

GAO

Report to the Chairman, Subcommittee  
on Housing and Community  
Development, Committee on Banking,  
Finance, and Urban Affairs, House of  
Representatives

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October 1994

# MORTGAGE FINANCING

## Financial Health of FHA's Home Mortgage Insurance Program Has Improved







United States  
General Accounting Office  
Washington, D.C. 20548

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Resources, Community, and  
Economic Development Division

B-258141

October 18, 1994

The Honorable Henry B. Gonzalez  
Chairman, Subcommittee on Housing  
and Community Development  
Committee on Banking, Finance,  
and Urban Affairs  
House of Representatives

Dear Mr. Chairman:

Through its Federal Housing Administration (FHA), the Department of Housing and Urban Development (HUD) provides insurance for private lenders against losses on home mortgages financed through its Mutual Mortgage Insurance Fund (Fund). These mortgages are currently valued at about \$269 billion. Although the Fund has historically been financially self-sufficient, it began to experience substantial losses during the 1980s, primarily because foreclosure rates on single-family homes supported by the Fund were high in economically stressed regions. To help place the Fund on an actuarially sound basis, legislative reforms, such as requiring FHA borrowers to pay more in insurance premiums, were made in November 1990.

Concerned about the current financial health of FHA's Fund and the impact of the reforms on FHA, you asked us to assess the actuarial soundness of the Fund. On June 30, 1994, we presented our assessment in testimony before your Subcommittee.<sup>1</sup> Our testimony also included a brief description of our econometric modeling approach for forecasting the actuarial soundness of the Fund. This report (1) summarizes our assessment of the economic net worth of the Fund<sup>2</sup> as of the end of fiscal year 1993 and (2) presents a complete description of our econometric and cash flow modeling approach for forecasting the economic net worth of the Fund.

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## Results in Brief

Although there is uncertainty associated with any forecast, the economic value of FHA's Fund clearly has improved significantly in recent years, and the Fund is on the way to accumulating sufficient capital reserves to be

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<sup>1</sup>Mortgage Financing: Financial Health of FHA's Home Mortgage Insurance Program Has Improved (GAO/T-RCED-94-255, June 30, 1994).

<sup>2</sup>The current cash available to the Fund, plus the net present value of all future cash inflows and outflows expected to result from outstanding mortgages in the Fund.

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considered actuarially sound under the law. Legislative and other changes to FHA's single-family mortgage insurance program have helped restore the Fund's financial health, but favorable prevailing and forecasted economic conditions in fiscal year 1993 were primarily responsible for this improvement. While the Fund fell short of achieving the legislative mandate for capital reserves of 1.25 percent of amortized insurance-in-force by the November 1992 deadline, the Fund's 1.83-percent capital reserve ratio at the end of fiscal year 1993 surpassed the mandate. Whether the Fund can sustain this progress; attain the legislative target of 2 percent for capital reserves by November 2000, thereby achieving actuarial soundness under the law; and maintain that ratio thereafter will depend on many economic and program-related factors that will affect the financial health of the Fund this year and over the next 6 years.

Our model consists of econometric and cash flow models of FHA's single-family mortgage insurance program that we used to estimate the economic net worth of and resulting capital ratios for FHA's loans over their life of up to 30 years. Our econometric model was used to predict, among other things, the probability of loan foreclosures and prepayments on the basis of historical relationships between these events and key explanatory variables such as the borrower's equity. Our cash flow model was used to predict the net present value of all future cash inflows and outflows expected to result from the outstanding mortgages in the Fund as of the end of fiscal years 1992 and 1993. The actual economic net worth and capital ratios of the Fund—and the validity of our estimates—will depend on a number of future economic and program-related factors, including the rate of appreciation in house prices over the life of the FHA mortgages. This factor is significant because, as house prices rise, the borrowers' equity increases and the probability of defaults and subsequent foreclosures decreases.

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## Background

FHA was established in 1934 under the National Housing Act (P.L. 73-479). The primary purpose of FHA's Fund is to insure private lenders against losses on mortgages that finance purchases of one to four housing units. To cover these losses, FHA deposits insurance premiums from participating home buyers in the Fund. According to 12 U.S.C. 1711, the Fund must meet or endeavor to meet statutory capital ratio requirements designed to achieve actuarial soundness; that is, it must contain sufficient reserves and funding to cover estimated future losses resulting from the payment of claims on defaulted mortgages and administrative costs.

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The Fund remained relatively healthy until the 1980s, when losses were substantial, primarily because foreclosure rates were high in economically stressed regions, particularly in the Rocky Mountain and Southwest regions. For example, in fiscal year 1988 the Fund lost \$1.4 billion. If the Fund were to be exhausted, the U.S. Treasury would have to directly cover lenders' claims and administrative costs.

Reforms designed to restore financial stability to the Fund and to correct problems in loan origination and property disposition were initiated by the Congress and HUD. The Omnibus Budget Reconciliation Act of 1990 (P.L. 101-508), enacted in November 1990, contained reforms to FHA's single-family mortgage insurance program designed to place the Fund on an actuarially sound basis. The legislation, among other things, required FHA borrowers to pay more in insurance premiums over the life of the loans by adding a risk-based annual premium to the one-time, up-front premium. Other changes made by the legislation in response to the Fund's financial problems included (1) limiting the loan-to-value ratio to a maximum of 97.75 percent of appraised value on homes whose appraised value exceeds \$50,000 and (2) effectively suspending payment of distributive shares (distribution of excess revenues to mortgagors) until the Fund is actuarially sound.

The legislation also mandated that the Fund attain a capital ratio (ratio of the Fund's economic net worth to its insurance-in-force) of 1.25 percent by November 1992 and required the Secretary of HUD to endeavor to ensure a capital ratio of 2 percent by November 2000 and maintain that ratio at a minimum at all times thereafter.

HUD's efforts to improve the financial stability of the Fund consisted of initiating several audits of the Fund; making program modifications, primarily to tighten controls and improve monitoring; and developing automated systems. We have concluded that in addition to economic factors, poor program management and waste, fraud, and abuse contributed to the losses sustained by FHA's Fund. The full extent of losses attributable to these factors is not known. As we have pointed out in previous testimonies and reports, some of the major management problems facing HUD concern FHA's single-family program. For example, the absence of internal controls over FHA's management systems for single-family property disposition allowed private real estate agents to steal millions of dollars in FHA funds. Moreover, we reported that a direct correlation exists between the effectiveness of internal controls, the

accuracy and timeliness of financial information, and the magnitude of the losses incurred by FHA as well as by other HUD programs.<sup>3</sup>

We and HUD's Inspector General have been reporting on these management problems since the early 1980s. HUD has taken steps to address some of these problems and to strengthen FHA's financial position. To reduce problems with loan origination, HUD tightened its screening of applicants, took steps to improve how it targets its efforts to monitor lenders, and strengthened appraisal requirements. To reduce problems with property disposition, HUD, among other things, tightened controls over closing agents and area management brokers and took actions to improve property pricing and automated accounting and management systems. However, we have concluded that much work remains to be done by HUD and FHA to resolve the underlying causes of FHA's problems, such as inadequate information and financial management systems. Any success achieved by HUD and FHA in reducing FHA's losses through better management will improve the financial health of the FHA Fund.

## Our Estimates of the Fund's Economic Net Worth

In assessing the actuarial soundness of FHA's Fund, we (1) estimated, under different economic scenarios, the economic net worth of the Fund as of the end of fiscal years 1992 and 1993 and (2) assessed the progress made by the Fund in achieving the legislatively prescribed capital ratios.

FHA's Fund made significant progress during fiscal year 1993 toward achieving the capital reserves needed for actuarial soundness under the law. As shown in table 1, under our baseline economic scenario, we estimated that the Fund had an economic net worth of about \$4.9 billion<sup>4</sup> and a resulting capital ratio of 1.83 percent at the end of fiscal year 1993. This estimate represents an improvement of about \$7.6 billion from the lowest level reached by the Fund—a negative \$2.7 billion estimated by Price Waterhouse at the end of fiscal year 1990.

As of September 30, 1993, the Fund had capital resources of about \$9.7 billion, which were sufficient to cover the \$4.8 billion in expenses that we estimate the Fund will incur in excess of anticipated revenues (\$19.3 billion in expenses less \$14.5 billion in anticipated revenues) over the life

<sup>3</sup>See *Impacts of FHA Loan Policy Changes on Its Cash Position* (GAO/T-RCED-90-70, June 6, 1990); *HUD Reforms: Progress Made Since the HUD Scandals but Much Work Remains* (GAO/RCED-92-46, Jan. 31, 1992); and *Letter to the Ranking Minority Member, Subcommittee on Housing and Community Development, House Committee on Banking, Finance, and Urban Affairs* (B-249052, Sept. 30, 1992).

<sup>4</sup>Our estimate of the economic value of the Fund is similar to that of Price Waterhouse (\$4.6 billion). Price Waterhouse has performed annual actuarial reviews of the Fund for FHA since 1990.

of the loans outstanding at that time. The remaining \$4.9 billion represents the Fund's economic net worth, or capital. We also estimated, under our baseline economic scenario shown in table 1, that the Fund had an economic net worth of about \$600 million and a resulting capital ratio of 0.21 percent at the end of fiscal year 1992.

**Table 1: GAO's Estimates of the Economic Net Worth and Capital Ratios of FHA's Fund as of September 30, 1992, and September 30, 1993**

Dollars in Billions				
GAO's scenarios	Estimated economic net worth		Estimated capital ratio (percentage)	
	FY 1992	FY 1993	FY 1992	FY 1993
High-case	\$0.99	\$5.2	0.35	1.92
Baseline case	\$0.60	\$4.9	0.21	1.83
Low-case	\$-0.34	\$4.0	-0.12	1.47

Note: FY = fiscal year.

Under our low-case economic scenario, which assumes a lower rate of appreciation in house prices than our baseline, we estimated that the Fund's economic net worth and capital ratios at the end of fiscal year 1993 would be lower—\$4.0 billion and 1.47 percent, respectively. Conversely, under our high-case economic scenario, which assumes a higher rate of appreciation in house prices than our baseline, we estimated that the Fund's economic net worth and capital ratios would be greater at the end of fiscal year 1993—\$5.2 billion and 1.92 percent, respectively.

As shown in table 1, we estimated that the economic net worth of the Fund increased under our baseline scenario by about \$4.3 billion during fiscal year 1993. This increase occurred even though, during fiscal year 1993, large numbers of FHA borrowers lowered their interest rates by refinancing their mortgages conventionally, which resulted in partial refunds of their insurance premiums. The financial improvement in the Fund is attributable to several economic and program-related factors working together to (1) increase the estimated economic net worth of loans endorsed by FHA in fiscal year 1992 and earlier years and (2) result in our estimate of a positive contribution to economic value made by those loans endorsed by FHA in fiscal year 1993. Legislative and other changes to the program contributed to this increase, but favorable prevailing and forecasted economic conditions in fiscal year 1993 were primarily responsible for this improvement.

Our analysis of the loans endorsed by FHA in fiscal year 1993 shows that some of the program-related changes made by the Congress and FHA in recent years contributed about \$1.3 billion, or 26 percent, to the Fund's economic value. Beginning on July 1, 1991, FHA borrowers were subject to the higher premium payments mandated by the Omnibus Budget Reconciliation Act of 1990. We estimated that if FHA borrowers in fiscal year 1993 had to pay only the premiums that were effective before the act's passage, the economic net worth of the Fund at the end of fiscal year 1993 would have been about \$4.1 billion, or \$0.8 billion (16 percent) less than our baseline estimate of \$4.9 billion. Similarly, we estimated that if FHA had not revised its premium refund schedule, the economic net worth of the Fund at the end of fiscal year 1993 would have been about \$4.4 billion, or \$0.5 billion (10 percent) less than our baseline estimate of \$4.9 billion.

Although the Fund has made a substantial financial improvement recently, we estimated that it fell about \$3 billion short of achieving the legislative mandate for capital reserves of 1.25 percent of its amortized insurance-in-force by the November 1992 deadline. However, the Fund surpassed the 1992 mandate for capital reserves by the end of fiscal year 1993 (1.83 percent). Whether the Fund can sustain this progress; attain the legislative target for reserves of 2 percent by November 2000, thereby achieving actuarial soundness under the law; and maintain that ratio thereafter will depend on many economic and program-related factors that will affect the financial health of the Fund this year and over the next 6 years.

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## Econometric and Cash Flow Models We Used to Forecast Economic Net Worth

To estimate the economic net worth of FHA's Fund as of September 30, 1992, and September 30, 1993, and its resulting capital ratios under different economic scenarios, we examined existing studies on the single-family housing programs of both HUD and the Department of Veterans Affairs (VA); academic literature on the modeling of mortgage defaults and prepayments; and previous work performed by Price Waterhouse, HUD, VA, ourselves, and others on modeling government mortgage programs. On the basis of this examination, we developed econometric and cash flow models to prepare our estimates. For these models, we used data supplied by FHA and DRI/McGraw-Hill, a private economic forecasting company.

Our econometric analysis estimated the historical relationships between the probability of loan foreclosure and prepayment and key explanatory



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factors such as the borrower's equity and the interest rate. To estimate these relationships, we used data on the performance of FHA-insured home mortgage loans—such as foreclosure, prepayment, and loss rates—originated from fiscal years 1975 through 1993. Also, using our estimates of these relationships and of economic conditions, we developed a baseline forecast of future loan performance to estimate the Fund's economic net worth and resulting capital ratio. We then developed additional estimates that assumed higher and lower future rates of appreciation in house prices; the scenario with the lower rate of appreciation of house prices also assumed higher unemployment.

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 1993. The five sources and uses of cash are

- income from mortgagees' premiums,
- payments associated with claims on foreclosed properties,
- net proceeds from the sale of foreclosed properties,
- refunds of premiums on mortgages that are prepaid, and
- administrative expenses for management of the program.

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 converting all income and expense streams—regardless of the period in which they actually occur—into 1993 dollars. In addition to estimating the economic value of the Fund as a whole, we also generated approximations of the economic value of the loans originated in 2 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.

To test the validity of our model, we examined how well our model predicted the actual rates of FHA's loan foreclosures and prepayments through fiscal year 1993. We found that our predicted rates closely resembled actual rates. A detailed discussion of our models and methodology for forecasting the economic net worth of FHA's Fund appears in appendix I.

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## Agency Comments

We discussed the facts in this report with the Acting Housing-FHA Comptroller; Deputy Assistant Secretary for Single Family Housing; Acting Director, Management Control Staff; Deputy Director, Office of

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Evaluation; Director, Program Evaluation Division; and Deputy Director, Office of Insured Single Family Housing. These officials generally agreed with our facts as presented on FHA's single-family mortgage insurance program and the economic net worth of the Fund. In addition, the officials told us that our econometric and cash flow models and methodology for forecasting the economic net worth of FHA's Fund were credible. The officials told us that they were considering including several aspects of our models in the models built by Price Waterhouse. We incorporated, where appropriate, changes suggested by the officials to clarify certain information presented. As requested, we did not obtain written agency comments on a draft of this report.

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We conducted our work between September 1993 and August 1994 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the appropriate congressional committees; the Secretary of HUD; and the Director, Office of Management and Budget. We will also make copies available to others on request.

Please contact me on (202) 512-7631 if you or your staff have further questions. Major contributors to this report are listed in appendix II.

Sincerely yours,

A handwritten signature in cursive script that reads "Judy A. England-Joseph".

Judy A. England-Joseph  
Director, Housing and  
Community Development Issues

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## Abbreviations

FHA	Federal Housing Administration
GAO	General Accounting Office
HUD	Department of Housing and Urban Development
LTV	loan-to-value
VA	Department of Veterans Affairs

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# GAO's Econometric and Cash Flow Models Used to Forecast FHA's Economic Net Worth

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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 years 1992 and 1993. 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 years 1992 and 1993 for each year from fiscal year 1994 through fiscal year 2022 on the basis of assumptions stated in this appendix. We estimated equations from data covering fiscal years 1975 through 1993 that included all 50 states and the District of Columbia, but excluded U.S. territories.<sup>5</sup>

Our forecasting models used observations on loan-years, that is, information on the characteristics and status of an insured loan during each year of its life to estimate conditional foreclosure and prepayment probabilities.<sup>6</sup> More specifically, our model used logistic equations to estimate the probability of a claim's payment (or prepayment) in a given year 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 loan's size, the geographic location of the house, and the number of years 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 mortgage insurance's premium. We forecasted the cash flows into and out of the Fund on the basis of our foreclosure and prepayment models and key economic variables as determined 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.

Separate estimations were obtained for investors' mortgages, fixed-rate mortgages with terms of 25 years or more, and fixed-rate mortgages whose terms were less than 25 years. A complete description of our models, the

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<sup>5</sup>We used an analogous approach in estimating the value of the Fund as of the end of fiscal year 1992. For that analysis, we used data covering fiscal years 1975 through 1992, so our coefficient estimates were slightly different from those presented here.

<sup>6</sup>These probabilities are conditional because they are subject to the condition that the loan has remained active until a given year.

data we used, and the results we obtained are discussed in detail in the following sections.

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## Data and Sample Selection

For our analysis, we selected from FHA's computerized files a 10-percent sample of records of mortgages insured by FHA from fiscal year 1975 through fiscal year 1993 (930,452 loans).<sup>7</sup> 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 1993.

To describe macroeconomic conditions at the national and local levels, we obtained data from DRI/McGraw-Hill, by state, on annual civilian unemployment rates and data from the Economic Report of the President on the implicit price deflator for personal consumption expenditures. DRI/McGraw-Hill's data on quarterly interest rates for 30-year mortgages on new and existing housing were used along with DRI/McGraw-Hill's forecast data, at the state level, on the median house price and civilian unemployment.

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## 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 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 purchaser may prefer to assume the seller's mortgage.

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<sup>7</sup>FHA's A-43 data base provides current and historical information on the mortgage loans that FHA insures.

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

Our first regression model estimated conditional mortgage foreclosure probabilities as a function of a variety of explanatory variables. In this regression, the dependent variable is an indicator of whether a given loan was foreclosed in a given year. Each loan-year observation was weighted by the outstanding mortgage balance, expressed in inflation-adjusted dollars.

Our claim rates are conditional on whether the loan survives an additional year. Conditional foreclosures were estimated in a logistic regression equation. Logistic regression is commonly used when the variable to be estimated is the probability that an event, such as a loan's foreclosure, will occur.<sup>8</sup> The dependent variable (whose value is 1 if foreclosure occurs and zero otherwise) was regressed on the explanatory variable listed above.

Our second regression model estimated conditional prepayment probabilities. Current interest rates are the primary determinant of a mortgage's refinance activity. This independent variable was the current interest rate relative to the contract rate. The variable was further separated between ratios above and below 1 to allow for the possibility of different marginal impacts in higher and lower ranges.

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 included most of the same variables in both the foreclosure and prepayment regressions.

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<sup>8</sup>If  $P_i$  is the probability that an event will occur in loan-year  $i$ , the "odds ratio" is defined as  $P_i/(1-P_i)$ . The logistic transformation is the natural logarithm of the odds ratio, or  $\text{LN}[P_i/(1-P_i)]$ , of which the logistic regression provides an estimate. See G.S. Maddala, *Limited Dependent Variables and Qualitative Variables in Econometrics* (Cambridge: Cambridge Univ. Press, 1983).



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## 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 and (2) property values can increase or decrease. 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.<sup>9</sup> 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, 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 year'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 region's median nominal house price between the year of origination and the current year.<sup>10</sup> Because the effects on claims of small changes in equity may differ depending on whether the level of equity is positive or negative, we used a pair of equity variables, LAGEQPOS and LAGEQNEG,<sup>11</sup> in our foreclosure regression. The effect of equity is lagged 1 year, as we are predicting the time of foreclosure, which usually occurs many months after a loan first defaults.

We also included LAGEQPOS and LAGEQNEG 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.

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<sup>9</sup>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.

<sup>10</sup>The estimated rate of appreciation in nominal median house prices, 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 the existing housing stock over time. Also, to ensure that our estimates were conservative, we subtracted an additional 1 percent annually from DRI/McGraw-Hill's forecasts.

<sup>11</sup>Essentially, LAGEQPOS takes the value of lagged equity if equity is positive or zero if equity is negative. LAGEQNEG takes the value of equity if lagged equity is negative or zero if equity is positive.

For the prepayment regression, equity was defined as book equity instead of market equity. Book equity was defined as the estimated property value less the amortized balance of the loan. It is book value, not market 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.

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## LTV Ratio

In addition to LAGEQPOS and LAGEQNEG, we included another variable in our regressions related to equity: the initial LTV ratio. LTV was entered as a series of dummy variables depending on its size. Loans fit into eight discrete categories. In some years, FHA measured LTV as the loan's amount less mortgage insurance premium financed in the numerator of the ratio, 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.<sup>12</sup>

One minus LTV measures a borrower's initial equity, so we anticipate that if LTV is an important predictor in an equation that also includes a variable measuring current equity, it will probably be positively related to the probability of foreclosure. One reason for including LTV 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 LTV and expecting it to have a positive 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 are not available.<sup>13</sup> However, it seems likely that borrowers with little or no down payment (high LTV) are more likely to be financially stretched in meeting their payments and, therefore, more likely to default. The anticipated relationship between LTV and the probability of prepayment is uncertain.

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## Unemployment

We used the annual unemployment rates for each state for the period from fiscal year 1975 through fiscal year 1993 to describe the condition of the economy in the state where a loan was made. We anticipated that

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<sup>12</sup>For the 1993 regressions, 600 loans with LTV above 106 were deleted. We assumed that these were the result of coding errors.

<sup>13</sup>We also do not know whether individual borrowers have subsequently acquired a second mortgage or other obligations that would affect prepayment or foreclosure probabilities.

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 preceding year's unemployment rate in that state.

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## Interest Rates

We included the interest rate on the mortgage as an explanatory variable in the foreclosure equation. We expected 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 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 increase. To capture the relative attractiveness of prepaying, we compared the interest rate on each loan with the interest rate on 30-year mortgages available in the current year.

In our prepayment regression, we used two relative interest rate variables RELINTH and RELINTL, so that the effect of changes in relative interest rates could be different over different ranges. RELINTH is defined as the ratio of the contract interest rate to the currently prevailing rate but is never smaller than 1. RELINTL is also defined as the ratio of the contract rate to the current rate but is never larger than 1.<sup>14</sup>

We created two 0-1 variables, REFIN and REFIN2, that take on a value of 1 if the borrower had not taken advantage of a refinancing opportunity in the past and zero otherwise. We defined a refinancing opportunity as having occurred if the interest rate on fixed-rate mortgages in any previous year in which a loan was active was at least 200 basis points<sup>15</sup> below the rate on the mortgage. REFIN takes a value of 1 if the borrower has passed up a refinancing opportunity at least once in the past. REFIN2 takes on a value of 1 if the borrower has passed up two or more refinancing opportunities in the past.

Several reasons might explain why borrowers passed up apparently profitable refinancing opportunities. For example, if they had been

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<sup>14</sup>For example, if a loan was made at an interest rate of 8 percent (0.08) and the current mortgage rate is 9 percent (0.09), the loan's interest rate is "low" relative to the prevailing mortgage rate. RELINTH is defined as 1 and RELINTL is 8/9.

<sup>15</sup>A basis point equals one one-hundredth of a percentage point.

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 in order to avoid the transaction costs associated with refinancing. In this case, there might be a positive relationship, with the probability of prepayment if the borrower fulfilled his/her anticipation and moved, thereby prepaying the loan.

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## Geographic Regions

We created nine 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 nine Bureau of the Census (Census) divisions on the basis of the state in which the borrower resided. The Pacific Division was the omitted category, that is, the regression coefficients show how each of the regions was different from the Pacific Division.

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## Loan Size

To obtain an insight into the differential effect of relatively larger loans on mortgage foreclosures and prepayments, we assigned each loan to one of seven variables (LOAN1-LOAN7). The omitted category was loans over \$100,000, and results on loan size are relative to those loans over \$100,000. All dollar amounts are inflation adjusted and represent 1991 dollars.

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## Policy Year

Finally, to capture the time pattern of foreclosures and prepayments (given the effects of equity and the other explanatory variables), we defined seven variables on the basis of the number of years that had

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passed since the year of the loan's origination. We refer to these variables as YEAR1-YEAR7 and set them equal to 1 during the corresponding policy year and zero otherwise.

Table I.1 summarizes the variables we used to predict claims and prepayments along with their corresponding means. These means are for fixed-rate mortgages of 25 or more years and less than 25 years and investor mortgages.

**Table I.1: Summary of Predictor Variables**

Predictor variables		Mean 25 years or more	Mean less than 25 years	Mean investor
<b>Loan size dummy variables</b>				
LOAN1	1 if loan amount is less than \$40,000	0.096	0.101	0.093
LOAN2	1 if loan above \$40,000 but below \$50,000	0.114	0.074	0.102
LOAN3	1 if loan above \$50,000 but below \$60,000	0.151	0.097	0.134
LOAN4	1 if loan above \$60,000 but below \$70,000	0.166	0.129	0.148
LOAN5	1 if loan above \$70,000 but below \$80,000	0.151	0.146	0.146
LOAN6	1 if loan above \$80,000 but below \$100,000	0.213	0.271	0.222
<b>Economic variables</b>				
INTEREST	Contract mortgage interest rate	0.099	0.103	0.104
RELINTH	The ratio of the interest rate of the loan and the current interest rate if the interest rate on the loan is higher than current mortgage rates, else 1	1.089	1.088	1.121
RELINTL	The ratio of the interest rate of the loan and the current interest rate if the interest rate of the loan is lower than current mortgage rates, else 1	0.923	0.924	0.952
REFIN	1 if, in at least 1 previous year, the mortgage interest rates had been at least 200 basis points below the contract rate and the borrower had not refinanced, else zero	0.088	0.111	0.152
REFIN2	1 if in at least 2 previous years the above situation prevailed, else zero	0.055	0.076	0.103
LIVUNT2	1 if the property has two living units	N/A	N/A	0.296
LIVUNT3	1 if the property has three or more living units	N/A	N/A	0.095
LAGUNEMPLOY	The previous year's unemployment rate in the state	0.066	0.068	0.066
<b>Policy year variables</b>				
YEAR1	1 if in loan's first year, else zero	0.168	0.172	0.166
YEAR2	1 if in loan's second year, else zero	0.152	0.143	0.156
YEAR3	1 if in loan's third year, else zero	0.135	0.121	0.141
YEAR4	1 if in loan's fourth year, else zero	0.114	0.106	0.122
YEAR5	1 if in loan's fifth year, else zero	0.092	0.093	0.103

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Predictor variables		Mean 25 years or more	Mean less than 25 years	Mean investor
YEAR6	1 if in loan's sixth year, else zero	0.075	0.080	0.088
YEAR7	1 if in loan's seventh year, else zero	0.061	0.067	0.072
<b>Loan-to-value dummy variable</b>				
LTV0	1 if LTV equals zero, assumed missing data	0.100	0.120	0.028
LTV0a	1 if LTV equals zero and loan was written in fiscal year 1983 or earlier, assumed missing data	0.089	0.100	0.025
LTV1	1 if LTV above 0 and less than 60	0.015	0.040	0.008
LTV2	1 if LTV greater than or equal to 60 but less than 85	0.092	0.169	0.244
LTV3	1 if LTV greater than or equal to 85 but less than 92	0.089	0.175	0.524
LTV4	1 if LTV greater than or equal to 92 but less than 96	0.165	0.248	0.056
LTV5	1 if LTV greater than or equal to 96 but less than 98	0.130	0.091	0.037
LTV6	1 if LTV greater than or equal to 98 but less than 100	0.179	0.081	0.047
LTV7	1 if LTV greater than or equal to 100 but less than 102	0.157	0.061	0.040
<b>Equity variables</b>				
LAGEQNEG	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 0, else 0	-0.006	-0.002	-0.002
LAGEQPOS	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 greater than zero, else zero	0.230	0.268	0.242
LAGBKNEG	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 zero, else zero	-0.001	-0.000	-0.000
LAGBKPOS	The value of equity, defined as 1 minus the ratio of the amortized loan balance to the current estimated house price, if equity is greater than zero, else zero	0.222	0.262	0.259
<b>Census division dummy variables</b>				
DV/A	1 if the loan was in the Mid-Atlantic states (N.Y., Pa., N.J.), else zero	0.069	0.063	0.148
DV/E	1 if the loan was in the East South Central states (Ky., Tenn., Ala., Miss.), else zero	0.070	0.062	0.048
DV/G	1 if the loan was in the West North Central states (Minn., Mo., Iowa, Neb., Kans., S.D., N.D.), else zero	0.089	0.090	0.071
DV/M	1 if the loan was in the Mountain states (Colo., Utah, Ariz., N.M., Nev., Idaho, Wyo., Mont.), else zero	0.149	0.153	0.155
DV/N	1 if the loan was in the New England states (Mass., Conn., R.I., N.H., Maine, Vt.) else zero	0.007	0.014	0.024
DV/R	1 if the loan was in the East North Central states (Ill., Mich., Ohio, Indiana, Wisc.), else zero	0.111	0.220	0.169

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Predictor variables		Mean 25 years or more	Mean less than 25 years	Mean investor
DV/S	1 if the loan was in the South Atlantic states (Hawaii, Ga., N.C., S.C., Va., Md., D.C., Del., W.Va.), else zero	0.194	0.111	0.124
DV/W	1 if the loan was in the West South Central states (Tex., Okla., La., Ark.), else zero	0.152	0.167	0.166

Note: DV = Division.  
 N/A = Applicable to investor loans only.

## Estimation Results

As described above, we used logistic regressions to model loan foreclosures and prepayments as a function of a variety of predictor variables. We estimated separate regressions for fixed-rate mortgages with terms over 25 years and terms under 25 years and for investors' loans originated from fiscal year 1975 through fiscal year 1993. We estimated loan activity throughout the life of the loan. The regressions were weighted by the outstanding loan balance of the observation.

The logistic regressions estimated the probability of a loan being prepaid or foreclosed in each year. The standard errors of the regressions are biased downward because the errors in the regression are not independent. The observations are on loan-years, and the error terms are correlated because the same underlying loan can appear several times. However, we did not view this downward bias as a problem because our purpose was to forecast the dependent variable, not to test hypotheses concerning the effects of independent variables.

In general, our results are consistent with the economic reasoning that underlies our models. Most importantly, the probability of foreclosure declines as equity increases, 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 LTV and INTEREST are higher. Tables I.2 and I.3 present the estimated coefficients for all of the predictor variables for foreclosure and prepayment equations. The overall goodness of fit was satisfactory: Chi-Square statistics were significant on all regressions at the 0.01-percent level.

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Table I.2 shows that increases in lagged equity were strongly associated with lower claim probabilities, as long as equity was greater than zero. Negative equity is not common and is generally observed in the early years of a loan's duration.

Because the coefficients from a nonlinear regression can be difficult to interpret, we transformed some of the coefficients for the 30-year fixed-rate regressions into statements about changes in probability.<sup>16</sup> Overall conditional foreclosure probabilities are estimated to be about 1.1 percent. In other words, there is little over a 1-percent chance for a loan to result in a claim payment in any particular year.<sup>17</sup> Evaluating all variables from this mean probability, our foreclosure regression results indicate that a 2.5-percentage-point increase in the average national unemployment rate will raise the average conditional claim probability by one-half a percentage point. Similarly, a 2-percentage-point increase in the mortgage contract rate will also raise the average conditional claim probability by one-half a percentage point. This finding is important, in that average contract rates have been generally declining since 1981, and our model predicts that conditional foreclosures should also fall, all else held constant.

Loans in the first policy year are least likely to default compared with loans held longer than 7 years, and a 20-percentage-point increase in equity, lagged by 1 year, decreases conditional foreclosure probabilities by one-half a percentage point.

**Table I.2: Foreclosure Equations**

<b>Predictor variables</b>	<b>30-year FRMs coefficient</b>	<b>Other FRMs coefficient</b>	<b>Investor coefficient</b>
INTERCEPT	-7.0953	-8.5572	-7.5798
<b>Loan size dummy variables</b>			
LOAN1	0.4242	0.3037	0.1288
LOAN2	0.2762	0.1470	0.0393
LOAN3	0.1377	0.0809	-0.0018
LOAN4	0.0865	-0.2473	-0.0069
LOAN5	0.0589	-0.1748	-0.1207

(continued)

<sup>16</sup>To determine the marginal impact of any variable on conditional foreclosures, we determined  $F(Z) = \text{EXP}(Z)/[1+\text{EXP}(Z)]$ , where  $Z = \sum_i(X_i * B_i)$ , and  $F(Z)$  was estimated by the ratio of foreclosed dollars to total dollars in the sample. We then took the derivative of  $F(Z)$  with respect to a specific variable. See John H. Aldrich and Forrest D. Nelson *Linear Probability, Logit, and Probit Models* (SAGE Publications: Beverly Hills, London, and New York, 1984), pp. 41-44.

<sup>17</sup>This average is actually for the dollar worth of a loan, not the number of loans.



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<b>Predictor variables</b>	<b>30-year FRMs coefficient</b>	<b>Other FRMs coefficient</b>	<b>Investor coefficient</b>
LOAN6	0.0781	-0.1773	-0.1285
<b>Economic variables</b>			
INTEREST	21.2515	24.9544	21.5946
REFINANCE	0.2638	0.1644	0.3440
REFINANCE2	0.1041	-0.1130	0.2490
LAGUNEMPLOY	14.5716	13.6482	19.4680
LIVUNIT2	N/A	N/A	0.3248
LIVUNIT3	N/A	N/A	0.4818
<b>Policy year variables</b>			
YEAR1	-3.7092	-3.8587	-3.5909
YEAR2	-1.1513	-1.3594	-0.7918
YEAR3	-0.2676	-0.2106	0.0881
YEAR4	-0.0038	0.0288	0.2829
YEAR5	0.1248	0.1235	0.3658
YEAR6	0.1273	0.0986	0.3605
YEAR7	0.0507	0.1287	0.2071
<b>Loan-to-value dummy variables</b>			
LTV0A	-0.5647	-0.2587	-0.3730
LTV0	0.0645	0.1063	-0.4703
LTV1	-0.3872	-2.0065	-0.2345
LTV2	-0.6314	-0.7016	-0.2541
LTV3	-0.5106	-0.2382	0.0569
LTV4	-0.3499	0.1073	-0.0967
LTV5	-0.3017	0.2590	-0.3078
LTV6	-0.1482	0.4050	-0.2066
LTV7	-0.0631	0.3419	-0.0510
<b>Equity variables</b>			
LAGEQNEG	0.6871	-0.2603	1.3446
LAGEQPOS	-2.9437	-1.9388	-2.9875
<b>Census divisions dummy variables</b>			
DV/A	-0.0636	0.4932	-0.8884
DV/E	0.1473	0.6874	0.1660
DV/G	0.3686	0.8296	0.3101
DV/M	0.9188	1.3307	0.9139
DV/N	0.1976	-2.0383	0.1103
DV/R	0.1268	0.6019	-0.3502
DV/S	0.2475	0.5630	0.2445
DV/W	0.8497	1.3850	0.8102

(continued)

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Predictor variables	30-year FRMs coefficient	Other FRMs coefficient	Investor coefficient
<b>Summary statistics:</b>			
Concordant	78.1%	81.3%	80.7%
Tied pairs	3.7%	5.4%	2.4%
Number of	4,282,370	259,833	526,816

Note: DV = Division.  
FRM = Fixed-rate mortgages.  
N/A = Applicable to investor loans only.

Table I.3 shows our prepayment regression results. Overall, conditional prepayment probabilities are estimated to be 8.3 percent. In any particular year, about 8 percent of the loan dollars outstanding will be prepaid. Evaluating all variables at the mean probability, indicate that a 1-percentage-point increase in the relative interest rate, when the contract rate is greater than the current market rate, will increase conditional prepayment probabilities by one-half of a percentage point. A 1.5-percentage-point increase in the unemployment rate will lower the prepayment probability by one-half of a percentage point. A 7-percentage-point increase in equity will raise the conditional prepayment probability by one-half of a percentage point.

**Table I.3: Prepayment Equations**

Predictor variables	30-year FRMs coefficient	Other FRMs coefficient	Investor coefficient
INTERCEPT	-11.7611	-11.4539	-11.3481
<b>Loan size variables</b>			
LOAN1	-0.9999	-0.8114	-1.0659
LOAN2	-0.6489	-0.4793	-0.6642
LOAN3	-0.4381	-0.3504	-0.4452
LOAN4	-0.3161	-0.2251	-0.3248
LOAN5	-0.2005	-0.1409	-0.2224
LOAN6	-0.0980	0.0012	-0.0946
<b>Economic variables</b>			
RELINTL	2.6976	3.3592	3.5573
RELINTH	6.3475	5.6768	5.3891
LIVUNIT2	N/A	N/A	-0.3615
LIVUNIT3	N/A	N/A	-0.4521
REFINANCE	-0.5837	-0.7497	-0.3477
REFINANCE2	-0.8898	-0.6058	-0.8537

(continued)

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<b>Predictor variables</b>	<b>30-year FRMs coefficient</b>	<b>Other FRMs coefficient</b>	<b>Investor coefficient</b>
LAGUNEMPLOY	-5.2021	-4.1567	-6.1090
<b>Policy year variables</b>			
YEAR1	-1.8259	-1.6314	-1.5694
YEAR2	-0.3186	-0.2969	-0.2528
YEAR3	0.1947	0.0404	0.0881
YEAR4	0.4187	0.2078	0.2811
YEAR5	0.2768	0.2467	0.2154
YEAR6	0.2036	0.1834	0.1857
YEAR7	0.3381	0.3461	0.4179
<b>Loan-to-value dummy variables</b>			
LTVOA	-1.1735	-0.8832	-0.8332
LTV0	1.4477	0.9036	1.0237
LTV1	0.2292	0.1679	0.3050
LTV2	0.2761	0.0128	0.1863
LTV3	0.2755	0.0642	0.0516
LTV4	0.2728	0.0346	0.2680
LTV5	0.2300	0.0191	0.1168
LTV6	0.1693	-0.0096	0.0679
LTV7	0.1060	-0.0846	-0.0118
<b>Equity variables</b>			
LAGBOOKNEG	-2.3698	-1.1267	-2.4068
LAGBOOKPOS	0.9276	0.3647	0.5980
<b>Census division dummy variables</b>			
DV/A	-0.5202	-0.3468	-0.3303
DV/E	-0.3285	-0.0301	-0.1728
DV/G	-0.0427	-0.0153	-0.0239
DV/M	-0.1909	-0.0166	-0.2152
DV/N	-0.2234	0.2769	-0.0666
DV/R	-0.0569	0.1093	0.0161
DV/S	-0.4345	-0.2077	-0.3741
DV/W	-0.5900	-0.5567	-0.4624
<b>Summary statistics:</b>			
Concordant	80.7%	78.0%	78.7%
Tied pairs	0.6%	0.6%	0.6%
Number of	4,283,370	259,833	526,816

Note: DV = Division.  
FRM = Fixed-rate mortgages.  
N/A = Applicable to investor loans only.

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## 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 1993. Using a sample of 10 percent of FHA's loans made from fiscal year 1975 through fiscal year 1993, 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 year between a loan's origination and fiscal year 1993. If our model predicted foreclosure or prepayment, we determined the loan's balance during that year 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 1993. We compared these predictions with the actual cumulative (through fiscal year 1993) claim and prepayment rates for the loans in our sample.

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 new and existing housing, by state and year, through fiscal year 1998. We averaged together DRI/McGraw-Hill's forecasts of new and existing housing prices by state and 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 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. 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 2002. We also used DRI/McGraw-Hill's forecasts of interest rates on 30-year mortgages. Figure I.1 compares predicted and actual cumulative foreclosure rates, and figure I.2 compares predicted and actual cumulative prepayment rates.

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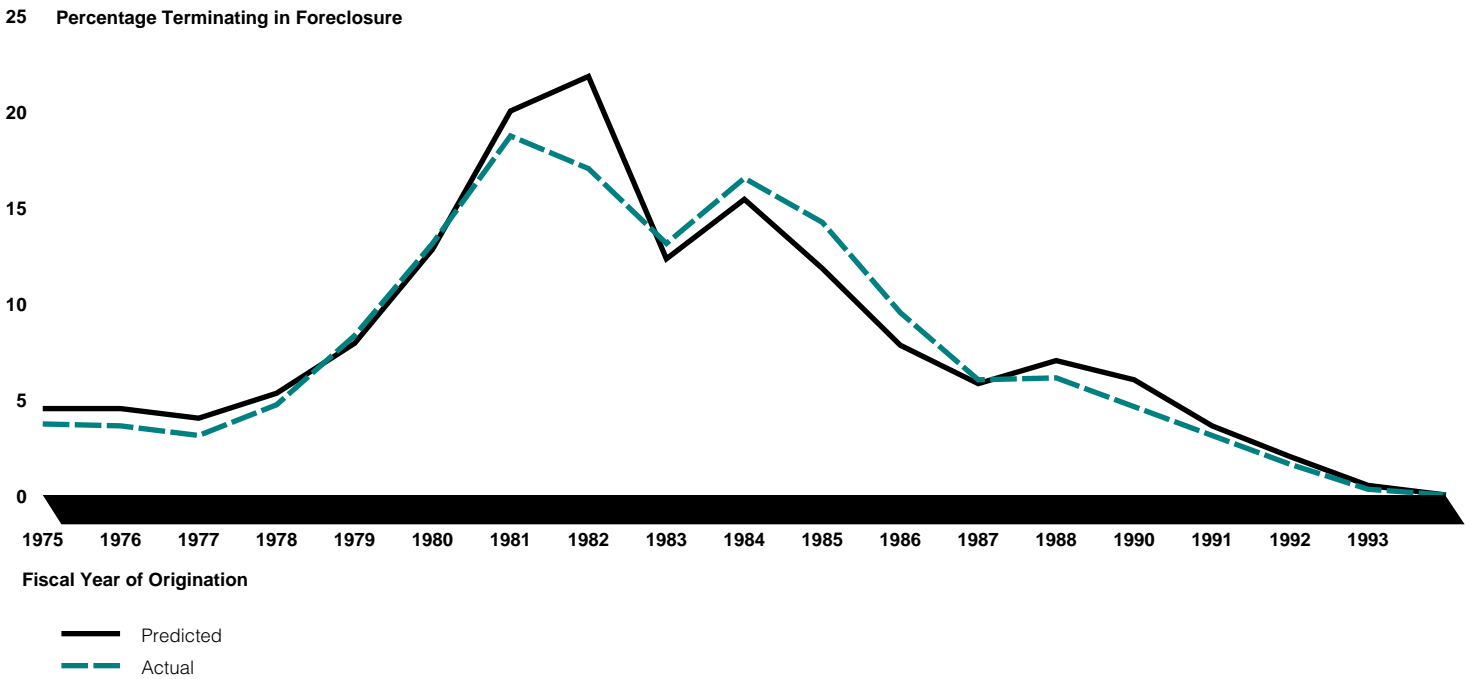
## Estimating Economic Value

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

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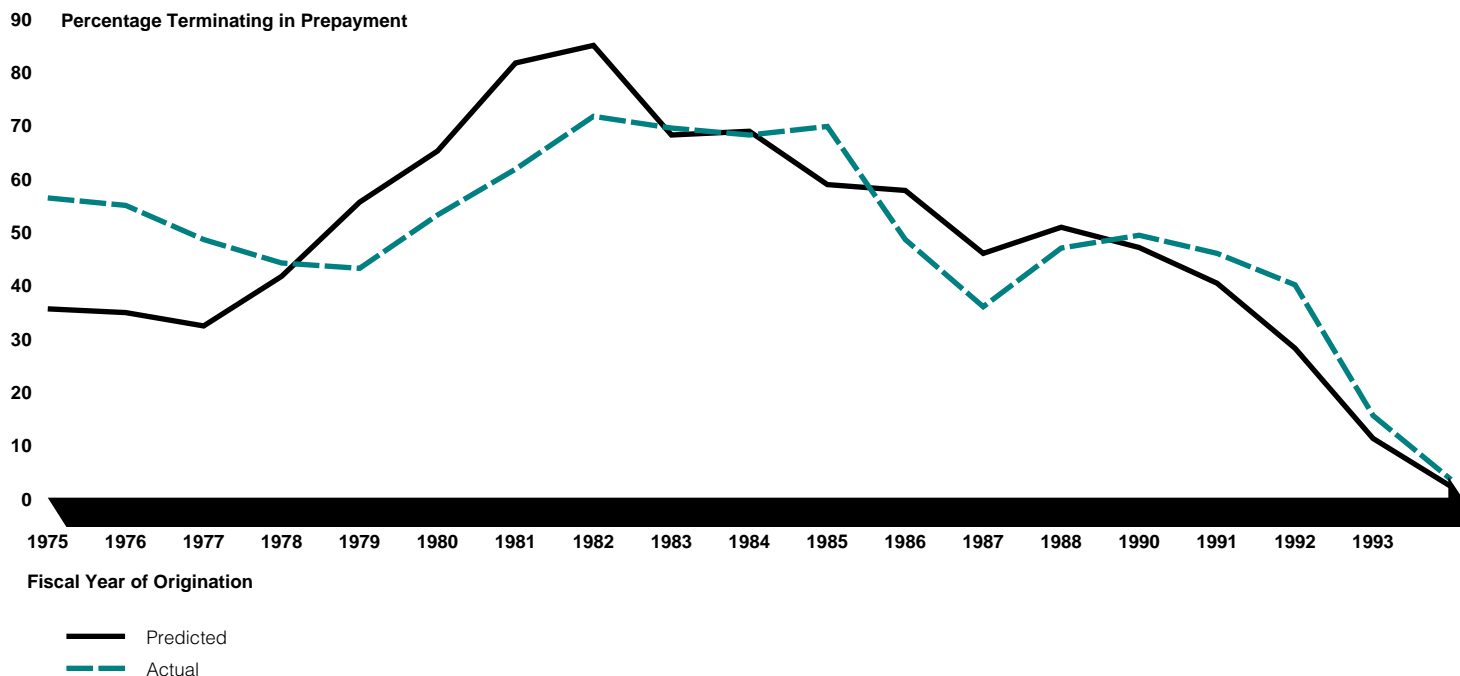
the net present value of all future cash inflows and outflows expected to result from the outstanding mortgages in the Fund.” Information on the capital resources of the Fund as of September 30, 1992, and September 30, 1993, was obtained from the audited financial statements for fiscal years 1992 and 1993. Capital resources were reported to be \$9.5 billion and \$9.7 billion, respectively.

**Figure I.1: Cumulative Foreclosure Rates by Book of Business Through Fiscal Year 1993 for 30-Year, Fixed-Rate, Noninvestor Loans; Actual and Predicted**



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Figure I.2: Cumulative Prepayment Rates by Book of Business Through Fiscal Year 1993, for 30-Year, Fixed-Rate, Noninvestor Loans; Actual and Predicted



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 fiscal years 1975 through 1993 books of business. The five sources and uses of cash are

- income from mortgagees' premiums,
- payments associated with claims on foreclosed properties,
- net proceeds from the sale of 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 whole, we also generated approximations of the economic value of the two most recent books of business. 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 converting all income and expense streams—regardless of the period in which they actually occur—into 1993 dollars. We applied discount rates to match as closely as possible the rate of return FHA likely earned in the past or would earn in the future from its investment in U.S. Treasury securities.<sup>18</sup> As an approximation of what FHA earned for each book of business, 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 between fiscal years 1992 and 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 discount at a rate of 7 percent.

Our methodology for estimating each of the five principal cash flows is described below.

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## 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.

For fiscal years 1975 through 1983:

$$\text{Premium} = \text{annual outstanding principal balance} \times 0.5\%.$$

For fiscal years 1984 through June 30, 1991:

$$\text{Premium} = \text{original loan amount} \times \text{mortgage insurance premium}.$$

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<sup>18</sup>Actual rates vary, of course, 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.

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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, FHA added an annual premium of 0.5 percent of the outstanding principal balance to its policy of 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 I.4.)

**Table I.4: Number of Years of Annual Premium Payments by Date of Mortgage Origination and LTV**

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

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

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

$$\text{Premium} = (\text{original loan amount} \times 3.8\%) + (\text{annual outstanding principal balance} \times 0.5\%).$$

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

$$\text{Premium} = (\text{original loan amount} \times 3.0\%) + (\text{annual outstanding principal balance} \times 0.5\%).$$

For the period January 1, 1993, through September 30, 1993:

30-year mortgages:

$$\text{Premium} = (\text{original loan amount} \times 3.0\%) + (\text{annual outstanding principal balance} \times 0.5\%).$$

15-year mortgages:

$$\text{Premium} = (\text{original loan amount} \times 2.0\%) + (\text{annual outstanding principal balance} \times 0.5\%).$$



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**Worth**

For 15-year mortgages, annual premiums are payable for 8, 4, or 0 years depending on the LTV category of the mortgage at the loan's origination.

Since some loans originated in the 1990s represent FHA streamline refinancings—and therefore are not subject to annual premiums—we estimated what proportion of the post-Omnibus Budget Reconciliation Act of 1990 loan originations were actually streamlined refinancings of business conducted before the act's passage. Since streamline refinancings do not require an appraisal, we decided that mortgages coded in FHA's data base with an LTV of zero could reasonably be assumed to represent streamlined refinancings business conducted before the act's passage. Since streamlined refinancings do not require an appraisal, we decided that mortgages coded in FHA's data base with an LTV of zero could reasonably be assumed to represent streamlined refinancings. On the basis of this assumption with which FHA officials concurred, 10 percent of the origination dollars of loans in the fourth-quarter of fiscal year 1991 were attributable to streamlined refinancings, 13 percent in fiscal year 1992, and 30 percent in fiscal year 1993.

**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 data base) divided by the outstanding principal balance on the mortgage at the time of foreclosure.

For the purposes 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. (See tables I.5 and I.6.)

**Table I.5: 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.6: Acquisition Cost Ratios by Book of Business, Fiscal Years 1984 Through 1993**

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

Net Proceeds

Net proceeds =  $(7.8/12) \times \text{claims payments from previous period} \times (1 - \text{loss ratio}) + (4.2/12) \times \text{claims payments from current period} \times (1 - \text{loss ratio})$ .

We assumed the lag time between the payment of a claim and the receipt of proceeds from the disposition of the property to be 7.8 months on the basis of the latest available information reported by Price Waterhouse in its fiscal year 1988 financial audit of FHA. We define the loss ratio as 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 1993. This is comparable to the weighted average of losses for fiscal years 1975 through 1989. We also used a loss rate of 38 percent to estimate the value of losses that had already occurred for fiscal years 1991 through 1993 books of business.

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 we used from the new schedule—which assume prepayment at mid-year—are found in table I.7.

For loans prepaying through December 31, 1993:

$$\text{Refunds} = \text{original loan amount} \times \text{refund rate.}$$

For loans prepaying on or after January 1, 1994:

$$\text{Refunds} = \text{up-front mortgage insurance premium} \times \text{refund rate.}$$

Table I.7: Premium Refund as a Percent 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

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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.

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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 rates of unemployment and of the 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 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. This formed our high case. 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 its forecasts. For our low case, we subtracted another 1 percentage point per year from our base case.

DRI/McGraw-Hill also forecast each state's unemployment rate through 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 2003 on would equal the rate in 2002. For our low case, we assumed that each state's 1993 unemployment rate would prevail during 1994 and beyond. Since average unemployment rate forecasts for 1994 to 1998 were lower than the 1993 average, this had the effect of raising average unemployment through the forecast period.

Table I.8 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.

**Appendix I**  
**GAO's Econometric and Cash Flow Models**  
**Used to Forecast FHA's Economic Net**  
**Worth**

**Table I.8: Summary of Forecast Scenarios**

Year	High scenario		Base scenario		Low scenario	
	Price rise	Unemployment rate	Price rise	Unemployment rate	Price rise	Unemployment rate
1993	.023	.065	.023	.065	.023	.065
1994	.046	.060	.036	.060	.026	.065
1995	.044	.059	.034	.059	.024	.065
1996	.039	.063	.029	.063	.019	.065
1997	.050	.061	.040	.061	.030	.065
1998	.045	.060	.035	.060	.025	.065

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 \$200 million decline in our estimate of the economic value of the Fund. Conversely, each percentage point decrease in the loss rate below 38 percent resulted in a \$200 million increase in our estimate of economic value. 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 \$120 million increase in our estimate of economic value. Conversely, each percentage point decrease in the discount rate below 7 percent resulted in a \$120 million decrease in our estimate of economic value.

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