 2001, FHA lowered the upfront premium rate of all mortgages to 1.50 percent. The annual premium was reduced to 0.50 percent on the UPB and the annual premium would stop as soon as the current LTV ratio of the loan was below 78 percent according to the home price as of the loan origination date. The annual premium must be paid for a minimum of five years for 30-year mortgages.

The upfront and annual premium rates are summarized in Exhibits B-3 and B-4.

**Exhibit B-3**

| Upfront Premium Rates for New FHA Originations | | |
|---|---|---|
| **Fiscal Year** | **30yr Loans, Fixed or Adjustable Rate (%)** | **15yr Loans, Fixed or Adjustable Rate (%)** |
| 9/1/83 to 6/30/91 | 3.80 | 2.40 |
| 7/1/91 to 9/30/92 | 3.80 | 2.00/3.80[b] |
| 10/1/92 to 4/16/94 | 3.00 | 2.00 |
| 4/17/94 to 9/30/96 | 2.25 | 2.00 |
| 10/1/96 to 9/21/97 | 2.25/2.00[a] | 2.00 |
| 9/22/97 to 12/31/00 | 2.25/2.00/1.75[a] | 2.00 |
| 1/1/01 to present | 1.50 | 1.50 |

[a] For first-time homebuyers who received homeowner counseling.
[b] For 15-year streamline refinance loans.

**Exhibit B-4**

| NAHA Annual Premium Rate for 15- and 30-Year Mortgages | | |
|---|---|---|
| **Fiscal Year** | **30yr Loans, Fixed or Adjustable** | **15yr Loans, Fixed or Adjustable** |
| Prior to 9/1/1983 | 0.5% for life of loan | 0.5% for life of loan |
| 9/1/83 to 6/30/91 | None | None |
| 7/1/91 to 9/30/92 | varies by LTV category[a] | varies by LTV category[a] |
| 10/1/92 to 12/31/00 | varies by LTV category[b] | varies by LTV category[c] |
| 1/1/01 to present | 0.5% until loan balance reaches 78% of original property value, minimum of 5 years | varies by LTV category[d] |

| **LTV Range:** | **a** | **b** | **c** | **D** |
|---|---|---|---|---|
| below 90% | 0.5% for 5 yrs | 0.5% for 7 yrs | 0% | 0% |
| Between 90%~95% | 0.5% for 8 yrs | 0.5% for 12 yrs | 0.25% for 4 yrs | 0.25% until LTV reaches 78% |
| above 95% | 0.5% for 10 yrs | 0.5% for 30 yrs | 0.25% for 8 yrs | 0.25% until LTV reaches 78% |

Insurance premium rules for streamline refinance (SR) loans are summarized in Exhibit B-5.

**Exhibit B-5**

| Premium Rates for Streamline Refinance Loans | | | | |
|---|---|---|---|---|
| **Period of Origination** | **30-Year Mortgages** | | **15-Year Mortgages** | |
| | **Upfront Premium** | **Annual Premium** | **Up-front Premium** | **Annual Premium** |
| Prior to 9/1/1983 | None | None | None | None |
| 9/1/83 to 6/30/91 | 3.80% | None | 2.40% | None |
| 7/1/91 to 9/30/92 | 3.80% | 0.5% for first 7 years | 3.80% | 0.5% for first 7 years |
| 10/1/92 to 4/16/94 | 3.00% | 0.5% for first 7 years | 2.00% | None |
| 4/17/94 to 12/31/00 | 2.25% | 0.5% for first 7 years | 2.00% | None |
| 1/1/01 & subsequent | 1.50% | 0.5% until loan balance reaches 78% of original property value, minimum of 5 years | 1.50% | varies by LTV category[a] |

[a] 0% if original LTV is below 90 percent; 0.25% until LTV reaches 78% if original LTV is 90 percent and above.

**2. Upfront Premium**

The upfront premium is assumed to be paid fully at the mortgage origination date and the amount is calculated as follows:

*Upfront Premium Payment =*
*Origination Amount before upfront premium * Mortgage Insurance Premium Rate (%)*

In practice, FHA offers a premium finance program to those qualified for mortgage insurance. Borrowers do not have to pay the upfront premium at the beginning of contract. Instead, the borrower can add it to the original loan balance, in essence paying the upfront premium at the same schedule as their principal balance. Nearly all borrowers finance their upfront premiums.

### 3. Annual Premium

The annual premium is calculated as follows:

*Annual Premium =*
*Amortized UPB (excluding any upfront premiums) * Annual Insurance Premium Rate (%) / 4*

The annual premium is actually collected on a monthly basis. The above formula models the premium as being collected at the beginning of each quarter for purposes of our analysis. In addition, the termination rate will have impacts on annual premium flows similar to the characteristics of an interest-only strip security. That is, all potential future annual premium income would no longer exist when the particular mortgage loan is prepaid or claimed.

Although FHA is effectively insuring the financed upfront premiums, the annual premium is not assessed on the amount of the financed upfront premium.

## B. Losses Associated with Claims

The MMI Fund's largest expense component comes in the form of losses due to claims. FHA pays the claim to the lender when a lender files a claim. In most cases, FHA takes possession of the foreclosed property and sells the property to partially recover the loss. This particular type of claim is called a conveyance.

Based on this practice, claim cash flows can actually be decomposed into two components:

- the cash outflow of the claim payment at the claim date and
- the cash inflow of any net proceeds received in selling the conveyed property at the property disposition date.

For tractability, we simplify this two-steps cash flow into one lump-sum amount. The single claim loss payment estimated in our model is

$Claim\ Payment_t =$
$Amortized\ Surviving\ UPB_t * Conditional\ Claim\ Rate_t * Loss\ Rate$

The $Amortized\ Surviving\ UPB_t$ is the amount of the unpaid balance of the loan after amortization multiplied by the probability that the loan will survive until the beginning of time $t$. The conditional claim rate is estimated from the multinomial mortgage termination model presented in Appendix A. Note that the claim rate and the prepayment rate are in terms of the number of loans instead of the UPB. Claim and prepayment rates do vary by loan size. We conducted the analysis

by cohort and aggregated across cohorts. One of the dimensions of determining cohorts is the loan size, so using the rates in terms of the number of loans produces the same results as using the rates in terms of UPBs.

The loss rate is usually referred to as the loss given default (LGD) or severity in the banking industry. It measures the amount of principal not recovered divided by the unpaid balance at the time of default. Based on the historical data of claimed mortgages provided by FHA, the average claim loss rate declined from 40 percent in 2000 to about 35 percent during the 2001 through 2003 exposure years. Then, this rate rose in the most recent three fiscal years to over 39 percent in FY 2006. Although significant efforts have been invested by FHA to improve the loss rate, with the rising loss-severity rate observed toward the end of the historical time series and the forecasted slowdown in house price appreciation rates over the next few years, we assumed the future loss rates will be similar to those in FY 2006, representing the highest single-year experience in the recent history.

**Exhibit B-6**

| Average Loss Severity Rate (%) of Claimed Loans by Claim Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Termination Year | Non-profit Gift | Judicial Foreclosure | Mortgage Product Type | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | Portfolio Average |
| 2004 | no | no | 34.72 | 39.44 | 28.83 | 29.83 | 34.29 | 31.05 | 36.21 |
| | | yes | 39.01 | 60.50 | 38.56 | 37.06 | 60.17 | 36.80 | |
| | yes | no | 39.41 | 46.69 | 36.29 | | | | |
| | | yes | 47.90 | 56.68 | 44.93 | | | | |
| 2005 | no | no | 35.72 | 41.01 | 30.23 | 29.76 | 27.01 | 29.67 | 37.82 |
| | | yes | 43.33 | 57.25 | 39.42 | 41.18 | 63.66 | 37.28 | |
| | yes | no | 37.88 | 43.39 | 32.45 | | | | |
| | | yes | 47.88 | 48.49 | 45.47 | | | | |
| 2006 | no | no | 36.00 | 39.11 | 31.48 | 31.27 | 31.39 | 32.42 | 39.05 |
| | | yes | 47.40 | 61.42 | 42.01 | 42.79 | 51.10 | 42.75 | |
| | yes | no | 37.49 | 39.15 | 33.84 | | | | |
| | | yes | 47.97 | 43.05 | 45.97 | | | | |

Exhibit B-6 shows the historical loss severity rate experience by claim year, mortgage product types, if the loans received a downpayment gift from a non-profit organization, and if the collateral housing is located in a judicial foreclosure state. It clearly shows that the loss severity rate is higher among the judicial foreclosure states. The longer time required to dispose a foreclosed properties in those states tend to increase the loss severity. We also observe that the loss rates of 15-year mortgages tend to be higher. However, due to the low claim rate of the 15-

year mortgage products, the impact of the higher loss rate is less severe as it appears. For property dispositions that occurred during FYs 2004, 2005, and 2006, FHA's loss rates averaged 36.21, 37.82, and 39.05 percent of unpaid principal balance, respectively. FHA, however, often expresses its loss rate in terms of a percentage of its acquisition cost, which is the sum of the unpaid principal balance and other allowable costs (such as interest during the foreclosure period and foreclosure expenses) for which FHA reimburses the lender upon the filing of a claim when the property is conveyed to FHA. Following FHA's definition, the loss rates for property dispositions occurring during FYs 2003, 2004 and 2005 would be 30.75, 32.05, and 33.02 percent, respectively, when expressed as a percentage of acquisition cost.

For the FY 2006 Actuarial Review, the cash flow model expressed the loss-severity rate in terms of the unpaid principal balance. The loss rates for each product type, the utilization of non-profit organization downpayment gifts, and the foreclosure law of the state during the termination year of FY 2006 are used as the expected loss severity rates for all future terminations, and are shown in the shaded areas of Exhibit B-6.

To provide insights into the impact on the economic value and capital ratios, this year's Review also includes an alternative scenario under which we assumed that the loss rate for each product was five percentage points higher than the above rates. This is discussed further in Appendix D.

## C. Refunded Premiums

FHA first introduced the upfront premium refund program in 1983. It specified that FHA would refund a portion of the upfront premium when a household prepaid its mortgage. The upfront premium was considered to be "earned" over the life of the loan. Upon prepayment, an approximation of the unearned upfront premium is returned to the borrower. Therefore, the amount of the refund depends on the time since origination that the mortgage is prepaid. The refund payments are calculated as follows:

*Refund Payments =*
*Original UPB * Upfront Premium Rate * Conditional Prepayment Rate * Refund Rate*

In the past, borrowers could receive the upfront premium refund when they prepaid their mortgages before the maturity of the mortgage contract. In 2000, FHA policy changed so that borrowers can obtain refunds only if they prepay within the first five years of their mortgage contracts. The most recent policy change at the end of 2004 eliminated refunds for early prepayments of any mortgages endorsed afterward, except for those occurring within 3 years following the original endorsement date, but only if the borrower refinanced with a new FHA loan.

The current and past policies relating to the upfront premium refund schedule are presented in Exhibit B-7.

**Exhibit B-7**

| Percentage of Upfront Premium Refunded | | | | | |
|---|---|---|---|---|---|
| Years since Origination | 9/1/83~12/31/93 | | 1/1/94~ 12/31/00[a] | 1/1/01 and later[b] | 12/8/2004 and later[c] |
| | 30-Year Mortgages | 15-Year Mortgages | All Mortgages | All Mortgages | If Refinanced into Another FHA Loan |
| 1 | 0.99 | 0.99 | 0.95 | 0.85 | 0.58 |
| 2 | 0.94 | 0.93 | 0.85 | 0.65 | 0.34 |
| 3 | 0.82 | 0.81 | 0.70 | 0.45 | 0.10 |
| 4 | 0.67 | 0.66 | 0.49 | 0.25 | 0.00 |
| 5 | 0.54 | 0.51 | 0.30 | 0.10 | |
| 6 | 0.43 | 0.39 | 0.15 | 0.00 | |
| 7 | 0.35 | 0.29 | 0.04 | | |
| 8 | 0.29 | 0.21 | 0.00 | | |
| 9 | 0.24 | 0.15 | | | |
| 10 | 0.21 | 0.11 | | | |
| 11 | 0.18 | 0.08 | | | |
| 12 | 0.16 | 0.06 | | | |
| 13 | 0.15 | 0.04 | | | |
| 14 | 0.13 | 0.03 | | | |
| 15 | 0.12 | 0.02 | | | |
| 16 | 0.11 | 0.00 | | | |
| 17 | 0.10 | | | | |
| 18 | 0.09 | | | | |
| 19 | 0.09 | | | | |
| 20 | 0.08 | | | | |
| 21 | 0.07 | | | | |
| 22 | 0.07 | | | | |
| 23 | 0.06 | | | | |
| 24 | 0.05 | | | | |
| 25 | 0.05 | | | | |
| 26 | 0.04 | | | | |
| 27 | 0.04 | | | | |
| 28 | 0.04 | | | | |
| 29 | 0.04 | | | | |
| 30 | 0.00 | | | | |

[a] Based on Mortgagee Letter 94-1, which provides a monthly schedule of refund rates
[b] Based on Mortgagee Letter 00-38
[c] Based on Mortgagee Letter 05-03, which provides a monthly schedule of refund rates. Applicable only if refinanced into a new FHA loan.

## IV. Economic Value and Capital Ratio

Once all the above future cash flow components are determined, the present value can be measured through an appropriate discounting method. Then the economic value is the sum of the present value of future cash flows plus the current capital resources.

### A. Discount Factor

The discount factors applied in discounting the cash flows are the official Federal credit subsidy present value conversion factors. The discount factor varies depending on how far into the future a cash flow will occur. The discount factors are shown in Exhibit B-8.

**Exhibit B-8**

| Years that Cash Flow Occur | Discount Factor | Years that Cash Flow Occur | Discount Factor | Years that Cash Flow Occur | Discount Factor |
|---|---|---|---|---|---|
| 2008 | 0.9516 | 2018 | 0.5797 | 2028 | 0.3426 |
| 2009 | 0.9074 | 2019 | 0.5503 | 2029 | 0.3248 |
| 2010 | 0.8654 | 2020 | 0.5223 | 2030 | 0.3080 |
| 2011 | 0.8248 | 2021 | 0.4957 | 2031 | 0.2920 |
| 2012 | 0.7854 | 2022 | 0.4704 | 2032 | 0.2768 |
| 2013 | 0.7477 | 2023 | 0.4463 | 2033 | 0.2624 |
| 2014 | 0.7114 | 2024 | 0.4234 | 2034 | 0.2487 |
| 2015 | 0.6765 | 2025 | 0.4016 | 2035 | 0.2357 |
| 2016 | 0.6429 | 2026 | 0.3809 | 2036 | 0.2234 |
| 2017 | 0.6106 | 2027 | 0.3612 | 2037 | 0.2117 |

### B. Calculating the Economic Value and Capital Ratio

The economic value of the MMI Fund as of the end of FY 2007 was calculated first by determining the present value of the future cash flows for all existing books of business as of September 30, 2007. This figure was then added to the current capital resources of the MMI Fund. The capital ratio is defined as the economic value divided by the unamortized IIF of the Fund.

For each fiscal year beyond 2007, the economic value of the fund as of the end of the fiscal year is calculated by the following equation:

*Year End Economic Value =*
*Economic Value at the beginning of the year + Total Return on the Beginning Economic Value + Economic Value of the New Book of Business*

The return on investment of the beginning economic value for each of the future fiscal years is assumed to equal the one-year Treasury forward rates implied by the discount factors. Specifically, these rates are shown in Exhibit B-9.

**Exhibit B-9**

| Interest Rate Earned by the MMI Fund | |
|---|---|
| **Fiscal Year** | **Interest Rate (%)** |
| 2007 | 5.01 |
| 2008 | 5.08 |
| 2009 | 4.87 |
| 2010 | 4.85 |
| 2011 | 4.93 |
| 2012 | 5.01 |
| 2013 | 5.05 |
| 2014 | 5.09 |