NBER WORKING PAPER SERIES

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Working Paper No. 4440

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 1993

This paper is part of NBER's research program in Public Economics. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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ABSTRACT

We examine foreclosures on FHA single family mortgages insured during 1975-87. The importance of the market value of borrower equity, and of the dispersion of national house prices support much earlier work emphasizing the key role of negative equity in triggering default. The lower the "mean" market value of equity is, and the greater dispersion is, the more borrowers will be likely to have negative equity.

The unemployment rate and the book value of borrower equity also are significant determinants of default. Unemployment is one event that can force borrowers to move. The decision to move increases the likelihood of default, because moving costs no longer deter default, and the costs of selling the house reduce the effective equity in the house. The book value of equity also is relevant to this decision, because it is what sellers will receive if they move without defaulting. Both of these variables are significant determinants of default, but the employment impact rises as book equity declines (with large book equity, unemployment should not matter, because selling the house is preferred to default).

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The incidence of mortgage default and foreclosure increased dramatically in the 1980s relative to the 1970s. To illustrate, less than 5 percent of single-family loans insured by FHA during the 1975-78 period were foreclosed by 1992, while over 19 percent of loans insured in 1981 and 1982 had been foreclosed. Even mortgages endorsed as recently as 1984 had already experienced an 16.7 percent foreclosure rate by 1992. As a result of increased foreclosures, the FHA Mutual Mortgage Insurance Fund lost all the capital it had accumulated since its inception in 1934, and in 1991 Congress raised MMI premiums by 45 to 85 percent, the larger increase being for higher loan-to-value mortgages (Hendershott and Waddell, 1992).[1]

The most obvious cause of the foreclosure increase is a sharp decline in house price appreciation. In the four years 1977-80, the average

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1 The Price–Waterhouse 1990 Report estimated a positive economic value of the insurance fund assuming no recession, but a negative value with a modest recession (Hendershott and Waddell, 1992). More recent PW Reports have confirmed the estimate of negative value.

annual increase in the Census Bureau's constant quality house price series (1990 revision) was 12.5 percent; in the four years 1982-85, the average was only 2.8 percent. With lower average inflation and a given dispersion of individual house price changes around the average, the probability of price declines sufficient to induce default and foreclosure rose sharply.

But what about other determinants of default? Is the book or market value of the mortgage relevant to the measure of equity households have in their houses? Did the dispersion in house prices change over the 1975-89 period and do other variables that can "force" households to move, such as unemployment, matter? Holding loan-to-value (LTV) constant, do loans of different sizes default at significantly different rates, and do changes in variables such as house price dispersion and unemployment affect default on loans with different LTVs differently? Have 1980s borrowers defaulted more aggressively, holding all economic determinants constant, than 1970s borrowers? These are the types of questions addressed in this paper.

We begin with a general discussion of the determinants of default and foreclosure and then discuss our data, report our estimates, and interpret the results. Historical simulations indicate how well foreclosures on loans with different initial LTVs, loan size, and origination year are explained. A summary concludes the paper.

I. A MODEL OF MORTGAGE DEFAULT[2]

The owner of a house financed by mortgage debt will default on that debt if the gains from doing so exceed the perceived costs. The gains are the value of the mortgage debt wiped off the books and the free rent that can be obtained between the time of default and actual foreclosure. The losses are the house given up and "default costs": the dollar costs of moving, losses of attachable assets and credit rating, and the psychological or moral cost of defaulting. The dollar costs include those associated with moving one's family and belongings and purchasing another house (if possible) or foregoing the advantage of ownership. Default should occur if negative housing equity exceeds net default costs (note that FHA has no recourse to borrower nonhousing assets). Measuring both negative equity and costs as fractions of existing house value, the default condition is

$$-\frac{(H-M)}{H} > \frac{C}{H} \qquad (1)$$

where H is the value of the house given up, M is the value of the mortgage, and C is net default costs (gross costs less the free rent gained).

Generally, M is measured as the market value of the mortgage. When current market rates rise relative

[2] This model builds on Cunningham and Hendershott (1984), Foster and Van Order (1984) (1985), Giliberto and Houston (1989), Hendershott (1984) and Vandell and Thibodeau (1985).

to a borrower's coupon rate, the market value of the mortgage falls and this will indeed discourage default: no one wants to give up a below-market mortgage. However, when the current market rate falls below the borrower's coupon rate, the borrower can truncate the increase in mortgage market value by refinancing -- converting the market value to the book value. Thus, equation (1) only holds when the market mortgage rate plus the premium needed to induce refinancing, ref, exceeds the mortgage coupon. When the reverse is true, default will occur when

$$-\frac{[H-(1+ref)\,BV]}{H} > \frac{C}{H} \qquad (1a)$$

where *BV* is book value and ref is the cost of refinancing per dollar of book value. This cost includes both origination costs and the expense of repurchasing mortgage default insurance.

While the default condition is similar in principle whether or not households have to move, the likelihood of a household defaulting is significantly increased if the household has to move in the absence of default. First, the costs of moving do not act as a deterrent to default. Second, the household must sell the house if it chooses not to default. This negative cost of defaulting (the cost has to be paid only if the household does not default) acts as an incentive to default. Because households have to repay the book value of the mortgage, the default condition for movers is: default if

$$-\frac{(1-s)H-BV}{H} > \frac{C}{H}(1-m) \qquad (2)$$

where s is the fractional cost of selling the house and m is the fraction of default costs attributable to moving. Note that s and ref are approximately equal in value (about 0.05). Dividing by 1-s and replacing 1/(1-s) with 1+ref, we have

$$-\frac{[H-(1+ref)BV]}{H} > \frac{C}{H}\frac{1-m}{1-s} \qquad (2a)$$

Because m is likely to be greater that s, movers will default in greater percentages than nonmovers when interest rates have declined sharply since origination (the right side of 2a is less than the right side of 1a). When interest rates have risen, movers will default in much greater percentages than nonmovers (1 is far more likely to hold than is 2a).

The dependency of foreclosure in year t for mortgages originated in year j on the percentage net market and book equity in the house is captured with three variables: the expected percentage market equity,

$$EM_{j,t} = \frac{E(H_{j,t})-E(M_{j,t})}{E(H_{j,t})}$$

the expected percentage book equity,

$$EB_{j,t}=\frac{[E(H_{j,t})-BV_{j,t}]}{E(H_{j,t})}$$

and, a measure of house price dispersion since the origination date, $DISP_{j,t}$. When the average property is experiencing positive growth in house value so that widespread borrower default is not likely, some borrowers will still be at risk because their regional or individual housing market is experiencing declining prices. It is the borrowers in the lower tail of a distribution for national house price appreciation that are at greatest risk of default. Increased volatility of house prices enlarges the fraction of properties that have small or negative changes in their house value. This dispersion in house price appreciation over time should capture the concentration of default incidence in regionally stressed areas.

To reflect the greater likelihood of having to move, we considered two variables, divorce and unemployment. While the divorce rate doubled between 1965 and 1976, it has since varied by less than ten percent. Thus the only variable tested is the unemployment rate, U.

The variable we explain is the conditional claim or foreclosure rate, the proportion of loans originated in a given year, *j*, and still outstanding at the beginning of a calendar year, *t*, on which FHA claim payments are made. Thus the model in its most general form is:

$$CCR_{j,t} = \Phi(\overset{-}{EM_{j,t}}, \overset{-}{EB_{j,t}}, \overset{+}{DISP_{j,t}}, \overset{+}{U_t}) \tag{3}$$

where the signs above the variables indicate the hypothesized directional impacts. Interactive effects should also matter. The lower is the market value of equity, the greater should be the impact of dispersion on default. Also, the lower is the book value of equity, the greater should be the impact of higher unemployment; those with large book equity will repay their mortgage rather than default.

II. THE DATA

A. Measure of Percent Equity

The fractional market equity index in policy year t for properties purchased in year j is:

$$EM_{j,t} = \frac{P_0 \prod_{\tau=j}^{t} (1 + r_\tau - 0.01) + p_{j,t} M_0 - MV1\$_{j,t}\, M_0}{P_0 \prod_{\tau=j}^{t} (1 + r_\tau - 0.01)} \tag{4}$$

P_0 - the purchase price of the property,

$r_{j,t}$ - the annual rate of change in the constant quality price index from loan origination year j to policy years t which, net of one percent depreciation, is used to grow property value over time,

$p_{j,t}$ - half of the current refund premium value as a percent of the total loan amount (see below),

$MV1\$_{j,t}$ - the mortgage value relevant to the default decision (see below).

Until late 1983, a 0.5 percent annual insurance premium was charged. In our analysis the 0.5 percent premium is added to the mortgage coupon each year in determining the mortgage payments and thus market value of the mortgage. Between then and 1991, an upfront-premium equal to 3.8 percent of the mortgage including financed closing costs has been charged. FHA policy has allowed one to borrow a fraction, LTV_f, of the sum of the property value, allowed closing costs and the initial insurance premium p_0. Assuming that allowable closing costs are 2.3 percent of the property value (the generally accepted industry view) and the maximum premium is borrowed, then

$$M_0 = LTV_f(1.023)(1.038)P_0 = 1.062LTV_fP_O. \tag{5}$$

Fractional net equity for the borrower can thus be expressed as

$$EM_{j,t} = \frac{\prod_{\tau=j}^{t}(1+r_\tau - 0.01) - 1.062LTV_f(MV1\$_{j,t} - p_{j,t})}{\prod_{\tau=j}^{t}(1+r_\tau - 0.01)} \tag{4a}$$

The FHA 3.8 percent up-front premium payment policy initiated in late 1983 has value to the borrower owing to the policy of refunding the unearned portion of the paid-in premium upon prepayment, although how aware borrowers are of this policy is unclear. Reflecting uncertainty about this awareness, only half of the value of the premium refund is included in the determination of the net equity index. This value depreciates quickly in accordance with the refund policy; after seven years the refund value is less than one percent.

As noted earlier, the equity value for homeowners that have to move differs from that for those who do not have to move. The alternative to defaulting for movers entails paying transactions costs to sell their houses and prepaying the book value of their mortgages. Assuming transaction costs to be six percent of value, the first term in equation (4a) should be multiplied by 0.94, and $MV1\$_{j,t}$ should be replaced with $BV1\$_{j,t}$, the book value. The analogue to equation (4a) for movers then becomes

$$EB_{j,t} = \frac{0.94\prod_{\tau=j}^{t}(1+r_\tau - 0.01) - 1.062\,LTV_f\,(BV1\$_{j,t} - p_{j,t})}{\prod_{\tau=j}^{t}(1+r_\tau - 0.01)} \tag{6}$$

Table 1 shows, for loans originated in 1984, the fluctuations in our two equity measures from 1984 through 1990. Movers with higher LTV loans have a precariously low and sometimes negative equity position. Further, when current mortgage interest rates fall below the contract rate, the market value of the mortgage rises and this directly lowers the net equity value of nonmovers. Over time the longer term tendency toward increasing house prices (captured by the cumulative growth in constant quality house prices) coupled with the amortization of the mortgage balance (measured by the book mortgage value) dominates, and the equity index increases significantly. Not surprisingly, loan default experience shows that the risk is most pronounced in the early years and diminishes significantly in the later years.

The net equity index over time captures the joint effects of house price fluctuations, interest rate movements and initial LTV. Higher LTV ratios at loan origination will lower the percent equity position and thus will increase the risk of loan default. The experience of FHA-insured loans indicates that default rates not only increase for higher LTVs but accelerate at levels above 90% (see footnote 7). The acceleration effect will not be captured in this specification. Therefore, separate regression models are estimated for each of six LTV categories.

B. Regional House Price Appreciation

While house prices have increased consistently on a national aggregate basis, substantial variability in house prices is seen in data for four census regions. Further disaggregation into twelve regions shows even more pronounced fluctuations in house price movements in both positive and negative directions. For a given mean house price appreciation rate, more borrowers will have negative equity during periods when dispersion is greater and thus defaults and foreclosures will be greater.

To test the effects of the dispersion in house price appreciation across regions on aggregate default rates, an index is constructed using the four regional constant quality house price indexes from the Bureau of the Census.[3]

$$DISP_{j,t} = \frac{\left[\sum_{r=1}^{4}\left(\frac{CQHP_{r,j,t}}{CQHP_{r,j,1}} - \frac{1}{4}\sum_{r=1}^{4}\frac{CQHP_{r,j,t}}{CQHP_{r,j,1}}\right)^{2}\right]^{\frac{1}{2}}}{\frac{CQHP_{n,j,t}}{CQHP_{n,j,1}}} \qquad (7)$$

First, for each of the regions, *r*, and the nation in aggregate, *n*, the ratio of the constant quality house price index in policy year t to the value in the origination year (policy year 1) is computed. Then for each loan origination year, *j*, and policy year, *t*, the standard deviation of these regional ratios is computed and divided by the national ratio to provide a measure of relative dispersion in house price

[3] An index computed from data supplied on 12 Census sub-regions looks very similar to that in Table 2.

appreciation that adjusts for the general overall trend in house prices.

Table 2 presents the dispersion index. The average for each policy year is reported in the far right column. As can be seen by comparing for each policy year the data to the left of the jagged line with that to the right, dispersion increased noticeably after 1984. This is consistent with data on house price appreciation in 30 cities presented in Abraham and Hendershott (1993).

C. Additional Economic Indicators

The other raw data used in constructing the equity measures or in the model estimation are the constant quality house price index (Bureau of Census), the FHA contract interest rate, the Freddie Mac survey rate for fixed rate loans, and the national unemployment rate. These data are listed in Table 3.

III. MODEL ESTIMATION

A. The Dependent Variable

Our empirical model explains default and subsequent claim termination experience for FHA's pool of insured single-family loans originated during the 1975-88 period. Default and foreclosure risk are measured as the percent of FHA insured loans that lenders submitted a claim to FHA during the policy year from the pool of loans surviving at the beginning of the policy year. By focusing on claim termination[4], we consider only default risk that financially affected the FHA insurance program. While actual default incidence is higher for lenders, a significant proportion of these defaults are cured with the lender and thus do not impact FHA. Using the FHA population of insured loans, we can develop a time series of the conditional claim rate to summarize default and foreclosure risk for specific pools of mortgages.

Separate claim-rate time series are generated for loan pools stratified by loan origination year and categories for the property's original loan-to-value ratio and real loan size. The time series of loan performance for each loan origination year extends from loan origination to 1990, comprising up to sixteen policy years. The 1989 and 1990 loan origination years were excluded from the analysis because of insufficient claim and prepayment history. Stratifying the claim rate experience across LTV and loan size categories will increase the diversity in

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[4] Claim termination refers to the lender submission of an insurance claim to FHA to recover the loss of principal and allowable expenses following foreclosure and taking property title from a borrower on a defaulted loan. Upon receipt of the claim, FHA takes title of the property before making a claim settlement payment. There are a small percentage of claim settlements that result in FHA being assigned the mortgage with the borrower retaining title of the property.

default experience and permit us to measure the interaction effects of equity, loan size and LTV on claim termination.

The loan size categories are established with reference to the 1979 nominal price of properties. For previous and subsequent years, price categories are rescaled according to changes in the constant quality house price index. The 1975 and 1990 loan size categories and the number and proportion of loans in the categories are listed in Table 4. Loans above the highest size were excluded because these loans did not conform to the FHA policies regarding loan size or were in isolated locations (e.g. Alaska, Hawaii, Guam) where higher limits were in effect.

The eight LTV categories are listed in Table 5, along with the percent of loans in each category for selected years. The 7 percent of loans with an LTV below 75 percent were excluded directly from the model estimation because of suspect LTV measurement. The 5 percent of loans above 97 percent were excluded because they were outside the standard FHA policies on maximum LTV. Smaller LTV category definitions have been established for the LTVs above 90 percent than below, both because there is a greater concentration of loans at the higher LTVs and because FHA experience suggests that the conditional claim rate accelerates at higher initial LTVs.

The pooling of data for each LTV equation is shown in Table 6. Summing the product of the number of policy years and seven loan sizes across origination years, the total number of observations is 931. This data set is weighted more heavily toward loans originated in earlier years because they have had more policy years in which to default. To illustrate, just over half of the observations are from the 1975-79 origination years, and only about a seventh are from the 1985-88 origination years. In reporting the results, it is thus important to note how well the model is explaining defaults for individual origination years, not just for the total sample.

B. The Estimation

To test a proportional default risk model, we specify a semi-log probability model that includes zero-one indicator variables to measure the underlying base claim risk at mean economic values during this period plus the previously discussed economic variables measured as deviations from their means. The model is:

$$lnCCR_{s,y,t} = \sum_{i=1}^{13} \alpha_i D_{i,t} + \sum_{s=1}^{7} \beta_j D_s (EM_{s,y,t} - EM) + \beta_8 (EB_{s,y,t} - EB)$$

$$+ \beta_9 (U_t - U) + \beta_{10} (DISP_{y,t} - DISP) + e_{s,y,t} \qquad (3a)$$

where bars over the variables denote means and the $e_{s,y,t}$ is the disturbance. A time series of conditional claim rates for up to sixteen policy years, t, in each stratified group are pooled across seven loan size categories, *s*, and fourteen loan origination years, *y*. Six separate models are estimated for each of the defined LTV categories.

The thirteen zero-one indicator variables, $D_{i,t}$, take a value of one in policy year *i* and zero otherwise, and their coefficients, αi, can be interpreted as a baseline claim rate in the *i*th policy year for average economic conditions. For the market equity index, $EM_{s,y,t}$, separate coefficients are estimated for each of the seven loan size cross sections to measure the interaction affect of loan size and market equity on claim termination. This is accomplished by multiplying the equity index by each of seven zero-one indicator variables, D_s, that equal one for loan size category *s* and zero otherwise. For the book equity, EBs,y,t, unemployment rate, Ut, and the house price dispersion index, DISPy,t, we measure the average effect across all loan size categories.

GLS estimates of equation (3a) yield coefficients generally consistent with the model, but the explanatory power for different origination years is unsatisfactory.[5] As a result, we experimented with

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[5] Applying an OLS estimator to our model would yield unbiased, but inefficient, coefficients. Maddala (1983) shows that the residuals from linear probability models vary across the range of dependent variable, $CCR_{s,y,t}$, and the size of the sample, $n_{s,j,t}$, in the following way:

$$\text{Var } e_{s,y,t} = \frac{(1-CCR_{s,y,t})}{n_{s,y,t}\ CCR_{s,y,t}}$$

different origination year dummy variables. That is, we added $\Sigma\gamma D_y$, where y runs over the relevant origination years, to equation (3a). This allows for a proportionately higher (or lower) default response of originations in these years to all variables.

Table 7 reports dynamically simulated claims as a percent of actual claims by origination year for the base model and two dummy variable variants. (The precise simulation method is described in Section IV.) The first variant includes a dummy variable for originations in the years 1984-86. The second, which was that used in the Price-Waterhouse 1991 and 1992 FHA Actuarial Reports, has two dummy variables, one for 1982-86 and another for 1987-88. As can be seen, with no dummies, the large numbers of defaults on loans originated in 1984-86 are under-predicted by 25 percent; the small numbers of defaults on loans originated in 1975-77 and 1987-88 are overpredicted by

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In our sample $n_{s,y,t}$ is the number of surviving loans to policy year, $\underline{t}$, for loan origination year, $\underline{y}$, that are contained in loan size category, $\underline{s}$. Efficient estimates of the coefficients can be obtained using a generalized least squares (GLS) estimator with weights taken as

$$w_{s,y,t} = \sqrt{\frac{n_{s,y,t}\, C\hat{C}R_{s,y,t}}{(1 - C\hat{C}R_{s,y,t})}}$$

where $C\hat{C}R_{s,y,t}$ is a consistent estimate of the conditional probability of claim termination. Initial estimates of $CCR_{s,y,t}$ are obtained from a first stage estimation of the model using only $[n_{s,y,t}]^{1/2}$ as the weight.

25 percent; and for all originations the model under-predicts defaults by 6 percent. The cause of the severe underprediction of defaults on 1984-86 FHA business is likely a failure of the model to fully capture the impact of the extreme declines in house prices in Texas (and other energy states), in which FHA wrote a disproportionately large amount of business. While our house price dispersion variable picks up some of this impact, obviously much is missed.

With the addition of the 1984-86 dummy, predicted defaults differ from actual by over 8 percent in only two origination years, 1981 and 1982, and for all originations the model under-predicts defaults by only 2 percent. The Price-Waterhouse variant does not fit nearly as well. Predicted defaults differ from actual by over 12 percent in nine origination years and over 22 percent in five years.[6] Thus the 1984-86 dummy is added to our basic model.

C. The Results

The estimated baseline claim rate profiles for five LTV categories and investor loans are reported in

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[6] Price Waterhouse has continued to use this dummy variable pattern in the annual reestimation of their model, with similar results: substantial overprediction of foreclosures on loans insured in the 1970s and significant underpredictions of foreclosures on loans originated in the 1985–89 period.

Table 8. These profiles exhibit a consistent pattern of rising claim termination risk through year six, flat claim terminations through years ten or eleven, and then rising further through year 13, the last year in our sample. Note that these coefficients are based on equity and house price dispersion being at their mean values over all policy years. In fact, both of these variables increase, on average, over time, eventually giving rise to declining foreclosure rates as the average equity influence overwhelms the dispersion influence.

The other regression coefficients and equation statistics are reported in Table 9. The variables generally work as expected. Claim rates are higher the lower are market and book equity, the greater is house price dispersion, and the higher is unemployment. The coefficients are statistically different from zero except for market value equity for the smallest loan size with initial LTV greater than 90 percent and unemployment for initial LTV less than 93 percent. The adjusted R-squares are near or above 0.9 for all initial LTV categories (and investor loans) except the lowest 75-85% category, where it is only 0.67 (recall that market value of equity does not work for these loans). The coefficient on the 1984-86 dummy variable implies that loans originated (insured) in these years were about twice ($e^{0.7} = 2.01$) as likely to go to foreclosure as were loans originated in other years.

The importance of market value equity and house price dispersion are consistent with the Foster/Van Order (1984 and 1985), Quigley and Van Order (1990) and Cooperstein/Redburn/Myers (1992) option pricing models where default occurs only when the borrower's default option is in-the-money, i.e., the borrower has little or no equity. The lower is our "mean" market value equity and the greater is dispersion, the more likely is equity to be negative. The significance of the unemployment rate and book equity confirm the importance of "having to move" to the default decision. Those who have to move (become unemployed) will default unless they have substantial book equity.

The impact of varying the initial LTV on the claim rate and the contributions of the various economic factors to this impact is illustrated in Table 10. In these calculations, the risk of claim termination for loans in each LTV category relative to 80 percent LTV loans is measured in the fifth policy year for $80,000 loans (category five). The impact of each economic factor on claim rates for higher LTV categories relative to the 80 percent LTV category is the product of the separate effects of equity, unemployment and house price dispersion times the difference in the constant terms for the two LTV loan categories. To illustrate, the ratio of the conditional claim rate on 95 percent LTV loans relative to the claim rate on an 80 percent loan is:

$$\frac{CCR_{95\%}}{CCR_{80\%}} = \exp(b_{95\%,0} - b_{80\%,0})\ \exp(b_{95\%,EM}EM_{95\%} - b_{80\%,EM}EM_{80\%})$$

$$\exp(b_{95\%,EB}EB_{95\%} - b_{80\%,EB}EB_{80\%})$$

$$\exp((b_{95\%,D} - b_{80\%,D})\ D) \qquad (8)$$

where the b's are the estimated coefficients for the two different LTVs. Using equation (8), the added risk of higher LTV as measured by the ratio of the claim rate to that in a lower risk category can be attributed to each of the independent variables.

At any given point in time, only the equity indexes vary across LTV categories. Market equity is computed as the inflated value of an initial $1 house less the initial LTV times the market value of the amortized fraction of an initial $1 mortgage. Book equity per house dollar is about 0.13 less than market equity for two reasons. First, book equity is calculated net of selling costs equal to 0.06 of house value. Second, interest rates were slightly higher in 1984 than in 1980, making the market value equity slightly more (the mortgage market value was slightly less than book).

The unemployment rate is set at 7.8 percent (1984 value) and dispersion is 5.6% (policy year 5 for the 1980 book of business). The TOTAL EFFECT line indicates that the 96% LTV loans were twenty times more likely to go into foreclosure in their fifth policy year than were 80% loans. Somewhat surprisingly, the risk increases most sharply as the LTV rises from 80 to 87%, with 87% LTV loans being six times more likely to go into foreclosure than 80% LTV loans.[7] The increase from 87% LTV to 96% LTV increases risk further by only a factor of just over three.

Not surprisingly, the impacts of both market and book equity are three times higher for the 95-97 percent LTV category than for 80 percent loans. This increase in measured default risk reflects both differences in the estimated equity coefficients in the LTV equations and differential levels of expected equity across the LTV loan categories in the same policy year.

The unemployment impact is double for the highest LTV loans relative to the 80% LTV loans. The greater impact is as expected; higher LTV loans have lower book equity and thus borrowers having to move are more likely to default rather than to repay their loans. While the house price dispersion impact is a little lower for 80% LTVs than for higher LTVs, the difference is not as great as we would have expected.

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[7] Five-year cumulative claim rates for different initial LTV loans originated in the 1975-85 period, <u>not</u> holding other factors (appreciation rates, dispersion, unemployment and loan size) constant, were slightly more than twice as large for 96% LTVs as for 80% LTVs, with most of the increase coming above the 91% LTV level (Hendershott and Waddell, 1992).

Also shown in Table 10 is the relative impact of the 1984-86 structural shift. As noted earlier, the structural shift coefficient indicated that loans insured in these years were roughly twice as likely to default, on average, than loans originated in other years. The lower ratio in this table for higher LTV loans indicates that the greater propensity for loans insured in 1984-86 to default was greater for lower (under 88%) LTV loans.

Table 11 illustrates the impact of loan size on the claim rate. These data are computed the same way as those in Table 9 (note that the loan size category 5 data are the same as the TOTAL EFFECT data in Table 10). In general, small loans (under $50,000 and especially under $45,000) are significantly more likely to default and large loans (over $100,000) are less likely to default. The relatively better performance of larger loans, which is especially striking for low initial LTVs, must be due to a combination of lower FHA underwriting standards for low valued houses and/or greater appreciation rates of higher valued houses.

IV. Dynamic Simulation of Historic Claims

The estimated conditional claim rate models can be used to simulate the history of loan termination performance. We begin with the conditional claim rates derived from the estimated model. A recursive exercise is then conducted to estimate the claim termination count for individual policy years and cross sections. This simulation exercise estimates the number of claims over the 1975 to 1990 period for disaggregations by loan size, LTV, loan origination year and termination year.

The simulation is dynamic in the sense that the number of claims in a policy year are computed recursively from the estimated number of loans surviving to the start of the policy year and the separate prediction of the conditional claim rate for that policy year. The predicted conditional probability rate is multiplied by the estimated number of loans that survived to the beginning of the policy year to compute the predicted number of claims in that policy year. The sum of estimated claim and observed non-claim terminations for each year is used to compute a projection of the number of loans that survive to the beginning of the next policy year. Predictive accuracy is determined by comparing the predicted numbers of claims with the actual claims across the selected loan categories. Tables 12 and 13 present the dynamic simulation results.

When simulating a model within the estimated sample period, the predicted average value generally equals the average of the actual dependent variable. In this dynamic simulation exercise the predicted and actual claims differ for two reasons. First, the model was optimized for a weighted dependent variable of log conditional probability and the model is simulated with non-weighted values. Second, our focus is on predicting claim termination counts and not conditional probabilities employed in the estimated model. The claims are estimated recursively with the current period estimated conditional claim rates (and actual conditional prepayment rate) and end of prior period estimated survivor count. In this recursive exercise the errors from prior period estimates of conditional claim rates can be carried forward. As we noted earlier, without a dummy to allow for worse claim behavior on loans originated in the 1984-86 period, total predicted claims are only 94 percent of actual claims. With the 1984-86 adjustment, predicted claims are 98 percent of actual.

As Table 12 shows, the predictability of the model differs little by either initial LTV or by loan size. The worst results are prediction of only 94 percent of the lowest LTV and smallest loan size categories. The LTV result is not surprising given that we estimated separate equations for the different LTV categories.

The predictability by origination and termination years is not as accurate, but still acceptable. As Table 13 indicates, the predicted percentage is within 10 of the 98 percent average predictability in all but two years origination years, 1981 and 1982, where claims are underpredicted by about 20 percent. For termination years, the predicted percentage is within 8 of the 98 percent average predictability in all but two years, 1983 and 1986 if we ignore the pre1983 years of extremely low claims.

V. Conclusions

After building substantial capital in the 1970s, the FHA single-family mortgage insurance fund lost roughly $10 billion in the 1980s and now has negative economic value. This study uses the FHA foreclosure experience on loans insured during the 1975-88 period to measure the impact of various factors on the rate of foreclosure. Loans are aggregated into six LTV ranges and seven loan size categories, as well as into origination (insurance) and policy years. Conditional claim rates for each of the LTV ranges are estimated, using 931 observations.

The importance of the market-value of borrower equity and national house price dispersion support much earlier work emphasizing the key role of negative equity in triggering default. The lower is "mean" market-value equity and the greater is dispersion, the greater is the fraction of borrowers likely is have negative equity.

The unemployment rate and the book-value of borrower equity are also shown to be significant determinants of default. Unemployment is one of those events that can force borrowers to move, and the moving decision increases the likelihood of default because moving costs no longer deter default and the costs of selling the house reduce the effective equity in the house. The book-value of equity is relevant to this decision because it is what the sellers receive if they move without defaulting. Not only are both of these variables significant determinants of default, but the employment impact is greater the smaller is book equity (with large book equity unemployment should not matter because selling the house is preferred to default).

Two other effects were documented. First, the larger the loan size the lower is default risk. Not only does this effect hold across all loan sizes, but the differential effect is greatest for the largest size loans. This presumably reflects some combination of looser underwriting standards or greater average appreciation for higher valued houses. Second, loans originated (insured) during the 1984-86 period defaulted at roughly double the rate for loans originated in other years, with the effect being greater at LTVs under 90%. This may be due to the crudeness of our proxy for house price dispersion.

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