Section 5.A - Assets Valued Using Option-Based Approaches

The following assets are valued using the option-based approach:

- Fixed-rate, single-family, first mortgage loans and securities,
- Adjustable-rate, single-family, first mortgage loans and securities,
- Mortgage loan servicing rights.

The NPV Model also uses the option-based approach to adjust the value of an institution's loan portfolio for servicing by others and to value mortgage-related escrow deposits and mortgage-related commitments. The methods used to value each of these instruments are discussed separately in later sections of this manual. Because these valuation methods share certain procedures, a general description of the option-based pricing methodology is provided here to avoid repetition later.

Option-Based Pricing Methodology

The option-based pricing approach is used to value assets with embedded options. It is designed to provide improved mortgage value estimates by taking into account interest rate volatility, which has a significant effect on the value of options embedded in mortgages, such as prepayments and interest rate caps and floors. It uses an interest rate simulation program to generate numerous random interest rate paths that are used to estimate and discount mortgage cash flows over a wide range of possible future interest rate environments. Because of its use of randomly generated interest rate paths, this particular pricing method is often called a Monte Carlo approach.

Pricing a mortgage instrument with Monte Carlo simulation involves three basic steps: (1) generating simulated interest rates, (2) calculating the option-adjusted spread (OAS) of a mortgage-backed security whose price is known, and (3) then using the OAS to estimate the prices of similar mortgage instruments whose prices are not known.

Step 1: Generating Simulated Interest Rates

The NPV Model simulates separately 200 sequences of 1-month and 5-year interest rates using an empirically estimated set of equations. The Model starts with the current 1-month and 5-year Treasury zero-coupon yields, respectively, and uses a random process to generate 200 360-month series of monthly 1-month zero-coupon Treasury rates and 5-year zero-coupon Treasury rates. The parameters of the formulas used to generate each series were estimated using regression analysis and Treasury rate data. The rate simulation for a given path, n, is described by Equations 5.A.1 through 5.A.3 below.

Equation 5.A.1 - The One-Month Interest Rate

$$\ln f_{n,t} = 0.135 \ln f^*_{n,t} + 0.865 \ln f_{n,t-1} + S_n$$

where $S_{n,t} = 0.596\, S_{n,t-1} - 0.365\, S_{n,t-2} + U_{n,t}$

Equation 5.A.2 - The Five-Year Interest Rate

$$\ln r_{n,t} = 0.038\left(\ln f_{n,t-1} + 0.156\right) + 0.962 \ln r_{n,t-1} + 0.23\ u_{n,t} + w_{n,t}$$

where $w_{n,t} = 0.495\ w_{n,t-1} - 0.314\ w_{n,t-2} + v_{n,t}$

Equation 5.A.3 - The Mean-Reverting One-Month Interest Rate

$$\ln f^{*}_{n,t} = 0.864\left(\ln r_{n,t-1} - 0.156\right) - 0.370$$

where
- $\ln$ = natural logarithm function
- $f_{n,t}$ = simulated 1-month rate at month t
- $r_{n,t}$ = simulated 5-year rate at month t
- $f^{*}_{n,t}$ = mean-reverting 1-month rate
- $u_{n,t}$ = random shock with a mean of zero and a standard deviation of 0.0367
- $v_{n,t}$ = random shock with a mean of zero and a standard deviation of 0.0297

Although all the randomly generated 1-month interest rate sequences start from the current 1-month Treasury rate, there is no guarantee that they will be consistent with the current term structure of interest rates at the time of the analysis. That is, if the randomly generated 1-month rates were used to discount the scheduled cash flows of actual Treasury securities and averaged, they would not necessarily produce average present values that accord with the observed prices of those Treasury securities.

Because the ability of the 1-month rate distribution to replicate current Treasury prices is a necessary requirement for it to be used in the pricing model, the generated distribution is adjusted so it will exactly price currently observed zero-coupon Treasuries. Beginning in month 1, and continuing to month 360, all 200 simulated 1-month rates in each month are increased or decreased by an amount chosen so that the average present value they provide for a zero-coupon Treasury security maturing that month agrees with the price of the actual security maturing that month. The resulting 1-month rate distribution is thus corrected, or calibrated, to be consistent with the current zero-coupon Treasury curve. Algebraically, Equation 5.A.4 is solved recursively in months $t = 1, 2, \ldots, 360$ for a_t, which is added to each of the 200 1-month rates so that they are consistent with the observed zero-coupon rate for that maturity, z_T, in the following way:

Equation 5.A.4 - Adjustment of Rate Distribution to Zero-Coupon Rates

$$\left(\frac{1}{200}\right)\sum_{n=1}^{200}\left[\prod_{t=1}^{T}\left(1+f_{n,t}+a_t\right)^{-1}\right] = \left(1+z_T\right)^{-T}$$

where:
- $f_{n,T}$ = simulated 1-month rate at month T
- z_T = observed zero-coupon Treasury rate for maturity T

and both $f_{n,T}$ and z_T are in monthly (as opposed to annual) form.

A simulated mortgage interest rate is calculated for each month on each path as the sum of the 5-year rate simulated for that month plus a spread. The spread is calculated as the average spread between the 60-day commitment rate on 30-year fixed-rate mortgages and the 5-year Treasury rate over the last 12 quarters.

The interest rates simulated in this step are used to generate OAS values for a set of benchmark mortgage-backed securities in Step 2.

Step 2: Calculating Option-Adjusted Spreads

For each of the major types of mortgage-backed securities, several generic "benchmark" securities are chosen.[1] Their current prices are obtained at the time of the analysis (i.e., at the relevant quarter-end date) and an option-adjusted spread (OAS) is calculated for each of them. As will be clarified below, the OAS of a given security is the unique spread that, when added to the simulated 1-month rates, causes the average present value of the projected cash flows along the 200 paths to equal the observed price of the security. This calculation involves four steps and is performed separately for each of the benchmark securities.

Step 2a: Simulating Scheduled Cash Flows

For fixed-rate mortgage securities, the scheduled payment in each month along each path is simply determined by amortizing the remaining balance over the remaining maturity[2] and deducting the security's servicing spread. Scheduled payments for adjustable-rate mortgages (ARMs) are determined in the same way, however, before the scheduled payment can be calculated for any future month, the coupon that will be in effect in that month must be projected. Future coupons along each path are projected based on the repricing rules of the particular ARM being modeled (i.e., by reflecting the proper index, margin, reset frequency, rate caps, etc.) and the simulated ARM index, which is in turn based on the 1-month rates simulated for each month along each path. (More information about the relation between ARM coupons and the simulated rates is provided in Sections 5.G and 5.H that deal with ARMs.)

Step 2b: Simulating Prepaid Principal Cash Flows

The prepayment rate of any mortgage in a given month is determined by a prepayment equation that depends on three factors. The first factor relates prepayments to mortgage age: new mortgages tend to prepay more slowly than seasoned ones. The second factor relates the prepayment speed to the month of the year: prepayments tend to be faster in summer and slower in winter. The third factor measures how the mortgage coupon compares to currently offered mortgage rates: the greater the mortgage coupon relative to current rates, the greater the prepayment speed. The product of the three factors provides an estimate of the prepayment rate for a given month, t, along a given rate path, n, expressed in terms of the annual conditional prepayment rate. That is:

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1 Benchmarks are chosen for each of the following: FNMA/FHLMC 30-year fixed-rate; GNMA 30-year fixed-rate; FNMA/FHLMC 15-year fixed-rate; FNMA 7-year fixed-rate balloon; 6-month, 1-year, and 3-year Treasury-indexed adjustable-rate; and 1-month and 1-year 11th District Cost-of-Funds-indexed adjustable-rate mortgage securities.

2 The equation used to determine monthly scheduled principal and interest is:

$$\text{Scheduled Payment}_t = \frac{B_t\left(\frac{c}{12}\right)}{\left\{1-\left[1+\left(\frac{c}{12}\right)\right]^{-T}\right\}}$$

where: B_t = outstanding balance in month t
c = annual coupon
T = months remaining to maturity

Equation 5.A.5 - Prepayment Rate

$$\text{cpr}_{n,\,t} = \text{seasoning}_t \cdot \text{seasonality}_t \cdot \text{refi}_{n,\,t}$$

where: seasoning_t = seasoning factor
seasonality_t = monthly seasonality factor
$\text{refi}_{n,t}$ = prepayment rate resulting from the refinancing incentive on path n

The seasoning factor, seasoning_t, has a value of .0333 for a new mortgage and increases linearly with mortgage age to a value of 1 at month 30, and remains constant thereafter.

The seasonality factor, seasonality_t, has the form:

Equation 5.A.6 - Seasonality Factor

$$\text{seaonality}_t = 1 + 0.2000 \cdot \sin\left\{1.571 \cdot \left[\frac{(\text{month} + t - 3)}{3}\right] - 1\right\}$$

where: month = number of the month of the year for which the analysis is run (3, 6, 9, or 12)
t = number of months into the simulation
sin = sine function

Several different equations are used in the NPV Model to model the refinancing factor, $\text{refi}_{n,t}$, depending on the type and characteristics of the mortgage being analyzed. All of the equations have a similar structure, shown below for moderately-seasoned 30-year conventional fixed-rate mortgages:[3]

Equation 5.A.7 - Refinancing Factor

$$\text{refi}_{n,\,t} = 0.2406 - 0.1389 \cdot \arctan\left[5.952 \cdot \left(1.089 - \frac{c}{m_{n,\,t-3}}\right)\right]$$

where: c = coupon of the mortgage
$m_{n,\,t\text{-}3}$ = simulated mortgage refinancing rate[4] (lagged three months)
arctan = arctangent function

The arctangent function is an S-shaped trigonometric function useful in representing the relation between the prepayment rate and the refinancing incentive. As shown in Figure 5.A.1 below, for 30-year conventional fixed-rate mortgages, the greater the refinancing incentive — i.e., the higher the coupon on the mortgages underlying the security compared to the coupon on a new fixed-rate mortgage — the greater will be the rate of prepayment. The equation produces a region of low, almost constant, prepayment rates when the refinancing incentive is low; a region of high, and again almost constant, prepayment rates when the refinancing incentive is high.

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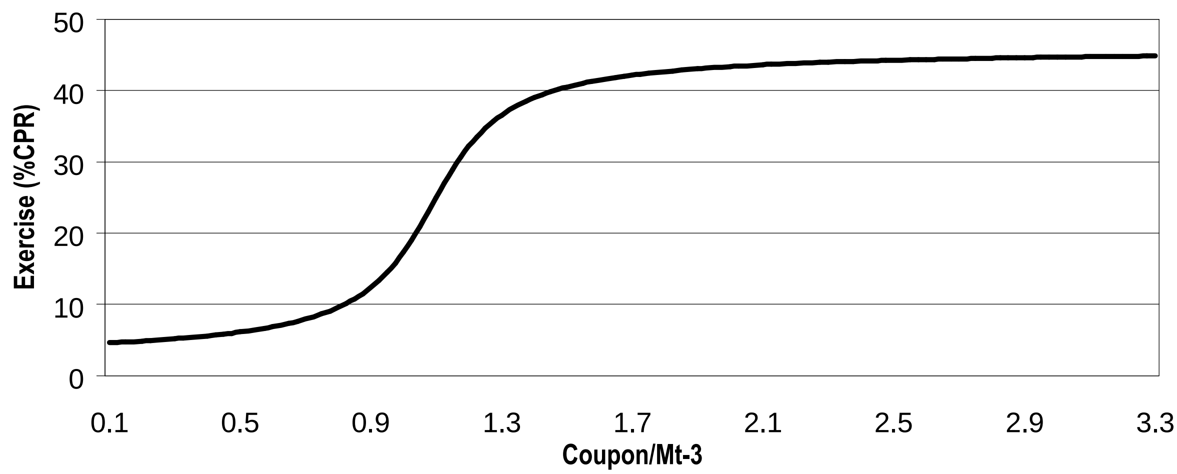
3 Note that the coefficient values in Equation 5.A.7 are subject to periodic revision. Current values may be obtained from *Selected Asset and Liability Price Tables*, available at http://www.ots.treas.gov/quarter.html.

4 Along any given path, the variable m_t is calculated as the simulated 5-year rate for month t plus the average historical spread between the FNMA 60-day commitment rate for 30-year conventional mortgages and the 5-year Treasury yield during the past 12 quarters.

The two extreme regions are joined by an S-shaped transition zone over which the prepayment rate changes rapidly.

Figure 5.A.1
Shape of "Refi" Equation



The prepayment equations for other types of mortgages have a similar general shape, but differ in the details. They are described in Sections 5.B to 5.H.
The annual prepayment rate is converted to a monthly rate using Equation 5.A.8.

Equation 5.A.8 - Conversion of Annual Prepayment Rate to Monthly

$$p_{n,t} = 1 - \left(1 - cpr_{n,t}\right)^{1/12}$$

The dollar amount of prepayments for each path is calculated as the product of the outstanding balance and prepayment rate for that path and month.

The total cash flow for each month is calculated along each of the 200 paths by calculating scheduled and prepaid cash flows as described in steps 2a and 2b for each month in sequence.

Step 2c: Calculating Discount Factors

Discount factors are calculated for each month along each of the 200 rate paths. The discount factors are similar in form to the discount factors used in the static cash flow valuation, described in Equation 1.4 of Chapter 1, and shown in Equation 5.A.9.

Equation 5.A.9 - The Discount Factor for Static Cash Flow Analysis

$$df_t = \frac{1}{\left[(1+f_1+s)(1+f_2+s)\ldots(1+f_t+s)\right]}$$

where: f_t = implied forward rate in month t
s = credit spread
and both variables are expressed monthly.

Unlike the static approach, which calculates a single present value using the existing term structure, the option-based approach calculates present values using each of the possible future term structures implicit in the 200 randomly generated rate paths. Thus, for any given rate path, n, the discount factor for any month, t, is calculated using Equation 5.A.10:

Equation 5.A.10 - The Discount Factor for OAS Analysis

$$df_{n,t} = \frac{1}{\left[\left(1+f_{n,1}+oas\right)\left(1+f_{n,2}+oas\right)\ldots\left(1+f_{n,t}+oas\right)\right]}$$

where: $f_{n,t}$ = simulated 1-month rate on path n for month t

oas = option-adjusted spread.

When a value is supplied for the OAS of a given security, the discount factors along each path can be used to discount the simulated monthly cash flows for that security along each path, producing 200 present value estimates.

Step 2d: Solving for the OAS

The value of the OAS is obtained for a security with a known price by searching iteratively for the particular spread that causes the average of the 200 present values to equal the observed market price of the security.

For example, for a security with a remaining maturity of 300 months, the NPV Model will calculate 60,000 monthly cash flows to be discounted by 60,000 discount factors (i.e., 60,000 = 200 paths x 300 months per path). An initial trial value is chosen for the OAS and it is used in calculating all 60,000 discount factors. Those discount factors are used, in turn, to calculate 200 present value estimates for the security. If the average present value exceeds the security's actual price, the initial guess for the value of the OAS was too low. If the average present value is below the actual price, the value of the OAS was too high. By adjusting the trial value of the OAS iteratively, the Model eventually finds the correct value.

Step 3: Generating Prices Using the OAS Values

The OAS for a given security represents the yield spread that investors require over the Treasury yield curve, after adjusting the security's cash flows for the effects of embedded options, such as prepayments. Once the OAS has been calculated for a particular security, it is used to: (a) estimate prices for similar mortgage instruments in the base case scenario, and (b) estimate prices in the alternate rate scenarios.

Step 3a: Estimating Prices of Similar Instruments in Base Case Scenario

The NPV Model assumes that instruments with similar credit risk, liquidity, and embedded options have approximately the same OAS. Price quotes are obtained, and OAS values are calculated, for a number of different securities for each type of mortgage instrument. These OAS values and the simulated interest rates (produced in Step 1 above) are then used to estimate prices for similar instruments.

For example, suppose one of the benchmark securities for which an OAS has been calculated is an 8% 30-year FNMA mortgage security. To estimate the price of a similar security, the Model would first simulate its cash flows using the simulated interest rates and the procedure described in Steps 2a and 2b, above. Second, it would calculate discount factors as described in Step 2c, using the OAS of the 8% mortgage security. Third, the simulated cash flows would be multiplied by those discount factors and summed along each path to produce 200 present values. Finally, the average present value would be the estimated price of the second security.

Step 3b: Estimating Prices in the Alternate Interest Rate Scenarios

Prices of mortgage-related instruments in the eight alternate interest rate scenarios are calculated by the NPV Model using the same OAS values used for those instruments in the base case scenario. The procedure for estimating the price of an instrument in each alternate scenario is as follows.

First, the interest rates simulated in Step 1 are generated for the alternate rate scenario. Instead of using the actual 1-month and 5-year zero-coupon Treasury rates as the starting points, however, the initial values of the 1-month and 5-year rates are set equal to the actual rates plus or minus the appropriate rate shock. Furthermore, the simulated 1-month rates are calibrated to be consistent with a “shocked” term structure in which the actual zero-coupon curve has been shifted up or down by the appropriate number of basis points.

Second, cash flows for the instrument are simulated as described in Steps 2a and 2b, but using the “shocked” interest rates described in the paragraph above. Cash flows differ from cash flows in the base case as a result of differing prepayments and, where relevant, different adjustable-rate coupons.

Third, discount factors are calculated as described in Step 2c, but again using the “shocked” interest rates. The OAS used is the same as that used for the instrument in the base case.

Fourth, the product of the simulated cash flows and the discount factors are added up along each rate path to produce 200 present values. The estimated price of the instrument in this alternate scenario is the average of those present values.

Price Tables Are Constructed to Store Price Estimates

Estimating prices using the option-based approach requires considerable computer time. Instead of calculating loan and security prices individually for the mortgages reported by each institution, prices — expressed as a percent of outstanding balance — are pre-computed each quarter for a large number of representative instruments, and then stored in price “look-up” tables (see, for example, Table 5.A.2). When the Model generates an IRR Exposure Report for an individual institution, prices for the particular instruments reported by the institution are retrieved from the appropriate tables. Separate price tables are constructed each quarter for each of the types of mortgage-related instruments in Table 5.A.1.

For each type of instrument, the option-based approach is used to estimate prices in all seven interest rate scenarios for a number of “benchmark” instruments covering a fairly wide range of characteristics. For example, prices are calculated for 252 different 30-year FHA/VA mortgage loans (i.e., all combinations of 12 different coupons and 21 different remaining maturities). An excerpt from that price table is provided in Table 5.A.2.

For adjustable-rate mortgages indexed to 1-year Treasury rates, 2,700 different benchmarks are priced (i.e., all combinations of 4 different coupons, 3 margins, 3 maturities, 3 intervals until next reset, 5 periodic cap and floor configurations, and 5 lifetime cap and floor configurations). The range of values for each characteristic is adjusted periodically to provide a reasonable representation of any combination of characteristics likely to be reported. For example, for conventional fixed-rate mortgages, the WACs for which prices are currently estimated range from 6.5 to 12 percent and the remaining maturities from 60 to 360 months.

How the Price Tables Are Used

The price tables are organized according to their various characteristics (e.g., by WAC and WARM). Prices for a given instrument are easily retrieved by looking in the appropriate table for that instrument’s particular combination of characteristics.

Table 5.A.1

List of Price Tables Created for Mortgage-Related Instruments

- 30-year conventional fixed-rate mortgage loans
- 30-year conventional fixed-rate mortgage securities
- 30-yr fixed-rate FHA/VA mortgage loans
- 30-yr fixed-rate GNMA mortgage securities
- 15-yr fixed-rate mortgage loans
- 15-yr fixed-rate mortgage securities
- 7-yr balloon mortgage loans
- 7-yr balloon mortgage securities

- 6-month Treasury-indexed adjustable-rate mortgage loans
- 6-month Treasury-indexed adjustable-rate mortgage securities
- 1-year Treasury-indexed adjustable-rate mortgage loans
- 1-year Treasury-indexed adjustable-rate mortgage securities
- 3-year Treasury-indexed adjustable-rate mortgage loans
- 3-year Treasury-indexed adjustable-rate mortgage securities
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage loans (non-teaser)
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage securities (non-teaser)
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage loans (teaser)
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage securities (teaser)
- 1-year 11th District Cost-of-funds-indexed adjustable-rate mortgage loans
- 1-year 11th District Cost-of-funds-indexed adjustable-rate mortgage securities

- 30-year conventional fixed-rate mortgage loans serviced for others (separate tables are used for servicing fees, costs, and escrow accounts)
- 30-yr fixed-rate FHA/VA mortgage loans serviced for others (separate tables are used for servicing fees, costs, and escrow accounts)
- 1-year Treasury-indexed adjustable-rate mortgage loans serviced for others (separate tables are used for servicing fees, costs, and escrow accounts)
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage loans serviced for others (separate tables are used for servicing fees, costs, and escrow accounts)

- Conventional 30-year fixed-rate mortgage loans serviced by others
- 1-year Treasury-indexed adjustable-rate mortgage loans serviced by others
- 1-month 11th District Cost-of-funds-indexed adjustable-rate mortgage loans serviced by others

- Float on escrow accounts related to owned conventional 30-year fixed-rate mortgage loans
- Float on escrow accounts related to owned 30-year FHA/VA fixed-rate mortgage loans
- Float on escrow accounts related to owned 15-year fixed-rate mortgage loans
- Float on escrow accounts related to owned 7-year balloon mortgage loans
- Float on escrow accounts related to owned 1-year Treasury-indexed adjustable-rate mortgage loans
- Float on escrow accounts related to owned 1-month COF-indexed adjustable-rate mortgage loans

For example, if an institution reports $200 in 30-year FHA/VA Mortgage Loans (in CMR017) with a weighted average coupon (in CMR012) of 7.5% and a weighted average remaining maturity (in CMR007) of 300 months, prices in the seven interest rate scenarios would be determined by referring to the line in the relevant price table having that combination of maturity and coupon. For instance, the price table shown in Table 5.A.2 indicates the estimated price for the reported balance was 96.48, as shown in line (1). In the +100 basis point alternate rate scenario, the estimated price was 90.65. These prices imply that the value of the reported $200 balance was $192 (= $200 x 0.9648) and that the estimated value would have declined to $181.30 if market interest rates had been 100 basis points higher. If the exact reported coupon and maturity do not appear on the price table, linear interpolation is used to determine the prices.

For example, if the mortgages in the example above were reported to have a weighted average coupon of 7.75% and a remaining maturity of 327 months, the NPV Model would determine their prices as follows.

Table 5.A.2

Excerpt from Price Table FHA/VA Loans
(as a Percent of Outstanding Balance)

	WAC	WARM	Interest Rate Shock (bp)						
	(%)	(mo)	-300	-200	-100	0	+100	+200	+300
	7.50	60	105.49	104.02	101.95	99.75	97.55	95.38	93.26
	7.50	120	107.56	105.68	102.35	98.66	94.97	91.39	87.95
	7.50	150	108.19	106.20	102.41	98.15	93.91	89.82	85.93
	7.50	180	108.68	106.62	102.45	97.73	93.03	88.53	84.28
	7.50	192	108.84	106.76	102.46	97.57	92.72	88.07	83.70
	7.50	204	108.99	106.89	102.47	97.43	92.43	87.65	83.17
	7.50	216	109.13	107.01	102.47	97.30	92.16	87.26	82.68
	7.50	228	109.25	107.12	102.48	97.17	91.91	86.90	82.23
	7.50	239	109.36	107.21	102.48	97.06	91.69	86.59	81.84
	7.50	240	107.77	105.91	102.23	97.00	91.62	86.52	81.80
	7.50	252	107.82	105.96	102.22	96.88	91.40	86.21	81.41
	7.50	264	107.87	106.01	102.21	96.77	91.19	85.92	81.05
	7.50	276	107.92	106.05	102.20	96.67	91.00	85.65	80.72
	7.50	288	107.96	106.09	102.19	96.58	90.82	85.40	80.41
(1) →	7.50	300	108.00	106.12	102.18	96.48	90.65	85.16	80.13
	7.50	312	108.03	106.15	102.17	96.40	90.49	84.95	79.87
(2a) →	7.50	324	108.07	106.18	102.16	96.31	90.35	84.74	79.62
(2b) →	7.50	330	108.08	106.20	102.15	96.28	90.28	84.65	79.51
	7.50	336	108.16	106.25	102.15	96.23	90.17	84.50	79.32
	7.50	348	109.93	106.64	102.19	96.04	89.80	83.98	78.68
	7.50	360	110.48	107.40	102.26	95.75	89.23	83.19	77.71
	8.00	60	105.95	104.77	102.84	100.67	98.48	96.30	94.17
	8.00	120	108.00	106.78	103.80	100.21	96.54	92.94	89.48
	8.00	150	108.60	107.40	104.06	99.95	95.73	91.62	87.69
	8.00	180	109.04	107.90	104.27	99.72	95.06	90.53	86.24
	8.00	192	109.19	108.06	104.34	99.64	94.82	90.15	85.73
	8.00	204	109.32	108.22	104.40	99.56	94.60	89.80	85.27
	8.00	216	109.44	108.36	104.45	99.49	94.40	89.47	84.84
	8.00	228	109.55	108.48	104.50	99.42	94.20	89.17	84.44
	8.00	239	109.64	108.59	104.54	99.36	94.04	88.91	84.10
	8.00	240	108.63	106.79	104.01	99.26	93.98	88.85	84.05
	8.00	252	108.69	106.85	104.04	99.19	93.81	88.59	83.71
	8.00	264	108.74	106.90	104.05	99.13	93.66	88.34	83.40
	8.00	276	108.79	106.94	104.07	99.07	93.51	88.12	83.11
	8.00	288	108.83	106.98	104.08	99.01	93.37	87.91	82.84
	8.00	300	108.87	107.02	104.10	98.96	93.25	87.72	82.60
	8.00	312	108.90	107.06	104.11	98.91	93.13	87.54	82.37
(2c) →	8.00	324	108.93	107.09	104.11	98.86	93.02	87.38	82.16
(2d) →	8.00	330	108.95	107.10	104.12	98.84	92.97	87.30	82.07
	8.00	336	109.04	107.17	104.14	98.81	92.89	87.17	81.89
	8.00	348	109.94	107.72	104.29	98.72	92.60	86.72	81.31
	8.00	360	111.74	108.80	104.59	98.56	92.15	86.03	80.43
	8.50	60	106.36	105.42	103.67	101.56	99.37	97.20	95.06
	8.50	120	108.36	107.63	105.11	101.68	98.06	94.46	90.97
	8.50	150	108.90	108.31	105.54	101.64	97.48	93.37	89.41
	8.50	180	109.30	108.83	105.88	101.59	97.01	92.48	88.15

First, it would select the four lines of prices that most closely bracket the reported WAC and WARM. Those are the lines labeled: (2a) with a WAC of 7.50% and WARM of 324 months, (2b) with a WAC of 7.50% and WARM of 330 months, (2c) with a WAC of 8.00% and WARM of 324 months, and (2d) with a WAC of 8.00% and WARM of 330 months.

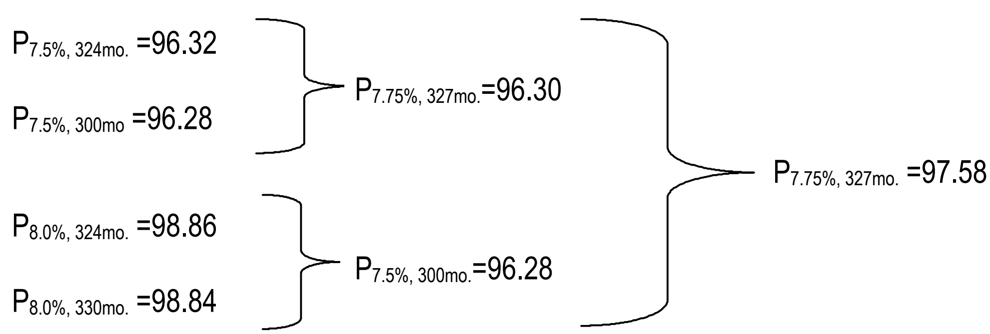
Next, it would estimate prices for mortgages having the reported WARM and coupons of 7.50% and 8.00% by interpolating between the prices in lines (2a) and (2b) and in lines (2c) and (2d).

Finally, it would estimate prices for mortgages having both the reported WARM and WAC by interpolating between the prices of the two lines in the previous step.

For the base case scenario, these calculations are as follows. First, the four base case prices selected from the price table are: (a) 96.32, (b) 96.28, (c) 98.86, and (d) 98.84. Interpolating between WARMs gives a price of 96.30 for 7.5% mortgages[5] and of 98.85 for 8.00% mortgages[6] with remaining maturities of 327 months. Interpolating between WACs gives the reported mortgages an estimated price of 97.58 in the base case.[7] This process is shown schematically in Figure 5.A.2.

Figure 5.A.3

Schematic of Interpolation in Base Case



Different types of mortgage-related instruments differ in the characteristics used to determine their prices and, thus, in the number of interpolations that must be performed. As shown above, fixed-rate mortgages must be interpolated in at most 2 dimensions — WAC and WARM. As described below, in Section 5.K, adjustable-rate mortgage prices are estimated by interpolating in up to 5 dimensions: (a) WAC, (b) margin, (c) time to next reset, (d) distance to lifetime cap, and (e) WARM.

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5 That is:

$$P_{7.5\%,\ 327\ mo.} = 96.32 \times \frac{(330 - 327)}{(330 - 324)} + 96.28 \times \frac{(327 - 324)}{(330 - 324)} = (96.32 \times 0.5) + (96.28 \times 0.5) = 96.30$$

6 That is:

$$P_{8.0\%,\ 327\ mo.} = 98.86 \times \frac{(330 - 327)}{(330 - 324)} + 98.84 \times \frac{(327 - 324)}{(330 - 324)} = (98.86 \times 0.5) + (98.84 \times 0.5) = 98.85$$

7 That is:

$$P_{7.75\%,\ 327\ mo.} = 96.30 \times \frac{(8.00 - 7.75)}{(8.00 - 7.50)} + 98.85 \times \frac{(7.75 - 7.50)}{(8.00 - 7.50)} = (96.30 \times 0.5) + (98.85 \times 0.5) = 97.58$$

Section 5.B - Fixed-Rate, Single-Family, First Mortgage Loans and MBS: 30-Year Mortgage Loans

Schedule CMR Line Numbers

The lines used to report these instruments on Schedule CMR are displayed below.

ASSETS

FIXED-RATE SINGLE-FAMILY FIRST MORTGAGE LOANS & MORTGAGE-BACKED SECURITIES	Coupon									
30-Year Mortgages and MBS:	Less Than 7%		7.00 to 7.99%		8.00 to 8.99%		9.00 to 9.99%		10.00% & Above	
Mortgage Loans	001	$	002	$	003	$	004	$	005	$
WARM	006	months	007	months	008	months	009	months	010	months
WAC	011	. %	012	. %	013	. %	014	. %	015	. %
$ of Which Are FHA or VA Guaranteed	016	$	017	$	018	$	019	$	020	$

Description of Instruments

This category includes:

- 30-year conventional fixed-rate mortgage (FRM) loans
- 30-year FHA/VA fixed-rate mortgage loans

Valuation Methodology

Method

Institutions can report up to ten separate FRM balances on Schedule CMR for this category (in CMR001 - CMR005 and CMR016 - CMR020).[1] These balances are valued separately using prices obtained from the appropriate price tables. For each mortgage included in the tables, prices in all seven interest rate scenarios are estimated using the option-based approach as follows.

Cash Flows

The NPV Model calculates a stream of monthly cash flows along each of the 200 randomly generated rate paths, based upon a beginning mortgage balance of $100. Each cash flow stream consists of interest, scheduled principal, and prepaid principal less estimated servicing costs, as discussed below.

Scheduled Principal and Interest

Given the fixed-rate coupon, scheduled payments of principal and interest are calculated each month along each rate path by amortizing the remaining balance over the remaining maturity.

[1] Balances reported in CMR016 through CMR020 are guaranteed by FHA or VA. Conventional mortgage balances are simply calculated by subtracting the FHA/VA balances from the combined balances reported in CMR001 through CMR005. For example, the outstanding balance of conventional 30-year fixed-rate mortgage loans with coupon less than 7% is CMR001 minus CMR016.

Prepaid Principal

Prepayments of 30-year conventional FRMs are calculated for each month along each rate path using the prepayment equations described in Step 2b of Section 5.A. The equation for the refinancing factor (refi) for well-seasoned conventional FRMs (i.e., those 10 years or more old) is given by Equation 5.B.1.

Equation 5.B.1 - Refinancing Factor for Well-Seasoned Conventional 30-Year FRMs

$$refi_{tn,\,t} = 0.1923 - 0.0834 \cdot \arctan\left[9.014 \cdot \left(1.052 - \frac{c}{m_{n,\,t-3}}\right)\right]$$

where: c = coupon of the mortgage being priced
$m_{n,\,t\text{-}3}$ = simulated mortgage refinancing rate (lagged three months)
arctan = arctangent function.

For conventional FRMs that are not well-seasoned (i.e., less than 10 years old), the equation is:

Equation 5.B.2 - Refinancing Factor for Moderately Seasoned and Unseasoned Conventional 30-Year FRMs

$$refi_{tn,\,t} = 0.2406 - 0.1389 \cdot \arctan\left[5.952 \cdot \left(1.089 - \frac{c}{m_{n,\,t-3}}\right)\right]$$

Prepayments of 30-year fixed-rate FHA/VA mortgages are estimated using a different refinancing factor than for conventional mortgages. For well-seasoned FHA/VA FRMs, it is:

Equation 5.B.3 - Refinancing Factor for Well-Seasoned FHA/VA 30-Year FRMs

$$refi_{tn,\,t} = 0.1658 - 0.0696 \cdot \arctan\left[8.746 \cdot \left(1.073 - \frac{c}{m_{n,\,t-3}}\right)\right]$$

For those that are not well-seasoned, it is:

Equation 5.B.4 - Refinancing Factor for Moderately Seasoned and Unseasoned FHA/VA 30-Year FRMs

$$refi_{tn,\,t} = 0.2047 - 0.1164 \cdot \arctan\left[6.1797 \cdot \left(1.095 - \frac{c}{m_{n,\,t-3}}\right)\right]$$

Note that the values of the coefficients in Equations 5.B.1 through 5.B.4 are subject to periodic revision. Current values may be obtained from *Selected Asset and Liability Price Tables* available at http://www.ots.treas.gov/quarter.html.

Servicing Costs

Because mortgages must be serviced, all monthly cash flows are reduced by an imputed cost of servicing the loans. For fixed-rate mortgages, an annual cost of 20 basis points is assumed.[2]

[2] If an institution reports (in CMR586) that it has fixed-rate mortgages serviced by others, the economic value of its mortgages is adjusted by an amount that depends on the servicing fee it reports in CMR587. (See Section 5.M, Mortgages Serviced By Others.)

Discount Factors

The present value of the stream of mortgage cash flows along each of the 200 simulated interest rate paths is calculated by multiplying each monthly cash flow by the discount factor appropriate to that path and month. That is, for any month, t, along any given rate path, n, the discount factor is:

Equation 5.B.5 - Discount Factor for 30-Year FRM Loans

$$df_{n,t} = \frac{1}{\left[\left(1+f_{n,1}+oas\right)\left(1+f_{n,2}+oas\right)\ldots\left(1+f_{n,t}+oas\right)\right]}$$

where: $f_{n,t}$ = simulated 1-month rate on path n for month t

oas = option-adjusted spread.

Option-Adjusted Spread

OAS values are calculated as described in Section 5.A for several benchmark FHLMC/FNMA and GNMA mortgage securities with a variety of coupons. In estimating mortgage loan prices for the price tables, cash flows are discounted using the OAS of the appropriate benchmark security that is most similar to the mortgage loan being priced, plus 25 basis points per year.[3] (For example, in estimating the price of an 8.5% FHA/VA mortgage loan, the Model would use the OAS of the GNMA benchmark security having the WAC closest to 8.5%, plus 25 basis points.) The same OAS is used in all 9 rate scenarios.

Price Tables

The average of the 200 discounted cash flows provides an estimate of the price of the mortgage, expressed as a percentage of the outstanding balance, in the particular interest rate scenario that is being evaluated. As described in Section 5.A, prices are calculated in all seven interest rate scenarios for 252 different combinations of WAC and WARM for both conventional and FHA/VA 30-year FRMs and stored in two separate price tables.

Using the Price Tables

Each of the ten 30-year FRM balances reported on Schedule CMR by a given institution is valued separately. Seven prices are retrieved from the price tables for each balance, as described in Section 5.A, based upon the reported WAC and WARM,[4] interpolating where necessary. Each balance is multiplied by those prices to provide an estimate of its economic value in each of the seven scenarios.

The IRR Exposure Report reports the aggregate value of the reported balances of 30-year conventional and FHA/VA mortgage loans in each of the interest rate scenarios on page 2 in the line titled 30-Yr Mortgage Loans.

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3 The benchmark securities differ from otherwise identical unsecuritized mortgage loans in two important respects. They have an agency guarantee against credit risk and, as securities, they are generally more liquid than unsecuritized mortgage loans. The discount factors for otherwise similar mortgage loans must, therefore, be adjusted for the extra risk they carry relative to the benchmark securities. In calculating the discount factors for whole loans, therefore, the NPV Model adds 25 basis points per year to the OAS.

4 The conventional and FHA/VA balances reported in a given column are assumed to have the WARM and WAC reported in that column (in CMR006 - CMR010 and CMR011 - CMR015, respectively).

Section 5.C - Fixed-Rate, Single-Family, First Mortgage Loans and MBS: 30-Year Mortgage Securities

Schedule CMR Line Numbers

The lines used to report these instruments on Schedule CMR are displayed below.

ASSETS

FIXED-RATE SINGLE-FAMILY FIRST MORTGAGE LOANS & MORTGAGE-BACKED SECURITIES	Coupon									
30-Year Mortgages and MBS:	Less Than 7%		7.00 to 7.99%		8.00 to 8.99%		9.00 to 9.99%		10.00% & Above	
Securities Backed by Conventional Mortgages	026	$	027	$	028	$	029	$	030	$
WARM	031	months	032	months	033	months	034	months	035	months
Wtd Avg Pass-Thru Rate	036	. %	037	. %	038	. %	039	. %	040	. %
Securities Backed by FHA or VA Mortgages	046	$	047	$	048	$	049	$	050	$
WARM	051	months	052	months	053	months	054	months	055	months
Wtd Avg Pass-Thru Rate	056	. %	057	. %	058	. %	059	. %	060	. %

Description of Instruments

This category includes:

- 30-year conventional fixed-rate mortgage securities
- 30-year fixed-rate GNMA mortgage securities

Valuation Methodology

Method

Institutions can report up to ten separate FRM security balances on Schedule CMR for this category (in CMR026 - CMR030 and CMR046 - CMR050). These balances are valued separately using prices obtained from the appropriate price tables. For each mortgage security that is included in the tables, prices in all seven interest rate scenarios are estimated using the option-based approach as follows.

Cash Flows

The NPV Model calculates a stream of monthly cash flows along each of the 200 randomly generated rate paths based on a beginning balance of $100 for the mortgage collateral underlying the security. Each cash flow stream of each security consists of the interest, scheduled principal, and prepaid principal generated by the collateral less an assumed servicing spread of 50 basis points, as explained below.

Scheduled Principal and Interest

The WAC of the collateral underlying the security is assumed to equal the weighted average pass-through rate of the security plus 50 basis points. Scheduled payments of principal and interest are then calculated for each month along each rate path by amortizing the remaining balance over the remaining maturity.

Prepaid Principal

Prepayments of collateral are calculated for each month along each rate path using the assumed collateral WAC and the prepayment equations described in Step 2b of Section 5.A. The NPV Model uses the same refinancing factors (refi) that it uses for conventional and FHA/VA whole mortgage loans (see Section 5.B for details).

Servicing Spread

The Model estimates collateral cash flows by assuming a WAC that is 50 basis points above the pass-through rate. Because investors in the security receive only the pass-through rate, this 50 basis point per year servicing spread is deducted from the interest portion of the monthly cash flows.

Discount Factors

The present value of the stream of cash flows generated by the security along each of the 200 simulated interest rate paths is calculated by multiplying each monthly cash flow by the discount factor appropriate to that path and month. That is, for any month, t, along any given rate path, n, the discount factor is:

Equation 5.C.1 - Discount Factor for 30-Year FRM Securities

$$df_{n,t} = \frac{1}{\left[(1+f_{n,1}+oas)(1+f_{n,2}+oas)\ldots(1+f_{n,t}+oas)\right]}$$

where: $f_{n,t}$ = simulated 1-month rate on path n for month t

oas = option-adjusted spread.

Option-Adjusted Spread

OAS values are calculated as described in Section 5.A for several benchmark FHLMC/FNMA and GNMA mortgage securities with a variety of coupons. In estimating prices of mortgage securities for the price tables, cash flows are discounted using the OAS of the appropriate benchmark security that is most similar to the security being priced.[1] (For example, in estimating the price of an 8.5% FHLMC/FNMA security, the Model would use the OAS of the FHLMC/FNMA benchmark security having the WAC closest to 8.5%.) The same OAS is used in all seven rate scenarios.

Price Tables

The average of the 200 discounted cash flows provides an estimate of the price of the mortgage, expressed as a percentage of the outstanding balance, in the particular interest rate scenario that is being evaluated. Prices are calculated in all seven interest rate scenarios for 252 different combinations of WAC and WARM (12 WACs x 21 WARMs) for both FHLMC/FNMA and GNMA 30-year FRM securities and stored in two separate price tables.

[1] Unlike the treatment for whole mortgage loans, the Model does not add a 25 basis point risk premium to the OAS for mortgage securities.

Using the Price Tables

Each of the ten 30-year fixed-rate security balances reported by a given institution on Schedule CMR is valued separately. Seven prices are retrieved from the price tables for each balance, as described in Section 5.A, based on the reported WAC and WARM,[2] interpolating where necessary. Each balance is multiplied by these prices to provide an estimate of its economic value in each of the seven scenarios.

The IRR Exposure Report reports the aggregate value of the reported balances of MBS backed by 30-year conventional and FHA/VA mortgage loans in each of the interest rate scenarios on page 2 in the line titled 30-Yr Mortgage Securities.

[2] The conventional and FHA/VA balances reported in a given column are assumed to have the WARM and WAC reported in that column (in CMR006 - CMR010, and CMR011 - CMR015, respectively).

Section 5.D - Fixed-Rate, Single-Family, First Mortgage Loans and MBS: 15-Year Mortgage Loans and Securities

Schedule CMR Line Numbers

The lines used to report these instruments on Schedule CMR are displayed below.

ASSETS

FIXED-RATE SINGLE-FAMILY FIRST MORTGAGE LOANS & MORTGAGE-BACKED SECURITIES	Coupon									
15-Year Mortgages and MBS:	Less Than 7%		7.00 to 7.99%		8.00 to 8.99%		9.00 to 9.99%		10.00% & Above	
Mortgage Loans	066	$	067	$	068	$	069	$	070	$
WAC	071	. %	072	. %	073	. %	074	. %	075	. %
Mortgage Securities	076	$	077	$	078	$	079	$	080	$
Wtd Avg Pass-Thru Rate	081	. %	082	. %	083	. %	084	. %	085	. %
WARM (of Loans & Securities)	086	months	087	months	088	months	089	months	090	months

Description of Instruments

This category includes all fully-amortizing mortgage loans with an original maturity of less than 25 years, participations in such loans, and mortgage securities backed by such loans. It also includes bi-weekly payment mortgages having an original maturity of 25 years or more. Insufficient detail is provided on the reporting form to identify separately the mortgage-types that qualify for this category, so the NPV Model treats all reported balances as consisting of:

- 15-year fixed-rate mortgage loans
- 15-year fixed-rate mortgage securities[1]

Valuation Methodology

Method

Institutions can report up to five separate loan balances and five separate security balances on Schedule CMR for this category (in CMR066-CMR070 and CMR076-CMR080, respectively). These balances are valued separately using prices obtained from the appropriate loan and securities price tables. The price tables contain prices in all seven interest rate scenarios. Each price is estimated using the option-based approach as follows.

[1] If any of the weighted-average remaining maturities reported in CMR086 through CMR090 exceed 180 months, the balances corresponding to these WARMs are treated as 20-year mortgages.

Cash Flows

The NPV Model calculates a stream of monthly cash flows along each of the 200 randomly generated rate paths based on a beginning mortgage balance of $100. Cash flows from mortgage loans consist of interest, scheduled principal, and prepaid principal less estimated servicing costs. Cash flows from mortgage securities consist of the interest, scheduled principal, and prepaid principal generated by the underlying collateral, less an assumed servicing spread of 50 basis points.

Scheduled Principal and Interest

For a mortgage loan with a given coupon, scheduled payments of principal and interest are calculated each month along each rate path by amortizing the remaining balance over the remaining maturity. For mortgage securities, the pass-through rate is assumed to be 50 basis points less than the WAC of the mortgages collateralizing the security. Scheduled payments for mortgage securities are calculated based on the WAC and WARM of the underlying collateral, but a servicing spread of 50 basis point per year is deducted from each scheduled interest payment.

Prepaid Principal

Prepayments of 15-year fixed-rate mortgages are calculated for each month along each rate path using prepayment equations similar to those described in Step 2b of Section 5.A. The equation for the refinancing factor (refi) for 15-year FRMs is:

Equation 5.D.1 - Refinancing Factor for 15-Year FRMs

$$refi_{n,t} = 0.2366 - 0.1282 \cdot \arctan\left[5.365 \cdot \left(1.097 - \frac{c}{m_{n,t-3}}\right)\right]$$

where: c = coupon of the mortgage being priced

$m_{n,t-3}$ = simulated mortgage refinancing rate (lagged three months)

arctan = arctangent function

For 15-year mortgage securities, prepayments are also calculated according to the equation above, but the coupon variable, c, corresponds to the WAC of the collateral. Note that the values of the coefficients in Equation 5.D.1 are subject to periodic revision. Current values may be obtained from *Selected Asset and Liability Price Tables* available at http://www.ots.treas.gov/quarter.html.

Discount Factors

The present value of the stream of cash flows generated by the mortgage loan or the mortgage security along each of the 200 simulated interest rate paths is calculated by multiplying each monthly cash flow by the discount factor appropriate to that path and month. For any month, t, along any given rate path, n, the discount factor for mortgage securities is:

Equation 5.D.2 - Discount Factor for 15-Year FRM Securities

$$df_{n,t} = \frac{1}{\left[\left(1+f_{n,1}+oas\right)\left(1+f_{n,2}+oas\right)\ldots\left(1+f_{n,t}+oas\right)\right]}$$

where: $f_{n,t}$ = simulated 1-month rate on path n for month t

oas = option-adjusted spread.

For loans, 25 basis points per year is added to the OAS in the Equation 5.D.2[2]

Option Adjusted Spread

OAS values are calculated as described in Section 5.A for several benchmark 15-year mortgage securities having a variety of coupons. In estimating prices of mortgage securities for the price tables, cash flows are discounted using the OAS of the benchmark security that is most similar to the security being priced. The same OAS is used in all seven rate scenarios.

Price Tables

The average of the 200 discounted cash flows provides an estimate of the price of the mortgage or the mortgage security, expressed as a percentage of the outstanding balance, in the particular interest rate scenario that is being evaluated. Prices are calculated in all seven interest rate scenarios for 252 different combinations of WAC and WARM (12 WACs x 21 WARMs) for both 15-year fixed-rate mortgage loans and mortgage securities and stored in two separate price tables.

Using the Price Tables

Each of the five 15-year mortgage loan and mortgage security balances reported by a given institution is valued separately. Nine prices are retrieved from the price tables for each balance, as described in Section 5.A, based on the reported WAC and WARM,[3] interpolating where necessary. Each balance is multiplied by those prices to provide an estimate of its economic value in each of the seven scenarios.

The IRR Exposure Report presents the aggregate value of the reported balances of 15-year mortgage loans and mortgage securities in each of the interest rate scenarios on page 2 in the line titled 15-Year Mortgages & MBS.

[2] The benchmark securities differ from otherwise identical unsecuritized mortgage loans in two important respects. They have an agency guarantee against credit risk and, as securities, they are generally more liquid than unsecuritized mortgage loans. In estimating prices of 15-year mortgage loans for the price tables, therefore, the discount factors for otherwise similar mortgage loans must be adjusted for the extra risk they carry relative to the benchmark securities. Thus, in calculating the discount factors for whole loans, the NPV Model adds 25 basis points per year to the simulated 1-month rates.

[3] The loan and security balances reported in a given column have separately reported WACs (CMR071-CMR075 and CMR081-CMR085, respectively) but are assumed to have the same WARM (reported in CMR086-CMR090).

Section 5.E - Fixed-Rate, Single-Family, First Mortgage Loans and MBS: Balloon Mortgage Loans and Securities

Schedule CMR Line Numbers

The lines used to report these instruments on Schedule CMR are displayed below.

ASSETS

FIXED-RATE SINGLE-FAMILY FIRST MORTGAGE LOANS & MORTGAGE-BACKED SECURITIES	Coupon									
Balloon Mortgages and MBS:	Less Than 7%		7.00 to 7.99%		8.00 to 8.99%		9.00 to 9.99%		10.00% & Above	
Mortgage Loans	096	$	097	$	098	$	099	$	100	$
WAC	101	. %	102	. %	103	. %	104	. %	105	. %
Mortgage Securities	106	$	107	$	108	$	109	$	110	$
Wtd Avg Pass-Thru Rate	111	. %	112	. %	113	. %	114	. %	115	. %
WARM (of Loans & Securities)	116	months	117	months	118	months	119	months	120	months

Description of Instruments

This category includes all fixed-rate balloon payment mortgages, mortgages scheduled for a single rate adjustment (such as those that would qualify for the FNMA Two-Step Mortgage program), adjustable-rate mortgages whose coupons reset less frequently than every 5 years, and call loans permitting the lender to reset the coupon in more than 5 years. Also included are participations in such mortgages and securities backed by such mortgages. Insufficient detail is provided on the reporting form to identify these mortgage-types separately, so the NPV Model treats all reported balances as consisting of:

- 7-year balloon mortgage loans
- 7-year balloon mortgage securities

Valuation Methodology

Method

Institutions can report up to five separate loan balances and five separate security balances on Schedule CMR for this category (in CMR096-CMR100 and CMR106-CMR110, respectively). All balances are assumed to amortize according to a 30-year schedule, with all remaining principal to be paid as a balloon on the scheduled maturity date.[1] The reported balances are valued separately using prices obtained from the appropriate loan and securities price tables. The price tables contain prices in all seven interest rate scenarios. Each price is estimated using the option-based approach as follows.

Cash Flows

The NPV Model calculates a stream of monthly cash flows along each of the 200 randomly generated rate paths, based upon a beginning mortgage balance of $100. As explained below, cash flows from mortgage

[1] The weighted average time until this balloon payment is reported as the WARM in CMR116 - CMR120. For the various types of adjustable-rate mortgages reported in this section, the time until the next scheduled reset is reported as the WARM.

loans consist of interest, scheduled principal, and prepaid principal less an estimated servicing cost of 20 basis points. Cash flows from mortgage securities consist of the interest, scheduled principal, and prepaid principal generated by the underlying collateral less an assumed servicing spread of 50 basis points.

Scheduled Principal and Interest

As stated above, all balances in this section are treated as 7-year balloon mortgages that amortize according to a 30-year schedule. For a mortgage loan with a given coupon, scheduled payments of principal and interest are calculated each month along each rate path by amortizing the remaining balance according to the appropriate number of remaining monthly payments,[2] with all remaining principal to be paid as a single payment on the maturity date.

For mortgage securities, the pass-through rate is assumed to be 50 basis points less than the WAC of the mortgages collateralizing the security. Scheduled payments for mortgage securities are calculated based upon the WAC and WARM of the underlying collateral, but a servicing spread of 50 basis point per year is deducted from each scheduled interest payment.

Prepaid Principal

Prepayments of balloon mortgages are calculated for each month along each rate path using prepayment equations similar to those described in Step 2b of Section 5.A. The equation for the refinancing factor (refi) for balloon mortgages is:

Equation 5.E.1 - Refinancing Factor for Balloon Mortgages

$$\text{refi}_{n,t} = 0.3570 - 0.2111 \cdot \arctan\left[4.744 \cdot \left(1.041 - \frac{c}{m_{n,t-3}}\right)\right]$$

where: c = coupon of the mortgage being priced

$m_{n,t-3}$ = simulated mortgage refinancing rate (lagged three months)

arctan = arctangent function.

For mortgage securities of this type, prepayments are also calculated according to the equation above, but the coupon variable, c, corresponds to the WAC of the collateral. Note that the values of the coefficients in Equation 5.E.1 is subject to periodic revision. Current values may be obtained from *Selected Asset and Liability Price Tables* available at http://www.ots.treas.gov/quarter.html.

Discount Factors

The present value of the stream of cash flows generated by the mortgage loan or the mortgage security along each of the 200 simulated interest rate paths is calculated by multiplying each monthly cash flow by the discount factor appropriate to that path and month. For any month, t, along any given rate path, n, the discount factor for balloon securities is given by Equation 5.E.2.

Equation 5.E.2 - Discount Factor for Balloon Securities

$$df_{n,t} = \frac{1}{\left[\left(1+f_{n,1}+oas\right)\left(1+f_{n,2}+oas\right)\ldots\left(1+f_{n,t}+oas\right)\right]}$$

[2] For example, if the reported WARM is 58 months, the balloon mortgage is assumed to be 26 months (= 84 - 58) old and to amortize as though there are 334 payments (= 360 - 26) left.

where: $f_{n,t}$ = simulated 1-month rate on path n for month t
oas = option-adjusted spread.

For loans, 25 basis points per year are added to the OAS in Equation 5.E.2.[3]

Option Adjusted Spread

OAS values are calculated as described in Section 5.A for several benchmark 7-year balloon mortgage securities having a variety of coupons. In estimating prices of mortgage securities for the price tables, cash flows are discounted using the OAS of the benchmark security that is most similar to the security being priced. The same OAS is used in all seven rate scenarios.

Price Tables

The average of the 200 discounted cash flows provides an estimate of the price of the mortgage or the mortgage security, expressed as a percentage of the outstanding balance, in the particular interest rate scenario that is being evaluated. Prices are calculated in all seven interest rate scenarios for 84 different combinations of WAC and WARM (12 WACs x 7 WARMs) for both balloon mortgage loans and mortgage securities and stored in two separate price tables.

Using the Price Tables

Each of the five balloon mortgage loan and mortgage security balances reported by a given institution is valued separately. Nine prices are retrieved from the price tables for each balance, as described in Section 5.A, based upon the reported WAC and WARM,[4] interpolating where necessary. Each balance is multiplied by those prices to provide an estimate of its economic value in each of the seven scenarios.

The IRR Exposure Report presents the aggregate value of the reported balances of balloon mortgage loans and mortgage securities in each of the interest rate scenarios on page 2 in the line titled Balloon Mortgages & MBS.

[3] The benchmark securities differ from otherwise identical unsecuritized mortgage loans in two important respects. They have an agency guarantee against credit risk and, as securities, they are generally more liquid than unsecuritized mortgage loans. In estimating prices of balloon mortgage loans for the price tables, therefore, the discount factors for otherwise similar mortgage loans must be adjusted for the extra risk they carry relative to the benchmark securities. Thus, in calculating the discount factors for whole loans, the NPV Model adds 25 basis points per year to the simulated 1-month rates.

[4] The loan and security balances reported in a given column have separately reported WACs (CMR101-CMR105 and CMR111-CMR115, respectively) but are assumed to have the same WARM (reported in CMR116-CMR120).

Section 5.F - General Discussion of Adjustable-Rate, Single-Family, First Mortgage Loans and Securities

Schedule CMR Line Numbers

The lines used to report these instruments on Schedule CMR are displayed below.

ASSETS

ADJUSTABLE-RATE SINGLE-FAMILY FIRST MORTGAGE LOANS & MORTGAGE-BACKED SECURITIES	Current Market Index ARMs By Coupon Reset Frequency			Lagging Market Index ARMs by Coupon Reset Frequency	
	6 Mo or Less	7 Mo to 2 Yrs	2+ Yrs to 5 Yrs	1 Month	2 Mo to 5 Yrs
Teaser ARMS					
Balances Currently Subject to Introductory Rates	141 $	142 $	143 $	144 $	145 $
WAC	146 . %	147 . %	148 . %	149 . %	150 . %
Non-Teaser ARMs					
Balances of All Non-Teaser ARMs	156 $	157 $	158 $	159 $	160 $
Wtd Avg Margin	161 bp	162 bp	163 bp	164 bp	165 bp
WAC	166 . %	167 . %	168 . %	169 . %	170 . %
WARM	171 months	172 months	173 months	174 months	175 months
Wtd Avg Time Until Next Payment Reset	176 months	177 months	178 months	179 months	180 months
Total Adjustable-Rate Single-Family First Mortgage Loans & Mortgage-Backed Securities					185 $

MEMO ITEMS FOR ALL ARMS (Reported at CMR185):	Current Market Index ARMs By Coupon Reset Frequency			Lagging Market Index ARMs by Coupon Reset Frequency	
	6 Mo or Less	7 Mo to 2 Yrs	2+ Yrs to 5 Yrs	1 Month	2 Mo to 5 Yrs
ARM Balances by Distance to Lifetime Cap					
Bal. W/Coupon Within 200 bp of Lifetime Cap	186 $	187 $	188 $	189 $	190 $
Wtd Avg Distance from Lifetime Cap	191 bp	192 bp	193 bp	194 bp	195 bp
Bal. W/Coupon 201-400 bp from Lifetime Cap	196 $	197 $	198 $	199 $	200 $
Wtd Avg Distance from Lifetime Cap	201 bp	202 bp	203 bp	204 bp	205 bp
Bal. W/Coupon Over 400 bp from Lifetime Cap	206 $	207 $	208 $	209 $	210 $
Wtd Avg Distance from Lifetime Cap	216 bp	217 bp	218 bp	219 bp	220 bp
Balances Without Lifetime Cap	211 $	212 $	213 $	214 $	215 $
ARM Cap & Flor Detail					
Balances Subject to Periodic Rate Caps	221 $	222 $	223 $	224 $	225 $
Wtd Avg Periodic Rate Cap (in basis points)	226 bp	227 bp	228 bp	229 bp	230 bp
Balances Subject to Periodic Rate Floors	231 $	232 $	233 $	234 $	235 $
MBS Included in ARM Balances	241 $	242 $	243 $	244 $	245 $

Description of Instruments

This category includes adjustable-rate, 1-4 family, first mortgage loans, participations in such loans, and securities backed by such loans. The data are arranged in five columns on Schedule CMR. Each column corresponds to a different type of index and coupon reset frequency (as discussed in Sections 5.G and 5.H below).

Valuation Methodology

The NPV Model uses four major steps to estimate the economic value of the ARMs reported by an institution in Schedule CMR.

Step 1: Calculating ARM Price Tables

The NPV Model uses pre-computed tables of prices. The first step is to estimate prices in the seven relevant interest rate scenarios for ARMs with various characteristics, and then to store them in the appropriate tables. Calculation of these prices is described for ARMs tied to "Current Market Rate" indexes (e.g., Treasury yields) in Section 5.G, and for ARMs tied to "Lagging Market Rate" indexes (e.g., the 11th District Cost of Funds Index) in Section 5.H. The organizational structure of the tables is described in Section 5.I entitled "Dimensions of ARM Price Tables."

Step 2: Disaggregating the Data Reported in Schedule CMR

Before the price tables can be used to value an institution's reported ARM balances, the Model must disaggregate each reported balance into a number of "sub-balances." This disaggregation is necessary because Schedule CMR collects information in an aggregated, weighted average form which may mask important characteristics. The Model must disaggregate the reported information into sub-balances that have characteristics which, individually, are more plausible than the weighted average characteristics that are reported, yet are consistent with the reported weighted averages. The disaggregation process is described in Section 5.J entitled "Disaggregating the Data Reported on Schedule CMR."

Step 3: Determining Prices Using the ARM Price Tables

The third step is to determine the nine required prices for each of the sub-balances calculated in step two. The price tables are organized so that prices for a given mortgage can be easily retrieved by "looking up" the particular combination of characteristics (e.g., WAC, margin, WARM, etc.) of that mortgage. If the exact characteristics of the mortgage do not appear on the price table, linear interpolation (in up to five dimensions) is used to determine the prices. This step is described in Section 5.K entitled "Determining Prices Using the ARM Price Tables."

Step 4: Valuing the ARM Sub-balances

The final step is to value each sub-balance by multiplying the amount of the sub-balance by each of the seven scenario prices determined in step 3, and then aggregating the values of all the sub-balances in each scenario. This step is described in Section 5.L entitled "Valuing the ARM Sub-balances."