GAO'S ECONOMETRIC AND CASH FLOW MODELS USED TO FORECAST FHA'S ECONOMIC NET WORTH

This appendix describes the econometric and cash flow models that we built and the analysis we conducted to estimate the economic net worth of the Federal Housing Administration's (FHA) Mutual Mortgage Insurance Fund (Fund) as of the end of fiscal year 1994. The goal of the econometric analysis was to forecast mortgage foreclosure and prepayment activity, which affect the flow of cash into and out of the Fund. We forecasted activity for all loans active at the end of fiscal year 1994 for each year from fiscal year 1995 through fiscal year 2024 on the basis of assumptions stated in this appendix. We estimated equations from data covering fiscal years 1975 through 1994 that included all 50 states and the District of Columbia but excluded U.S. territories.

Our forecasting models used observations on loan-quarters, that is, information on the characteristics and status of an insured loan during each quarter of its life to predict conditional foreclosure and prepayment probabilities.[1] More specifically, our model used a continuous time estimation routine, CTM[2] to jointly predict the probabilities of a loan terminating in a claim or a prepayment at a given time, as a function of interest and unemployment rates, the borrower's equity (computed using a house's price and current and contract interest rates as well as a loan's duration), the loan-to-value (LTV) ratio, the house price, the geographic location of the house, and the length of time that the loan has been active.

Cash flows out of the Fund when FHA pays a claim on a foreclosed mortgage and when a prepaid mortgage results in the partial refund of a premium. Cash flows into the Fund when FHA sells the foreclosed property and when borrowers pay the premium for the mortgage insurance. We forecasted the cash flows into and out of the Fund on the basis of our foreclosure and prepayment models and key economic variables provided by DRI/McGraw-Hill, a leading economic forecasting firm. We then used the forecasted cash flows, including an estimate of interest that would be earned or foregone, and the Fund's capital resources to estimate the economic net worth of the Fund.

We conducted separate estimations for investors' mortgages,

[1]These probabilities are conditional because they are subject to the condition that the loan has remained active until a given quarter.

[2]CTM was developed by George Yates, and many others at the University of Chicago. Information on CTM is contained in CTM: User's Manual, Honore, Walker, Yi 1987. University of Chicago National Opinion Research Center.

fixed-rate mortgages with terms of 25 years or more (hereafter referred to as 30-year mortgages), fixed-rate mortgages with terms of less than 25 years (hereafter referred to as 15-year mortgages), and adjustable-rate mortgages (ARMs). The 30-year fixed-rate mortgages and investor mortgages were further divided into new (purchase money) and refinancing mortgage samples. A complete description of the data we used, our models, and the results we obtained are discussed in detail in the following sections.

DATA AND SAMPLE SELECTION

For our analysis, we selected from FHA's computerized files a random sample of 1.4 million mortgages insured by FHA from fiscal year 1975 through fiscal year 1994.[3] From FHA's records, we obtained information on the initial characteristics of each loan, such as the year of the loan's origination and state in which the loan originated; the LTV ratio; the loan's amount; and the contract's interest rate. We categorized the loans as either foreclosed, prepaid, or active as of the end of fiscal year 1994.

To describe macroeconomic conditions at the national and state levels, we obtained data from the 1995 Economic Report of the President on the implicit price deflator for personal consumption expenditures. The Federal Home Loan Mortgage Corporation's quarterly interest rates for 30-year fixed-rate mortgages were used along with DRI/McGraw-Hill's data, at the state level, on the median house price appreciation and civilian unemployment rates, and interest rates on 1-year and 10-year U.S. Treasury bonds.

SPECIFICATION FOR MODEL

People buy homes for consumption and investment purposes. Normally, people do not plan to default on loans. However, conditions that lead to defaults occur. Defaults may be triggered by a number of events: unemployment, divorce, death, etc. These events are not likely to trigger foreclosure if the owner has positive equity in his/her home because the sale of the home with realization of a profit is better than the loss of the home through foreclosure. However, if the property is worth less than the mortgage, these events may trigger default.

Prepayments to financial institutions may be triggered by other events--declining interest rates, which prompt refinancing; rising house prices, which prompt the take-out of accumulated equity; or the sale of the residence. Because FHA's mortgages are assumable, the sale of a residence does not automatically trigger prepayment. For example, if interest rates have risen substantially since the time the mortgage was originated, a new

[3]FHA's A-43 data base provides current and historical information on the mortgage loans that FHA insures.

purchaser may prefer to assume the seller's mortgage.

We hypothesized that foreclosure behavior is influenced by the level of unemployment, price of the house, value of the home, current interest rates, contract interest rates, home equity, and region of the country within which the home is located. We hypothesized that prepayment is influenced by (1) a function of the difference between the interest rate specified in the mortgage contract and the mortgage rates generally prevailing in each subsequent year, (2) the amount of accumulated equity, (3) the price of the house, and (4) the region of the country in which the home is located.

The estimated model also allows for the presence of unobserved heterogeneity, that is, the possibility that individual borrowers will refinance (or default) at different interest rate differentials (or levels of equity) for reasons not recorded in the data. Such reasons might include differences in financial sophistication, differences in moving plans, or differences in the value attached to a good credit rating. In models that do not allow for the presence of heterogeneity, the impact of time on termination probabilities will be overstated, since the loans most likely to terminate will terminate first. Additionally, estimating a heterogeneity distribution provides a method of capturing the effect of refinancing waves, such as those that occurred during 1986-1987 and 1992-1993, on the termination probabilities of the mortgages that remain.

Our first set of coefficients estimate conditional mortgage foreclosure probabilities as a function of a variety of explanatory variables. Our second set of coefficients estimate conditional prepayment probabilities. The model estimated is a competing risks hazard model. The probability of prepaying or terminating with a loss to the Fund over the course of a quarter is jointly estimated as a function of time (the baseline hazard) multiplied by a linear function of the independent variables. The baseline hazards are estimated as a Box-Cox transformation[4] of time measured in months.

The two equations are estimated jointly and include an estimate of heterogeneity parameters. CTM estimates a distribution of points between 0 and 1, and the percentage of the population of mortgages at each point, referred to as the heterogeneity distribution. For each method of termination (claim or prepayment) CTM also estimates a coefficient by which those points are multiplied, referred to as the factor loading. In effect, CTM estimates a distribution of intercepts for each

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[4]The Box-Cox transformation is a general class of power transforms that include the log transformation and no-transformation as special cases. The Box-Cox transformation is $Y = (X^{\lambda} - 1)/\lambda$ when λ is not 0, and $\ln(x)$ when $\lambda=0$.

termination probability. This incorporates the assumption that mortgage borrowers differ in their probabilities of mortgage termination in unobservable ways. While the different probabilities are not attached to individual borrowers, the heterogeneity parameters produce an estimate of the proportions of borrowers with high or low termination propensities. The methodology is analogous to a random effects model for the analysis of panel data.

The variables we used to predict foreclosures and prepayments fall into two general categories: descriptions of states of the economy and characteristics of the loan. In choosing explanatory variables, we relied on the results of our own and others' previous efforts to model foreclosure and prepayment probabilities and on implications drawn from economic principles. We allowed for many of the same variables to affect both foreclosure and prepayment.

Equity

The single most important determinant of a loan's foreclosure is the borrower's equity in the property, which changes over time because (1) payments reduce the amount owed on the mortgage, (2) property values can increase or decrease, and (3) prevailing mortgage interest rates change, while the rate on a fixed-rate mortgage remains constant. Equity is a measure of the current value of a property compared with the current value of the mortgage on that property. Previous research strongly indicates that borrowers with small amounts of equity, or even negative equity, are more likely than other borrowers to default.[5] We computed equity as the difference between the value of the property and the value of the mortgage, expressed as a percentage of the value of the property. For example, if the value of a property is $100,000 and the value of the mortgage is $80,000, then equity is 20 percent, or 0.2. To measure equity for the purpose of modeling the foreclosure behavior of fixed-rate mortgages, we calculated the value of the mortgage as the present value of the remaining mortgage payments (up to a maximum of 10 years), evaluated at the current quarter's fixed-rate mortgage interest rate, and added the book value of the mortgage at the end of 10 years, thus assuming a prepayment 10 years into the future. We calculated the value of the property by multiplying the value of the property at the time of the loan's origination by the change in the state's median nominal house price between the year of origination and the current year.[6]

[5]When we discuss the likely effects of one of our explanatory variables, we are describing the marginal effects of that variable while holding the effects of other variables constant.

[6]The estimated rate of appreciation in each state's median existing house price, which was obtained from DRI/McGraw-Hill, was revised downward by 2 percentage points per year to account for depreciation and the gradual improvement in the quality of

Because the effects on claims of small changes in equity may differ depending on whether the level of equity is high or low, we used a pair of equity variables, LAGEQHI and LAGEQLOW,[7] in our foreclosure regression. The effect of equity is lagged 1 year, since we are predicting the time of foreclosure, which usually occurs many months after a loan first defaults.

We also included lagged equity in our prepayment regression. We anticipated that higher levels of equity would be associated with an increased likelihood of prepayment. Borrowers with substantial equity in their home may be interested in prepaying their existing mortgage and taking out a larger one to obtain cash for other purposes. Borrowers with little or no equity may be less likely to prepay because they may have to take money from other savings to pay off their loan and cover transaction costs.

For the prepayment regression, we defined equity as book equity (LAGBKHI and LAGBKLOW). Book equity was defined as the estimated property value less the amortized balance of the loan. It is book value that the borrower must pay to retire the debt. Additionally, the effect of interest rate changes on prepayment are captured by the relative interest variables, RELEQHI and RELEQLO.

Down payment

In addition to LAGEQHI and LAGEQLOW, we included another variable in our regressions related to equity: the initial DOWNPAY, calculated as 1 minus the LTV ratio. In some years, FHA

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the existing housing stock over time. For calendar years 1993 and 1994, we made some adjustments to DRI/McGraw-Hill's forecasts. Texas homes were estimated to have fallen in price in calendar year 1994, but others familiar with the Texas economy claimed that prices had risen during that year. We adjusted the forecast for Texas so that Texas home prices grew at 1 percent during 1994. Also, the ratio between the median price of existing housing and the constant quality price index, reported by DRI/McGraw-Hill for calendar years 1993 and 1994, was much lower than for other years. We adjusted price appreciation rates for calendar years 1993 and 1994 to bring the median-constant quality ratio more in line with other years. Finally, to ensure that our estimates were conservative, we subtracted an additional 1 percent annually from DRI/McGraw-Hill's forecasts.

[7]LAGEQHI takes the value of lagged equity minus 20 percent if equity is at least 20 percent. LAGEQLOW takes the value of equity if lagged equity is less than 20 percent. For instance, with 10 percent equity, LAGEQLOW would be 0.10, and LAGEQHI would be zero. With 30 percent equity, LAGEQLOW would be 0.20, and LAGEQHI would be 0.10. The 20% threshold was chosen because loans with equity of 20% or more do not require insurance in the private market.

measured the LTV ratio as the loan amount less the financed portion of the mortgage insurance premium in the numerator and appraised value plus closing costs in the denominator. To reflect true economic LTV, we adjusted FHA's measure by removing closing costs from the denominator and including financed premiums in the numerator.

DOWNPAY measures a borrower's initial equity, so we anticipate that it will be negatively related to the probability of foreclosure. One reason for including DOWNPAY is that it measures initial equity accurately. Our measures of current equity are less accurate because we do not have data on the rate of change for the price of each borrower's house.

Another reason for including DOWNPAY and expecting it to have a negative sign in our foreclosure equation is that it may capture the effects of income constraints. We are unable to include borrowers' incomes or payment-to-income ratios directly because data on borrowers' incomes were not available for every year in the sample period.[8] However, it seems likely that borrowers with little or no down payment are more likely to be financially stretched in meeting their payments and, therefore, more likely to default. The anticipated relationship between DOWNPAY and the probability of prepayment is uncertain.

Unemployment

We used the natural logarithm of the annual unemployment rate for each state for the period from 1975 through 1994 to describe the condition of the economy in the state where a loan was made. We anticipated that foreclosures would be higher in years and states with higher unemployment rates and that prepayments would be lower because property sales slow down during recessions. The actual variable we used in our regressions, LAGUNEMP, is defined as the logarithm of the preceding year's unemployment rate in that state.

Interest Rates

We included the logarithm of the interest rate on the mortgage as an explanatory variable in the foreclosure equation. We expected a higher interest rate to be associated with a higher probability of foreclosure because a higher interest rate causes a higher monthly payment. However, in explaining the likelihood of prepayment, our model uses a function of the ratio of current mortgage rates to the contract rate on the borrower's mortgage. A borrower's incentive to prepay is high when the interest rate on a loan is greater than the rate at which money can now be borrowed, and it diminishes as current interest rates

[8]Also FHA data does not indicate whether individual borrowers have subsequently acquired a second mortgage or other obligations that would affect prepayment or foreclosure probabilities.

increase. To capture the relative attractiveness of prepaying, we calculated the present value of the mortgage payments over the remaining term of the mortgage (up to 10 years) using the currently prevailing mortgage interest rate to estimate the market value of the mortgage. This value was divided by the book value of the mortgage (the unpaid principal balance), and the relative balance was used as an explanatory variable for prepayment.

In our prepayment regression, we used the two relative interest rate variables defined above, RELEQHI and RELEQLO, so that the effect of changes in relative interest rates could be different over different ranges. RELEQHI is defined as the ratio of the market value of the mortgage to the book value of the mortgage but is never smaller than 1. RELEQLO is also defined as the ratio of the market value of the mortgage to the book value but is never larger than 1. Thus, RELEQHI captures a borrower's incentive to refinance, and RELEQLO captures a new buyer's incentive to assume the seller's mortgage.

We created two variables, REFIN and REFIN2, that measure how many quarters have passed in which the borrower had not taken advantage of a refinancing opportunity. We defined a refinancing opportunity as having occurred if the interest rate on fixed-rate mortgages in any previous quarter in which a loan was active was at least 150 basis points below the contract rate on the mortgage. REFIN counts the number of quarters in which the loan has been active and a refinancing opportunity has not been seized, up to a maximum of 8 quarters. REFIN2 counts the number of passed refinancing opportunities in excess of 8 quarters, up to a maximum of 8 more quarters.

Several reasons might explain why borrowers passed up apparently profitable refinancing opportunities. For example, if they had been unemployed or their property had fallen in value, they might have had difficulty obtaining refinancing. This reasoning suggests that REFIN and REFIN2 would be positively related to the probability of foreclosure; that is, a borrower unable to obtain refinancing previously because of poor financial status might be more likely to default.

Similar reasoning suggests a negative relationship between REFIN and REFIN2 and the probability of prepayment; a borrower unable to obtain refinancing previously might also be unlikely to obtain refinancing currently. A negative relationship might also exist if a borrower's passing up one profitable refinancing opportunity reflected a lack of financial sophistication that, in turn, would be associated with passing up additional opportunities. However, a borrower who anticipated moving soon might pass up an apparently profitable refinancing opportunity to avoid the transaction costs associated with refinancing. A positive relationship might exist in this case, with the probability of prepayment if the borrower fulfilled his/her anticipation and moved, thereby prepaying the loan.

Another explanatory variable is the volatility of interest rates, INTVOL, defined as the standard deviation of the monthly average of the Federal Home Loan Mortgage Corporation's series of 30-year fixed-rate mortgage effective interest rates. We calculated the standard deviation over the previous 12 months. Financial theory predicts that borrowers are likely to refinance more slowly at times of volatile rates because there is a larger incentive to wait for a still-lower interest rate.

We also included the slope of the yield curve, YIELDCUR, in our prepayment estimates, which we calculated as the difference between the 1-year and the 10-year Treasury rates of interest. We then subtracted 250 basis points from this difference and set differences that were less than zero to zero. This variable measured the relative attractiveness of adjustable-rate mortgages versus fixed-rate mortgages. When ARMs have low rates, borrowers with fixed-rate mortgages may be induced into refinancing into ARMs to lower their monthly payments.

For adjustable-rate mortgages, we did not use relative equity variables as we did with fixed-rate mortgages. Instead, we defined four variables, CHANGEPOS, CHANGENEG, CAPPEDPOS, and CAPPEDNEG, to capture the relationship between current interest rates and the interest rate paid on each mortgage. CHANGEPOS measures how far the interest rate on the mortgage has increased since origination, with a minimum of zero, while CHANGENEG measures how far the rate has decreased, with a maximum of zero. CAPPEDPOS measures how much farther the interest rate on the mortgage will rise, if prevailing interest rates in the market do not change, while CAPPEDNEG measures how much farther the mortgage's rate will fall if prevailing interest rates do not change. For example, if an ARM is originated at 7 percent and interest rates have increased by 250 basis points 1 year later, CHANGEPOS will equal 100 because FHA's ARMs can increase by no more than 100 basis points in a year. CAPPEDPOS will equal 150 basis points, since the mortgage rate will eventually increase by another 150 basis points if market interest rates do not change, and CHANGENEG and CAPPEDNEG will equal zero. As interest rates have generally trended downwards since FHA introduced ARM's, there is very little experience with ARM's in an increasing interest rate environment.

Geographic Regions

We created four 0-1 variables to reflect the geographic distribution of FHA loans and included them in both regressions. Locational differences may capture the effects of differences in borrowers' income, rates of appreciation in house prices, underwriting standards by lenders, economic conditions not captured by the unemployment rate, or other factors that may affect foreclosure and prepayment rates. We assigned each loan to one of the four Bureau of the Census (Census) regions on the basis of the state in which the borrower resided. The West

Region was the omitted category, that is, the regression coefficients show how each of the regions was different from the West Region. We also created a variable, JUDICIAL, to indicate states that allowed judicial foreclosure procedures in place of nonjudicial foreclosures.

House Price

To obtain an insight into the differential effect of relatively larger loans on mortgage foreclosures and prepayments, we used the logarithm of the initial house price as an explanatory variable. This variable was divided into three ranges, below $60,000, $60,000 to $120,000, and $120,000 and over, to allow the effect of house price to change over its range. The three ranges were called LOGPRICL, LOGPRICM, and LOGPRICH, respectively. All dollar amounts are inflation adjusted and represent 1994 dollars.

Time

Finally, to capture the time pattern of foreclosures and prepayments (given the effects of equity and the other explanatory variables), we defined two variables on the basis of the number of quarters that had passed since the year of the loan's origination. We refer to these variables as YEAR12 and YEAR345. YEAR12 counts the number of quarters since origination, up to the sixth quarter. YEAR345 counts the number of quarters since origination from the 7th to the 14th quarter. TIME measures the number of months elapsed since origination, and EXPONENT is the estimated value of a Box-Cox transformation of TIME. We created the variables YEAR12 and YEAR345 to allow for the passage of time to have much stronger impacts on termination probabilities in the early months of a mortgage's life.

Table II.1 summarizes the variables we used to predict claims and prepayments along with their corresponding means. These means are for investor mortgages, both for purchase and for refinancing purposes, 30-year fixed-rate mortgages, both for purchase and for refinancing purposes, 15-year fixed-rate mortgages, and adjustable-rate mortgages.

Table II.1 Summary of Predictor Variable Means

Predictor Variables		30-year fixed-rate new	30-year fixed rate refinance	15-year fixed-rate	Investor new	Investor refinance	ARM
House Price Variables							
LOGPRICL	Log of house price if < $60,000	6.34	6.35	6.27	6.36	6.37	6.38
LOGPRICM	Log of house price > $60,000 but < $120,000	0.32	0.28	0.27	0.37	0.38	0.39
LOGPRICH	Log of house price > $120,000	0.01	0.06	0.02	0.02	0.02	0.01
Economic Variables							
LOGINT	Log of contract interest rate	-2.27	-2.29	-2.27	-2.23	-2.28	-2.59
INTVOL	The volatility of mortgage rates, defined as the standard deviation of 30 year fixed mortgage rates over the prior 12 months	5.26	3.78	4.78	5.12	3.19	3.69
YIELDCUR	The slope of the yield curve, defined as the difference between 1-year and 10-year Treasury interest rates minus 250 basis points, but no less than 0	0.13	0.20	0.15	0.14	0.16	0.36
RELEQLO	The ratio of the market value of the mortgage to the book value if the market value is below the book value, else 1	9.44	9.97	9.65	9.64	9.98	NA
RELEQHI	The ratio of the market value of the mortgage to the book value if the market value is above the book value, else 1	10.42	10.83	10.30	10.54	10.75	NA
REFIN	Number of quarters that the prevailing mortgage interest rate had been at least 150 basis points below the contract rate and the borrower had not refinanced, up to 8 quarters	0.54	0.48	0.49	0.86	0.53	0.06
REFIN2	Number of quarters that the above situation prevailed, beyond 8 quarters	0.14	0.13	NA	0.28	0.03	NA
LAGUNEMP	The logarithm of the previous year's unemployment rate in the state	-2.76	-2.82	-2.77	-2.76	-2.83	-2.86

Time Variables							
YEAR12	Number of quarters since origination, up to 6	5.06	3.80	5.00	5.05	3.86	4.58
YEAR345	Number of quarters since the 6th, up to 14	4.40	1.43	4.24	4.36	1.88	3.02
Equity Variables							
DOWNPAY	The down payment, expressed as a percentage of the purchase price of the house. The values reported in FHA's database were adjusted to ensure that closing costs were included in the loan amount and excluded from the house price.	0.48	0.19	0.12	0.11	0.10	0.36
LAGEQLOW	The value of equity, defined as 1 minus the ratio of the present value of the loan balance, evaluated at the current mortgage interest rate, to the current estimated house price, if equity is less than 20%, else 20%	1.36	0.64	0.16	0.17	0.14	NA
LAGEQHI	The value of equity, defined as 1 minus the ratio of the present value of the loan balance, evaluated at the current mortgage interest rate, to the current estimated house price, minus 20%, but no less than 0	0.91	0.09	0.13	0.09	0.10	NA
LAGBKLOW	The value of equity, defined as 1 minus the ratio of the amortized loan balance to the current estimated house price, if equity is less than 20%, else 20%	1.34	0.69	1.62	1.67	1.38	1.13
LAGBKHI	The value of equity, defined as 1 minus the ratio of the amortized loan balance to the current estimated house price, minus 20%, but no less than 0	0.76	0.10	0.14	0.09	0.15	0.23
Geographic Dummy Variables							
EAST	1 if the loan was in the East (NY, PA, NJ, MA, CT, RI, NH, ME, VT), else 0	0.07	0.02	0.10	0.15	0.04	0.05
SOUTH	1 if the loan was in the South (KY TN AL, MS, GA, NC, SC, VA, MD, DC, DE, WV, TX, OK, LA, AR), else 0	0.37	0.31	0.37	0.29	0.23	0.29
MIDWEST	1 if the loan was in the Midwest (MN, MO, IA, NE, KS, SD, ND, IL, MI, OH, IN, WI), else 0	0.21	0.21	0.32	0.20	0.17	0.33
JUDICIAL	1 if state allowed judicial foreclosure (list of states varies by year)	0.37	0.21	0.44	0.43	0.26	0.42

Note: For ARM loans, REFIN is a simple dummy variable which equals 1 for refinancing loans and 0 for purchase money loans.
Note: Orders of magnitude are those used in the regressions.

ESTIMATION RESULTS

As described above, we used competing risks hazard rate models to estimate loan foreclosures and prepayments as a function of a variety of predictor variables. We estimated separate regressions for 30-year fixed-rate mortgages, 15-year fixed-rate mortgages, investors' loans, and adjustable-rate mortgages originated from fiscal year 1983 to fiscal year 1993. The 30-year fixed-rate mortgages and investors' mortgages were further divided into samples of purchase money loans and loans made for the purpose of refinancing. Although FHA was given authority to insure streamline refinancing loans in 1983, FHA's database can not reliably identify refinancing loans before 1991. Therefore, we placed any loan written after fiscal year 1982 with an LTV ratio of 0 into the refinanced loan sample, along with loans which FHA's database identified as refinancing loans. We estimated quarterly termination probabilities throughout the life of the loan or the end of fiscal year 1994, whichever came first.

Tables II.2 and II.3 present the estimated coefficients for all of the predictor variables for foreclosure and prepayment equations. Table II.4 displays the estimated heterogeneity distributions for the regression results in the previous tables. ARM loan regression results are presented in table II.5. A heterogeneity distribution was not estimated for ARMs. All loan categories except for the refinanced investor loans were estimated with hundreds of thousands of observations, so most coefficients are significant at standard levels.

In general, our results are consistent with the economic reasoning that underlies our models. Most importantly, the probability of foreclosure declines as current equity and down payment increase, and the probability of prepayment increases as the current mortgage interest rate falls below the contract

mortgage interest rate. Both of these effects are very strong. As expected, the unemployment rate is positively related to the probability of foreclosure and negatively related to the probability of prepayment. Our results also indicate that the probability of foreclosure is higher when the contract rate of interest is higher. Mortgages on more expensive houses have higher prepayment probabilities. For purchase money mortgages foreclosure probability declines with price of house, but for refinanced mortgages foreclosure probability rises with price. For 30-year fixed mortgages and for investor mortgages, passing-up a profitable refinancing opportunity raises the probability of foreclosure. For all mortgages, passing up profitable refinancing opportunities lowers prepayment probabilities.

The heterogeneity distributions presented in table II.4 indicate substantial differences in intercepts among different classifications of borrowers. For instance, among new 30-year fixed-rate borrowers, 62.9 percent are estimated to have a foreclosure intercept of 17.739, 24.8 percent (87.7 percent minus 62.9 percent) are estimated to have a foreclosure intercept of 17.202 (a location of 0.169 times a factor loading of -3.179, added to the intercept of 17.739), 5.9 percent are estimated to have a foreclosure intercept of 16.503, and 6.4 percent are estimated to have a foreclosure intercept of 14.56. This indicates that about 6.4 percent of borrowers have substantially lower termination probabilities than do most borrowers.

Table II.2: Foreclosure Equations

Predictor variable	New 30-year fixed	Refinance 30-year fixed	New investor	Refinance investor	15-year fixed
Intercept	17.739	14.106	15.158	14.692	18.662
Time	0.564	0.543	0.332	0.061	0.906
Exponent	-1.126	-1.000	-1.522	-2.257	-0.939
Year12	-0.571	-0.297	-0.660	-0.436	-0.638
Year345	-0.155	0	-0.152	0	-0.200
Northeast	-0.351	-0.734	-0.773	-0.890	-0.164
Midwest	-0.177	-0.132	-0.242	-0.187	0.050
South	0.119	0.228	0.322	0.353	0.235
Judicial	-0.030	-0.241	-0.070	-0.298	0.033
NoAppraisal	-0.365	0.583	-0.651	0.187	-0.198
Refin1	0.081	0.041	0.078	-0.011	-0.112
Refin2	-0.028	0	-0.045	0	0.040
Logpriclow	-0.552	0.478	-0.004	0.784	-0.276
Logpricmed	-0.144	0.424	-0.276	0.684	-0.595
Logprichi	0.060	1.494	0.792	1.008	-0.943
Downpay	-0.183	0.097	-0.072	0.577	-0.323
Lageqhi	-0.486	-0.481	-0.471	-0.967	-0.342
Lageqlow	-0.236	-0.206	-0.205	-0.380	-0.128
Intvol	0.006	0.062	0.003	-0.016	0.041
Lagunemp	0.785	0.689	0.653	0.243	0.706
Logint	3.390	5.856	3.781	7.685	4.289

Table II.3: Prepayment Equations

Predictor variable	New 30-year fixed	Refinance 30-year fixed	New investor	Refinance investor	15-year fixed
Intercept	-25.374	-30.372	-23.236	-17.113	-25.331
Time	0.256	0.556	0.306	0.227	0.865
Exponent	-0.982	-0.583	-0.762	-0.832	-0.482
Year12	-0.151	-0.368	-0.170	-0.248	-0.377
Year345	-0.046	0	-0.054	0	-0.132
Northeast	-0.230	-0.859	-0.188	-1.094	-0.340
Midwest	0.180	0.139	0.120	0.052	0.124
South	-0.305	-0.466	-0.143	-0.278	-0.279
NoAppraisal	-0.031	0.431	-0.277	-0.033	0.169
Refin1	-0.081	-0.121	-0.071	-0.126	0.338
Refin2	-0.081	0	-0.117	0	-0.066
Logpriclow	1.186	1.632	1.019	0.766	1.172
Logpricmed	0.828	0.913	0.785	0.734	0.763
Logprichi	0.690	-0.810	-0.090	-0.663	0.093
Downpay	-0.013	-0.103	0.015	-0.122	-0.056
Lagbkhi	0.069	0.056	0.058	0.279	0.075
Lagbklow	0.026	-0.055	0.059	-0.089	-0.010
Intvol	0.026	0.215	0.035	0.251	0.060
Releqlow	0.444	0.387	0.558	-0.022	0.671
Releqhi	1.314	1.454	1.060	1.211	1.382
Lagunemp	-0.211	-1.400	-0.305	-0.466	-0.331
YieldCurve	0.542	-0.769	1.281	-0.847	0.798
Number of loans	334,987	228,307	233,920	46,788	259,328

Table II.4: Heterogeneity Distributions

			Factor	Factor

Type of loan	Cumulative probability	Location	loading foreclose	loading prepay
New 30-year	0.629	0	-3.179	-7.800
fixed-rate	0.877	0.169		
	0.936	0.389		
Refinance 30-year	0.621	0.000	-3.861	-5.56
fixed-rate	0.917	0.352		
New investor	0.879	0.000	-1.407	-4.124
Refinance	0.846	0.000	-0.863	-2.38
investor				
15-year	0.511	0.000	-4.58	-4.94
fixed-rate	0.888	0.291		

Table II.5: Adjustable Rate Mortgage Model

Predictor variable	Foreclosure	Prepayment
Intercept	16.418	-2.404
Time	0.450	0.772
Exponent	-1.392	-0.583
Year12	-0.668	-0.396
Year345	-0.109	-0.127
Northeast	-0.037	-0.200
Midwest	-0.363	0.174
South	0.170	-0.276
Judicial	-0.195	0.010
NoAppraisal	0.184	0.555
Refi	0.031	0.582
Logpriclow	-1.082	0.605
Logpricmed	-0.335	0.376
Logprichi	0.711	-0.611
Downpay	-0.118	0.006
Lagbkhi	-0.598	0.144
Lagbklow	-0.284	0.245
Changepos	-0.052	-0.727
Changeneg	-0.264	-0.117
Cappedpos	-0.113	-0.010
Cappedneg	-0.030	-0.271
Intrvolatil	0.115	0.167
Lagunemp	0.535	-0.282
Logint	1.530	0
Yieldcurve	0	0.833
Number of loans	296,659	296,659

FORECAST OF LOAN FORECLOSURES AND EARLY PAYMENTS

To test the validity of our model, we examined how well the model predicted actual patterns of FHA's claim and prepayment rates through fiscal year 1994. Using a sample of 10 percent of FHA's loans made from fiscal year 1975 through fiscal year 1994, we found that our predicted rates closely resembled actual rates.

To predict the probabilities of claim payment and prepayment, we combined the model's coefficients with the information on a loan's characteristics and information on economic conditions described by our predictor variables in each quarter between a loan's origination and fiscal year 1994. For each loan-quarter we predicted termination probabilities and compared them to random numbers from a Uniform distribution. If the termination probability was greater than the random number the loan was assumed to terminate in that quarter. If our model predicted a foreclosure or prepayment termination, we determined the loan's balance during that quarter to indicate the dollar amount associated with the foreclosure or prepayment. We estimated cumulative claim and prepayment rates by summing the predicted claim and prepayment dollar amounts for all loans originated in each of the fiscal years 1975 through 1994. We compared these predictions with the actual cumulative (through fiscal year 1994) claim and prepayment rates for the loans in our sample. Figure II.1 compares predicted and actual cumulative foreclosure rates, and figure II.2 compares predicted and actual cumulative prepayment rates.

Figure II.1: Cumulative Foreclosure Rates by Book of Business Through Fiscal Year 1994 for 30-Year, Fixed-Rate, Noninvestor Loans; Actual and Predicted

Figure II.2: Cumulative Prepayment Rates by Book of Business Through Fiscal Year 1994 for 30-Year, Fixed-Rate, Noninvestor Loans; Actual and Predicted

We then forecasted future loan activity (claims and prepayments) on the basis of the regression results described above and on DRI/McGraw-Hill's forecasts of the key economic and housing market variables. DRI/McGraw-Hill forecasts the median sales price of existing housing, by state and year, through fiscal year 1998. We subtracted 2 percentage points per year to adjust for improvements in the quality of housing over time and the

depreciation of individual housing units. After fiscal year 1998, we assumed that prices would rise at 3 percent per year. For our base case, we made DRI/McGraw-Hill's forecasts of appreciation rates less optimistic by subtracting another 1 percentage point per year from the company's forecasts.[9] DRI/McGraw-Hill also forecast each state's unemployment rate through fiscal year 2002. For our base case, we used DRI/McGraw-Hill's forecasts of each state's unemployment rate and assumed that rates from fiscal year 2003 on would equal the rate in fiscal year 2002. We also used DRI/McGraw-Hill's forecasts of interest rates on 30-year fixed-rate mortgages.

Estimating Economic Value

The economic value of the Fund is defined in the Omnibus Budget Reconciliation Act of 1990 as the "current 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." Information on the capital resources of the Fund as of September 30, 1994, was obtained from the audited financial statements for fiscal year 1994. Capital resources were reported to be $10.8 billion.

To estimate the net present value of future cash flows of the Fund, we constructed a cash flow model to measure the five primary sources and uses of cash for loans originated in fiscal years 1975 through 1994. The two sources of cash are income from mortgagees' premiums and net proceeds from the sale of foreclosed properties. The three uses of cash are payments associated with claims on foreclosed properties, refunds of premiums on mortgages that are prepaid, and administrative expenses for management of the program.

In addition to estimating the economic value of the Fund as a

[9]Other adjustments were also made, as indicated previously in footnote 6.

whole, we also generated approximations of the economic value of the loans originated in the two most recent fiscal years. To conduct this analysis, it was necessary not only to project future cash flows but also to estimate the level of past cash flows.

Our model was constructed to estimate cash flows for each policy year through the life of a mortgage. An important component of the model is its ability to convert all income and expense streams--regardless of the period in which they actually occur--into 1994 dollars. We applied discount rates to match as closely as possible the rate of return that FHA likely earned in the past or would earn in the future from its investment in U.S. Treasury securities.[10] As an approximation of what FHA earned for each book of business[11], we used a rate of return comparable to the yield on 7-year U.S. Treasury securities prevailing when that book was written to discount all cash flows occurring in the first 7 years of that book's existence. We assumed that after 7 years, the Fund's investment was rolled over into new Treasury securities at the interest rate prevailing at that time and used that rate to discount cash flows to the rollover date. For rollover dates occurring in fiscal year 1994 and beyond, we used 7 percent as the new discount rate. As an example, cash flows associated with the fiscal year 1992 book of business and occurring from fiscal year 1992 through fiscal year 1998 (i.e, the first 7 policy years) were discounted at the 7-year Treasury rate prevailing in fiscal year 1992. Cash flows associated with the fiscal year 1992 book of business but occurring in fiscal year 1999 and beyond are discounted at a rate of 7 percent.

Our methodology for estimating each of the five principal cash

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[10]Actual rates vary by the specific date in which the investment is made and the length of maturity of the note. Precise data on the length of maturity of FHA's investments were unavailable, but we estimated the average to be approximately 7 years and used this as the basis for our selection of discount rates.

[11]New mortgage loans insured by FHA in a given fiscal year.

flows is described below.

Premium Income

Because FHA's premium policy has changed over time, our calculations of premium income to the Fund changes depending on the date of the mortgage's origination.[12]

For fiscal years 1975 through 1983:

Premium = annual outstanding principal balance x 0.5%.

For fiscal years 1984 through June 30, 1991:

Premium = original loan amount x mortgage insurance premium.

The mortgage insurance premium during this period is equal to 3.8 percent for 30-year mortgages and 2.4 percent for 15-year mortgages. For the purposes of this analysis, mortgages of other lengths of time are grouped with those they most closely approximate.

Effective July 1, 1991, legislation mandated that FHA add an annual premium of 0.5 percent of the outstanding principal balance to its up-front premiums. The number of years for which a borrower would be liable for making premium payments depended on the LTV ratio at the time of origination. (See table II.6.)

Table II.6: Number of Years of Annual Premium Payments by Date of Mortgage Origination and LTV

[12]These premium rates also apply to adjustable-rate mortgages insured since fiscal year 1983.

	LTV ratio		
	<90%	>=90%to<=95%	>95%
4th quarter FY 1991	5	8	10
FY 1992	5	8	10
FY 1993 and 1994	7	12	30

Notes: FY = fiscal year. > = Greater than. < = Less than.

For the period July 1, 1991, through September 30, 1992:

Premium = (original loan amount x 3.8%) +
(annual outstanding principal balance x 0.5%).

For the period October 1, 1992, through December 31, 1992:

Premium = (original loan amount x 3.0%) +
(annual outstanding principal balance x 0.5%).

For the period January 1, 1993, through April 17, 1994:

30-year mortgages:

Premium = (original loan amount x 3.0%) +
(annual outstanding principal balance x 0.5%).

15-year mortgages:

Premium = (original loan amount x 2.0%) +
annual outstanding principal balance x 0.25%).

For the period April 18, 1994, through September 30, 1994:

30-year mortgages:

Premium = (original loan amount x 2.25%) +
(annual outstanding principal balance x 0.5%).

15-year mortgages:

Premium = (original loan amount x 2.00%) +
(annual outstanding principal balance x 0.25%).

For 15-year mortgages, annual premiums are payable for 8, 4, or zero years depending on the LTV category of the mortgage at loan origination.

Claims Payments

Claims Payments = outstanding principal balance on foreclosed mortgages x acquisition cost ratio.

We define the acquisition cost ratio as being equal to the total amount paid by FHA to settle a claim and acquire a property (i.e., FHA's "acquisition cost" as reported in its database) divided by the outstanding principal balance on the mortgage at the time of foreclosure. For the purpose of our analysis, we calculated an average acquisition cost ratio for each year's book of business using actual data for fiscal years 1975 through 1992, and applied that average to projected claims. Beginning is fiscal year 1993, FHA's A43 database no longer contained the information needed to calculate the acquisition cost ratio. Therefore, we used the fiscal year 1992 ratio for fiscal years 1993 and 1994. (See tables II.7 and II.8.)

Table II.7: Acquisition Cost Ratios by Book of Business, Fiscal Years 1975 Through 1983

	Fiscal Year								
	1975	1976	1977	1978	1979	1980	1981	1982	1983
Ratio	1.39	1.31	1.28	1.23	1.21	1.20	1.21	1.21	1.19

Table I.8: Acquisition Cost Ratios by Book of Business, Fiscal Years 1984 Through 1994

	Fiscal Year										
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Ratio	1.20	1.18	1.15	1.13	1.14	1.14	1.12	1.11	1.08	1.08	1.08

Net Proceeds

Net proceeds = (5.9/12) x claims payments from previous period x (1 - loss ratio) + (6.1/12) x claims payments from current period x (1 - loss ratio).

We assumed the lag time between the payment of a claim and the receipt of proceeds from the disposition of the property to be 5.9 months on the basis of the latest available information reported by Price Waterhouse in its fiscal year 1994 financial audit of FHA. We define the loss ratio as being equal to FHA's reported dollar loss after the disposition of property divided by the reported acquisition cost. For forecast periods, we applied a loss rate of 38 percent, which is the average loss reported by FHA's financial auditors for fiscal year 1994. This is comparable to the weighted average of losses for fiscal years 1975 through 1989.

Refunded Premiums

The amount of premium refunds paid by FHA's Fund depends on the policy year in which the mortgage is prepaid and the type of mortgage. For mortgages prepaid between October 1, 1983, and December 31, 1993, we used the refund rate schedule that FHA published in the April 1984 edition of Mortgage Banking. In 1993, FHA changed its refund policy to affect mortgages prepaid on or after January 1, 1994. The refund rates that we used from the new schedule--which assume prepayment at mid-year--are found in table II.9.

For loans prepaying through December 31, 1993:

Refunds = original loan amount x refund rate.

For loans prepaying on or after January 1, 1994:

Refunds = up-front mortgage insurance premium x refund rate.

Table II.9: Premium Refund as a Percentage of Up-Front Premium Paid, Assuming Prepayment in the Sixth Month

	Policy Year						
	1	2	3	4	5	6	7
Percent of premium refunded	95.0	85.0	70.1	49.4	30.2	15.1	4.2

Administrative Expenses

Administrative expenses = outstanding principal balance x 0.1%

Our estimate of administrative expenses as 0.1 percent of the outstanding principal balances was based on data in recent years' financial statements.

SENSITIVITY ANALYSIS

We conducted additional analyses to determine the sensitivity of our forecasts to the values of certain key variables. Because we found that projected losses from foreclosures are sensitive to the rate of unemployment and the rate of appreciation of house prices, we adjusted the forecasts of unemployment and price appreciation to provide a range of economic value estimates under alternative economic scenarios. Our starting points for forecasts of the key economic variables were forecasts made by DRI/McGraw-Hill.

We used DRI/McGraw-Hill's forecasts of house prices in each state, adjusted as described above, as the basis for our estimation of future equity. We subtracted 2 percentage points per year from DRI/McGraw-Hill's projected price increases to adjust for quality improvements over time. For our base case, we made DRI/McGraw-Hill's forecasts of appreciation rates less optimistic by subtracting 1 percentage point per year from its forecasts. For our high case, we added 2 percentage points per year to our base case. For our low case, we subtracted 2 percentage points from our base case.

DRI/McGraw-Hill also forecast each state's unemployment rate through fiscal year 2002. For our high case and our base case, we used DRI/McGraw-Hill's forecasts of each state's unemployment rate and assumed that rates from fiscal year 2003 on would equal the rate in fiscal year 2002. For our low case, we added 1 percentage point to the forecasted unemployment rate during 1995 and beyond.

Table II.10 summarizes the three economic scenarios. The rates of house price appreciation and unemployment are based on DRI/McGraw-Hill's forecasts. The numbers in the table are our weighted averages of DRI/McGraw-Hill's state-level forecasts; each state's number is weighted by the state's share of FHA's fiscal year 1993 business.

Table II.10: Summary of Forecast Scenarios

	Low scenario		Base scenario		High scenario	
Year	Price rise	Unemployment rate	Price rise	Unemployment rate	Price rise	Unemployment rate
1995	.004	.063	.024	.053	.044	.053
1996	.013	.067	.033	.057	.053	.057
1997	.002	.068	.022	.058	.052	.058
1998	.002	.057	.022	.057	.042	.057

To assess the impact of our assumptions of the loss and discount rates on the economic value of the Fund, we operated our cash flow model with alternative values for these variables. We found that for the economic scenario of our base case, a 1-percentage-point increase in the loss rate (from our assumption of 38 to 39 percent) resulted in a $201 million decline in our estimate of the economic value of the Fund. With respect to the discount rate, we found that for our base case economic scenario, a 1-percentage-point increase in the interest rate applied to most periods' future cash flow (from our assumption of 7 to 8 percent) resulted in a $90 million increase in our estimate of economic value.