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MORTGAGE DEFAULT RISKS ASSOCIATED WITH EARTHQUAKES: AN ANALYSIS BASED ON THE 1971 SAN FERNANDO EARTHQUAKE

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Results are presented of a study undertaken to analyze the mortgage default process following the 1971 San Fernando earthquake. Net equity following the disaster is said to be the major influence of default. Related to this is the conclusion that net equity can be influenced by mortgage lenders, government agencies, and by others. Additionally, it is shown that nonproperty-related variables such as prior delinquency, the existence of secondary financing, divorce subsequent to loan origination, and marital status at origination influence default, especially default that culminates in foreclosure. Mortgage variables such as the loan-to-value ratio at loan origination revealed little or no independent effect on default. Differing default relationships were observed across different lenders, and it is suggested that lender attitude and behavior can have a mitigating or aggravating effect on default.

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CHAPTER I

INTRODUCTION

Relatively little is known about the relationship between natural disasters and mortgage markets. Natural disasters, like floods, earthquakes, tornadoes, and hurricanes can cause considerable damage to properties on which mortgages are being held. Property damages resulting from natural disasters in the United States are currently estimated at about three billion dollars annually. Property damage amounts have been rising--not only from inflation, but also from increased use and development of high risk areas (e.g., flood plains, earthquake zones, coastal plains). [6,25,30,39,45,47,63,69]

One of the potential effects of natural disasters on mortgage markets is to increase the mortgage default risk. Mortgage default risks arise from the losses faced by financial institutions when borrowers default on their mortgage obligations. Losses occur if the outstanding mortgage balance exceeds the net proceeds of the sale of the collateralized default property. Mortgage default risks are also faced by secondary mortgage market intermediaries and investors holding securities backed by mortgages.

Past empirical studies of mortgage delinquency and default have identified the loan-to-value ratio, age of the mortgage, borrower income (to a lesser extent), and property location as key determinants of delinquency and default. The published studies all support the hypothesis that a borrower will "cure" a deficiency by selling the property or somehow obtaining the payment as long as the expected net dollar proceeds of the sale are positive. Thus, the studies suggest that the ratio of the original property value to the current principal balance due on the loan and the ability to sell are the key issues. [29,31,35,36,72,77,78]

While research has been conducted on the general problem of mortgage default risks, virtually no work has been conducted on the specific problem of mortgage defaults resulting from natural disasters. In these cases, the values of the collateralized properties are decreased by the damage caused by the natural disaster. In addition, overall property values may be altered by the disaster. Mortgage default risks are increased because the net proceeds of disposing of the damaged properties are diminished, thus increasing the chance these net proceeds will not cover outstanding mortgage balances.

In previous research efforts,[1] the authors studied a number of communities which had incurred heavy property damage from a natural disaster. The authors interviewed mortgage lenders at the sites of one tornado (Xenia, Ohio-1974); one earthquake (San Fernando, California-1971); and three floods (Wilkes-Barre, Pennsylvania-1972; Johnstown, Pennsylvania-1977; and Jackson, Mississippi, 1979). The main purpose of these research efforts was to analyze the actions of financial institutions following a natural disaster. In addition, the authors queried lenders on the number of mortgage defaults they experienced following the natural disaster.

A surprising result of the above efforts was that a significant number of defaults was only found following the San Fernando earthquake. The authors were intrigued by this finding and the general notion of the mortgage default process following natural disasters. Accordingly a proposal was sent to the Natural Science Foundation to analyze the mortgage default process following the 1971 San Fernando earthquake. The resulting grant led to this study.

THE PURPOSE OF THE STUDY

The purpose of the study is to analyze the mortgage default process following the 1971 San Fernando earthquake. Those variables which are associated with mortgage defaults will be identified and prioritized. Attempts will be made to discover the reasons why a significant number of defaults only occurred following the 1971 earthquake. Estimates as to the extent of mortgage defaults following the next great California earthquake will be given. Mitigation strategies for reducing mortgage default losses will be put forth. Finally, a better understanding of the general problem of mortgage default risks associated with natural disasters will be gained.

RESEARCH PLAN

The research plan will be as follows: Chapter I will generally introduce the subject area of study and set forth the research plan. Chapter II will discuss the mortgage default process from a theoretical viewpoint. Chapter III will present an overview of the 1971 San Fernando earthquake and its resulting property damages. The specific steps and parameters of the study of defaults following the 1971 earthquake are set for the Chapter IV. Chapter V will present the results of the statistical analysis of the defaults. Mitigating factors and strategies to reduce defaults will be examined in Chapter VI. In Chapter VII, estimates of the number of defaults resulting from California's next great earthquake will be presented. Finally, Chapter VIII will be devoted to a summary and conclusions.

Footnotes

1. Dan R. Anderson and Maurice Weinrobe, "Effects of a Natural Disaster on Local Mortgage Markets: The Pearl River Flood in Jackson, Mississippi-April, 1979," _Natural Hazard Research_, September 1980. Also Kaplan, Smith and Associates, _Geographic Mortgage Risk: Implications for the Federal Home Loan Mortgage Corporation_, a report prepared for the Federal Home Loan Mortgage Corporation with D. Anderson and M. Weinrobe serving as principal consultants. (Washington, D.C.: Kaplan, Smith and Associates, 1978).

CHAPTER II

MORTGAGE DEFAULTS AND NATURAL DISASTERS

It is not unusual to speculate on the financial effects of natural disasters, and especially the effects on the financial situation of households (Vinso). Potentially, the most important financial effect on households and on financial institutions has to do with the home mortgage.

The home is easily the single most important asset of households. The Flow of Funds Section of the Federal Reserve System defines saving of individuals as the sum of increase in financial assets plus net investment in tangible assets less net increase in debt. Between 1977 and 1983, net investment (by individuals) in owner-occupied houses averaged slightly under 25 percent of individuals' saving (for the seven individual years: 31.4%, 33.5%, 35.4%, 22.3%, 16.8%, 8.5%, and 18.1% respectively). Net investment in owner occupied housing as a percentage of net investment in tangible assets averaged 47 percent over the seven years (45.4%, 45.1%, 48.9%, 59.3%, 42.8%, 37.7%, and 49.7% respectively). Equity in houses is an important repository of savings for many households and may often be tapped to fund current expenses (see Seiders) or be looked at to finance future expenses, including retirement (see Scholen & Chen). Beyond the importance to homeowners, home purchase financing is a vital part of the financial system and the residential mortgage is an important and even dominant asset to a number of financial intermediaries. It is surprising, given these observations, that the effect of natural disasters on home mortgage default has received relatively little attention.[1]

Default on payments on a residential mortgage is a complicated matter in the most ordinary of times. In times of a disaster it is even more complex. One of the curiosities of the subject has to do with the observed frequency of default in the wake of a disaster. In some disasters there has been virtually a zero incidence of default, in spite of large uninsured damages (e.g., Johnstown flood of 1977). In other disasters the incidence of default has been large. If, in fact, the incidence of default is so varied then the causes must be complex. It would also follow that different governmental policies relating to disaster assistance and mitigation would have substantially different effects on mortgage default. In order to be able to suggest correct post-disaster policy (or even pre-disaster default mitigation policy) it is essential that the default process be understood. The first step towards understanding residential mortgage default in the wake of a disaster is to model the action. That is the purpose of this chapter.

The essence of the analysis is that mortgage default involves a rational economic decision. It may seem ingenuous to adopt that approach to the action of individuals and families in the aftermath of a great earthquake or flood, but it does appear that in such times, over time, victims do not lose their ability to make wise economic (and non-economic) decisions. (See Rossi et al., Freisma et al. and Douty, 1972.) Loss of rationality and extravagant behavior is not a characteristic of post-disaster decision making.

What is characteristic of post-disaster decision making is confusion. It is difficult to obtain the information necessary for decision making. Data on matters such as the value of damage sustained and the effects on neighborhood housing values are difficult to come by. Information on whether a local employer will return to full production at the same old location or do something completely different is often not available, or if available it may be untrustworthy or subsequently contradicted. Information on the real promise of promised disaster assistance may be tentative, as may be the terms of disaster assistance (i.e., interest rates, maturities, pay-back provisions, etc.). For many of these types of variables, it is not that someone is holding back information: it is simply that it does not exist. (See Anderson/Weinrobe, C.U., paper on Jackson flooding.)

The fact that information relevant to decision making does not exist, might work in curious ways in its effect on decisions such as home mortgage default. If an individual is economically rational, poor or incomplete data does not necessarily prevent a decision--it may simply bias the decision making. In this chapter the intention is to make clear how incomplete data affects decision making and how it affects the time pattern of decision making.

In the next section the process of default is examined. In the third section the focus is on default and residential mobility. In section four, the post-disaster default decision is modeled and default is considered in a world where information unfolds slowly.

A RATIONAL DEFAULT DECISION

"Default" is generally used to refer to violations of an agreement. In the case of a mortgage it would be a violation of the terms of the note, and could be anything from a failure to maintain the property in appropriate physical condition to a failure to make payments on the loan. When a condition of default exists the lender can take action, ultimately leading to foreclosure. There is no convenient term to refer to a decision on the part of a borrower (or mortgagor) to abandon the financial obligation and the house. In the following, default will be used to refer to such a decision and action.

The default decision is ultimately a decision based on utility maximization. If rational, the decision will be based on a comparison of all benefits and costs of committing default. The decision rule to be analyzed is: if the total benefit to remaining in a residence is less than the total liability of remaining then the homeowner should default. The decision is based on a comparison of two stocks. The most simple version of such a rule would be to default if the value of the mortgage obligation exceeds the property value.

The default decision is one that is properly made or reviewed on a continuing basis. In some cases the effort necessary to estimate the benefit of default may be trivial, as would be the case for a homeowner with substantial equity in a property, and in that case the decision would not be seriously considered. If, however, the decision is not so one-sided then it would be appropriate to review benefits and costs periodically, updating information. Once a decision is made that default is rational, there is no purpose in delaying the default action. The reason for this is that if default is rational the liabilities of remaining the owner exceed the value of ownership. That means that the cost of maintaining the assets exceed the value of the assets' returns. And that in turn means that each day of additional ownership is costly.[2]

If there were no consequences of mortgage default then the default decision would simply involve a comparison of property value to mortgage liability, but default involves other consequences and considerations. Default is intimately related to mobility--a default necessitates some kind of move. Consequently, the default decision is heavily influenced by factors that would independently affect the homeowner's decision to stay or move. The case of a householder having already decided to move remains relatively simple for purposes of analyzing default, and it provides a good starting point for analyzing the decision.

Assume the homeowner wishes to move. In that situation the first consideration is, what is the net equity in the house? Net equity can be defined as the difference between the net sales price (P_{sn}) and the loan balance due (L).[3] The net sales price is the actual sales price (P_s) less any transactions costs associated with the sale (T), such as real estate commissions.

(1) $NE = P_{sn} - L$

(2) $P_{sn} = P_s - T$

Suppose net equity is negative. This might well be the case for a home that was purchased relatively recently and has not appreciated in value. Does that insure that default would be rational? The answer is no. Other factors are relevant. One very important factor would be the effect on the homeowner's credit rating. Another might be social ostracization or a negative reaction by an employer. These costs of default (C_D) are relevant to the decision. They should be added to NE to determine a total or default net equity--that amount which would be sacrificed as a result of default (NE').

(3) $NE' = NE + C_D$

It should be clear that NE' combines expected magnitudes, as one can only speculate on the actual house value and costs of default without going through the process of trying to sell or the process of default. To keep the situation as simple as possible, let all costs and prices be known with certainty. Then the default decision should be based solely on NE'. If $NE' > 0$ the homeowner should sell. If $NE' < 0$ it is to his best interest to default.

The default decision thus far has not taken into account very much information. One variable not yet considered is the mortgage interest rate. It would be appropriate to consider the mortgage interest rate in the modeling of the default decision if the mortgage rate had any effect on any of the variables in equations (1)-(3).

It is common for the interest rate on an outstanding mortgage to be different from that on a new mortgage. If the old rate is below the current market and the mortgage is assumable, this should affect the expected sale price of the house. If the homeowner has not decided to move then the low coupon mortgage has an additional effect: the real value of the liability is less than the "balance due" on the mortgage.

If no immediate move is contemplated the real value of the mortgage liability is a function of the expected length of time for the mortgage to be outstanding. The liability is the present value of the future mortgage payments, including any early payoff of the principal balance. The longer one plans to keep the mortgage the more important is the discounting process in the determination of the present value.

If the contract mortgage rate is below current rates the liability is less than the balance due on the loan. If this is the case a decision to default would involve the sacrifice of a low interest liability, which in essence amounts to a capital loss. The extent of the loss depends on what would have been planned otherwise--absent default.[4,5]

In terms of equation (1), both the loan balance due, (L), and the net sales price (P_{sn}), are variables, the value of which depend on whether or not a move is contemplated and whether or not the loan is assumable. If the loan is assumable and a move is contemplated then P_{sn} is increased. If the loan is non-assumable and a move is contemplated P_{sn} is not changed. If the homeowner is contemplating remaining in the home, then whether or not the loan is assumable the value of L will fall. In a number of possible cases, then, a low coupon mortgage will discourage default.

To summarize the analysis to this point, the determination of the desirability of default in a rational and certain world is the value of NE', the adjusted net equity. It is comprised of the expected net equity plus any costs that would result from a default, less any benefits, plus any difference in cap ital value between the current principal balance outstanding and the present value of the mortgage liability.[6,7]

(4) $NE' = NE + C_D + (Prin_t - PV_t)$

DEFAULT AND RESIDENTIAL MOBILITY

The consideration of the role of the mortgage interest rate indicated that a prior decision to move has a substantial role in the default decision. But the importance of the move decision goes well beyond the matter of interest rates. If one plans to move (say for purposes of a job related transfer) then costs and benefits associated with the move are fixed and irrelevant to any default decision. If a move has not been previously planned then costs and benefits associated with the move are variable costs in the default decision and, consequently, are relevant to the default decision. The move related costs (C_m) would include the following: costs directly related to the move, such as physical transport of possessions; costs of search for a new residence; costs of search for a new job; loss of benefits due to relocation (as might be true for AFDC and unemployment benefits); and social costs of relocating to a different environment and breaking established ties. Move related benefits (B_m) would include: moving to a more pleasant environment; becoming eligible for financial benefits not available at the previous location; finding a new location with a more attractive employment climate and so on. As with other factors entering the default decision, these benefits and costs are perceived phenomena.

The net costs of a move (C_M-B_M) play essentially the same role in the default decision as do the costs of default--they are additive to the net equity in determining the total cost of default. If the costs and benefits of a move were known with certainty, and if B_M exceeded C_M, the individual would move and (C_M-B_M) would not be considered in the default decision. Alternatively, if $C_M > B_M$ the move would not be undertaken independently of a default and the net cost of the move would become relevant to the default decision. Hence, equation (3) can be rewritten as equation (5).

(5) $NE' = NE + C_D + (C_M - B_M)$ if $C_M \geq B_M$

$NE' = NE + C_D$ if $C_M < B_M$ [8]

The matter of moving costs is a bit more complicated, however, because a move decision would generally be characterized by substantial uncertainty. Let $M = B_M - C_M$. Then the distribution of expected values of M can be described as in Figure II-1. μ_M, σ_M are the mean and standard deviation of the function. Figure II-1 is drawn arbitrarily, as there is no reason to believe that the distribution should be symmetrical or bounded. It is also drawn so that the mean value of the expected net benefit is positive.

The move decision in an uncertain world is dependent on the utility of the move or the utility function. Utility should be a function of both the expected value of M and the magnitude of uncertainty surrounding M. If the homeowner is risk averse the preference set should be as shown in Figure II-2B. It is helpful to think of $U_1 < 0$, $U_2 = 0$, and $U_3 > 0$. This is shown in Figure II-2A. Even though the expected value of the move is positive for the three points shown, the offsetting factor of uncertainty leads to positive utility in only one of the three situations.

FIGURE II-1

THE EXPECTED NET BENEFIT OF A MOVE

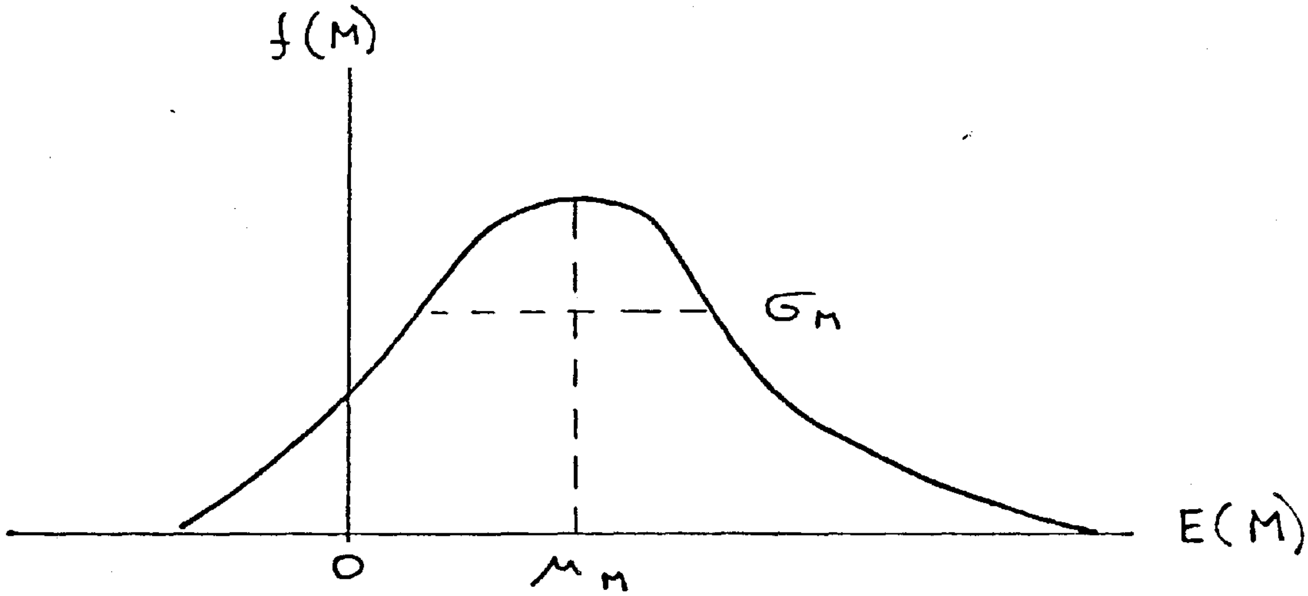
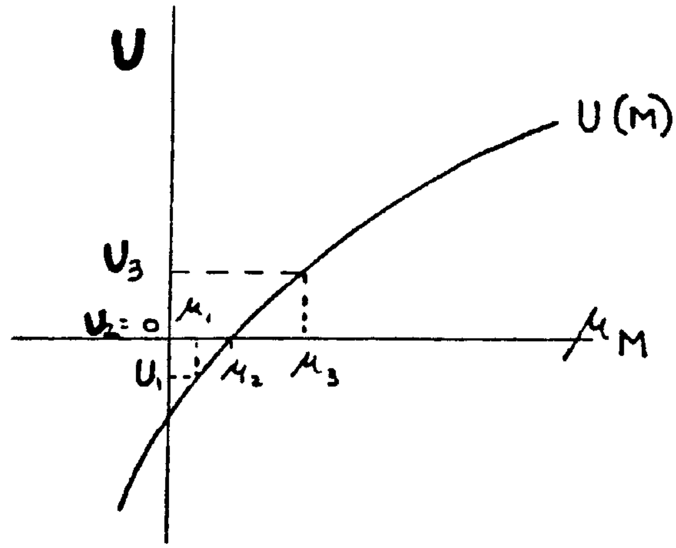
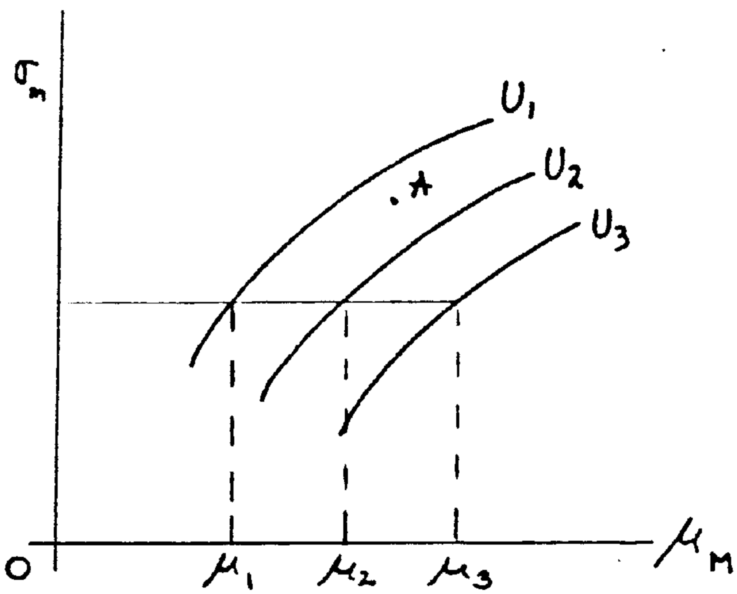


FIGURE II-2

THE UTILITY FROM A MOVE IN AN UNCERTAIN WORLD



A. The utility function holding uncertainty constant



B. The preference set taking uncertainty into account

For a homeowner the (μ_M, σ_M) faced is a datum, a given quantity. Further in a period of time such as a year, it is fair to assume that for most homeowners (μ_M, σ_M) is northwest of U_2 in Figure II-2B (such as point A), simply because most homeowners do not move in any given year. Another assumption that one could make with confidence is that for many homeowners, the consideration of a move is not a serious matter. A contemplated move is connected with a particular event such as a change in family status or the receipt of a job offer. That being the case, it may well be that for persons not seriously considering a move, the value of σ_M is large.

Now return to the question of the default decision in a world of uncertainty with respect to the costs and benefits of moving (but where other variables are known with certainty). In the certain world, only if $B_M < C_M$ was the net cost relevant to the determination of NE'. But if the expected value of M is uncertain, a move may not be undertaken even though its expected value is positive, and accordingly would become a factor that is relevant to the default decision. The expected benefit of a move would be subtracted from NE + C_D--possibly making NE' negative. But that is not sufficient information for the default decision. Just as it was necessary to focus on the utility function in the move decision, it is necessary to focus on a utility function for the default decision.[9]

Even though NE' and C_D might be known with certainty, if M is an uncertain quantity then the default decision embodies risk. And if risk is involved, risk aversion is relevant. The utility function of default can be shown using the same general description as the utility function of a move. See Figures II-3 and II-4. The principal difference between default and move descriptions is that the default decision will depend on NE'. NE' < 0 is a necessary but not sufficient condition for default (assuming risk aversion).

FIGURE II-3

THE EXPECTED VALUE OF NET EQUITY

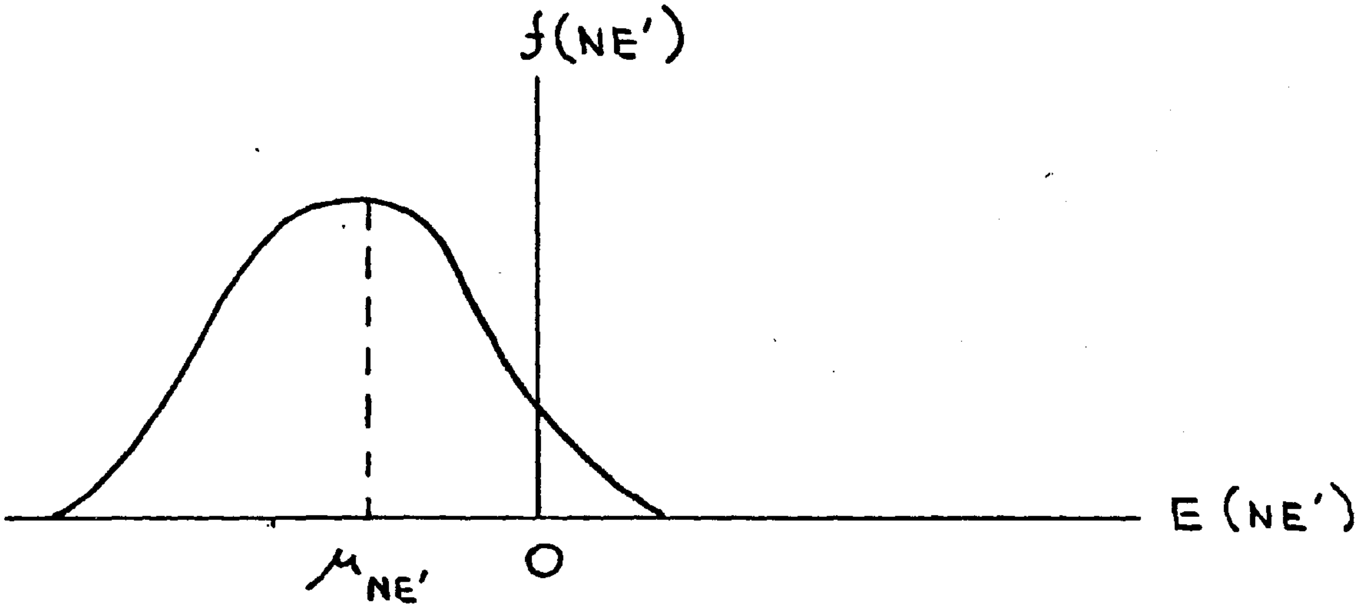
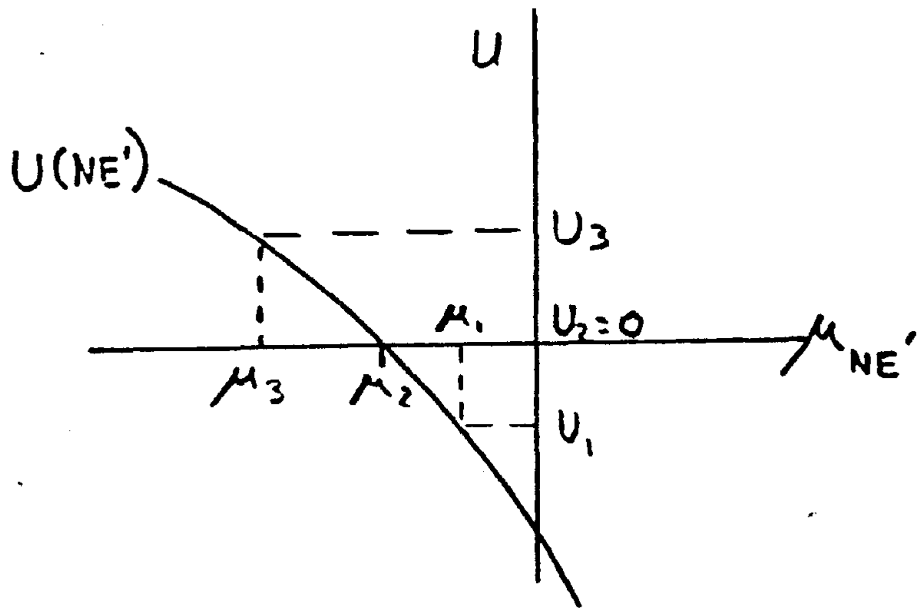
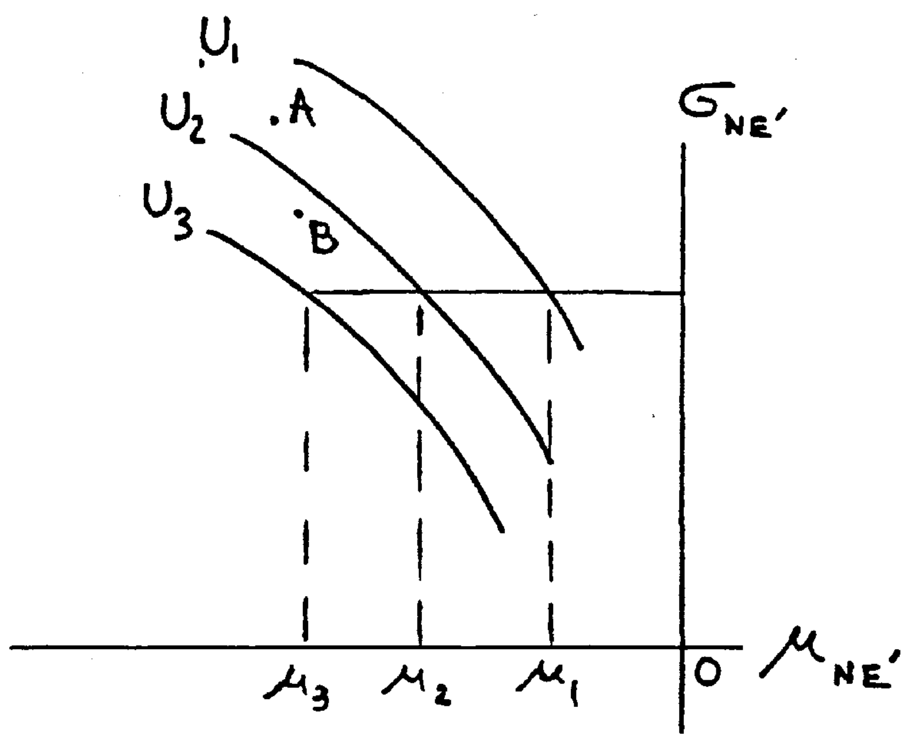


FIGURE II-4

THE UTILITY FROM DEFAULT IN AN UNCERTAIN WORLD



A. The utility function holding uncertainty constant



B. The preference set taking uncertainty into account

Figures II-3 and II-4 describe the utility from defaulting, which is a function of net equity, U = U(NE'). As was the case with the move decision, it is appropriate to assume that the point ($\mu_{NE'}, \sigma_{NE'}$) is a datum. It is reasonable to assume that the more negative is the expected value of NE', the greater would be the value of U(NE'). This is shown in Figure II-4A. As for uncertainty, it is an uncertainty of the effect of defaulting. It is reasonable that this would be a negative influence on utility. This is shown in Figure II-4B.

For purposes of example, Figure II-4 has $U_1 < 0$, $U_2 = 0$ and $U_3 > 0$. Thus if (μ, σ) is located at point A, the homeowner would choose not to default, but if (μ, σ) was point B, the homeowner would default. Rather than discussing at any length a situation where the move parameters are uncertain and the default parameters are known with certainty, it is better to go to the situation where all parameters are uncertain. By allowing all parameters in equation (5) to be uncertain, one allows for the possibility of interaction between variables.

$$(6) \quad E(NE') = \mu_{NE'} = E(NE) + E(C_D) + E(-M)$$

but

$$(7) \quad \sigma^2_{NE'} = \sigma^2_{NE} + \sigma^2_{CD} + \sigma^2_{-M} + 2COV(NE, C_D) + 2COV(NE, -M) + 2COV(C_D, -M).$$

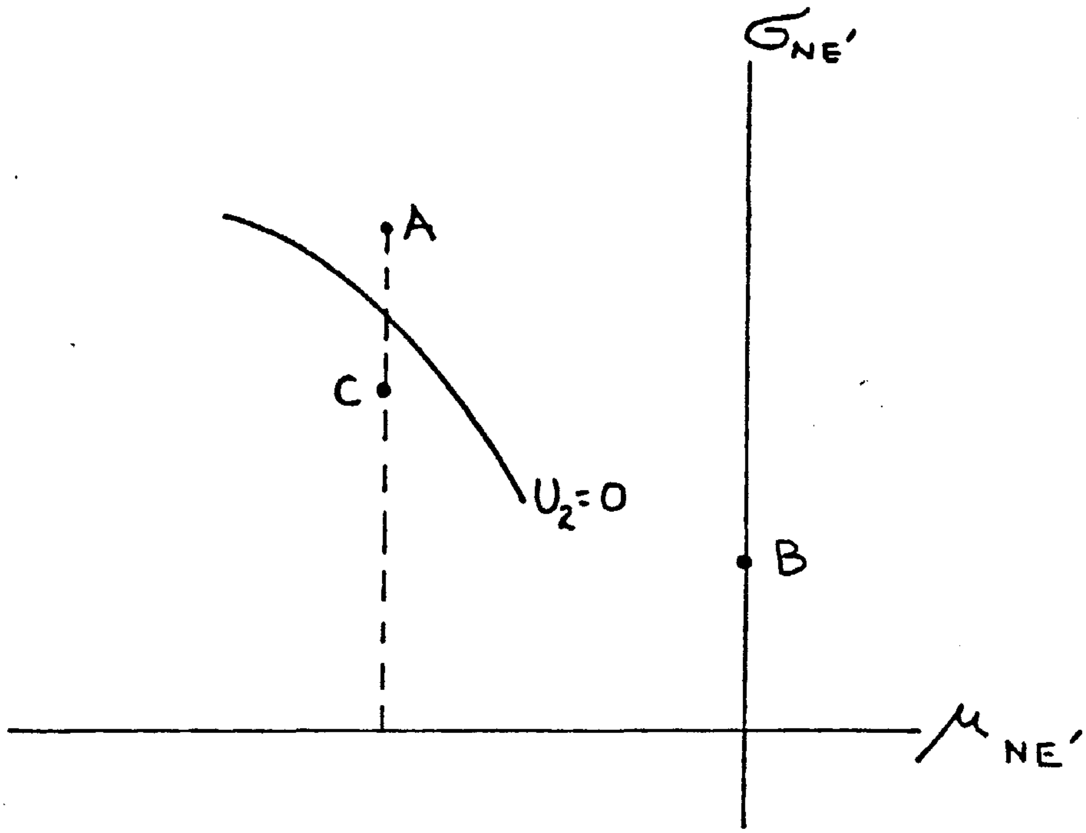
Equation (7) highlights an interesting twist on the matter of uncertainty precipitating a move or default. The uncertainty relevant to the default decision is the combined uncertainty of (7). Suppose the expected net benefit of a move was positive, but uncertainty about the move discouraged the homeowner from moving. This information would be relevant to a default decision. Because of the presence of the covariance terms involving M, it is possible that the uncertainty associated with M might be offset by uncertainty associated with NE or C_D. A plausible example of that might be the following: a household is uncertain about the benefits of moving and about the cost of defaulting on a home mortgage, but believes that a move away from the current location would diminish the effects of default on their credit rating. In that case the covariance between C_D and $-M$ would be negative, reducing $\sigma_{NE'}$. This can be shown with Figure II-5.

Let the value for the consequences of default be represented by point A in Figure II-5, before the consideration of move related benefits. If the move was considered by itself, the homeowner believes that the move would have no measurable net benefits, but s/he is uncertain. The move decision alone would be represented by point B. Now let there be interaction of expectations of the type discussed in the previous paragraph. This could shift the overall (μ,σ) to point C (no change in $\mu_{NE'}$, but a reduction in $\sigma_{NE'}$), thus leading to a default/move decision, even though the expected net benefit of default was unchanged.

One other interaction between move and default parameters is worthy of attention. Consider again, a homeowner who, without the stimulus of some event probably would not consider moving. A good example of such an event is a job offer from another location. Following that stimulus, a serious consideration of the value of the move related costs and benefits would be undertaken. By making such an attempt to quantify benefits and costs, the uncertainty of the effect of the move would be reduced. A similar effect could be brought on by a default related event. So, again, the move/default decisions are dependent on one another.

FIGURE II-5

THE INTERACTION OF MOVE AND DEFAULT DECISION



NATURAL DISASTERS AND THE DEFAULT DECISION

The default decision has been portrayed in this analysis as a rational calculated decision. One might wonder about the applicability of such a model for analyzing behavior in the aftermath of a natural disaster.[10] A natural disaster may seem a rather hostile environment for cold calculation, but so many factors change that are potentially important for the default decision that even without precise calculation the default model is an excellent tool for understanding the decision in the wake of a disaster.[11]

It is customary to break the effects of a natural disaster into stages. One schema is to divide the phases of recovery into emergency, restoration and reconstruction periods (Kates, et al.). That can be a helpful division but for an economist it is more appropriate to classify stages on a short-run/long-run basis, with the distinction made according to replacement of capital. In the long-run capital destroyed by the disaster is replaced.

The effects of disasters that are relevant to the study of mortgage default are numerous. In the short-run they include: immediate effects on properties in the form of damages; effects on neighborhood property values in general; actions of eleemosynary institutions and commercial and financial institutions that are specifically directed at housing; the social climate as it relates to default; the availability and coverage of private insurance; the availability and terms of public relief; and the general level of economic activity and its effect on employment. The long-run effects would involve the same items noted for as the short-run, plus: changes in the distribution of economic activity in a region brought about through capital deepening; changes in the social overhead capital of a community; and changes in employment patterns due to changes in technology and productivity.

Short-Run Effects.

In the immediate aftermath of a natural disaster the atmosphere is one of uncertainty and confusion. For a victim homeowner, little will be known of dollar magnitudes, property damage and property value. Only those who have suffered total property destruction will have an accurate estimation of what has happened to them, and even they have to be able to recognize "total" damage. Apart from the uncertain magnitude of property damages, most victim-homeowners have little idea of what is in store in any dimension, whether it be aid and assistance, insurance, or even job related effects. Transportation, communication and major utilities may be disrupted along with urban services. Clearly in the immediate wake of a disaster information is limited.

As the community moves out of the immediate aftermath of the flood, earthquake, hurricane or other disaster, information on some important variables should develop quickly. In the United States the Federal Emergency Management Agency will establish a one-stop disaster assistance center, the major function of which is to provide information. Most governmental agencies involved in disaster assistance will be represented at the center as will private agencies such as the Red Cross and certain religious groups. At a minimum a victim-homeowner can find out what services are available as well as receive advice on how to obtain emergency aid or how to begin the application process for assistance.

By one month after the event, a victim-homeowner should have some idea of the dollar magnitude of damages that have occurred, of how the damages can and should be repaired, and of what type of funds should be available. In addition, the homeowner should have some idea of the employment situation for the near term future and an idea of what income and property tax benefits may be available. On the other side, the effects of the disaster on neighborhood property values still will be difficult to estimate, terms of disaster assistance may be unavailable or unclear, insurance claims may be indefinite, and employment alternatives away from the home community may be unknown.[12]

Four to six months following the disaster, essentially all information pertinent to a default decision should be available. By this time some residential property sales should have taken place and real estate specialists should have a good idea of neighborhood property value.[13] Individual property owners should be in a position where they can determine the value of their homes, whether or not repairs have been begun or completed. Financial terms for assistance should have been established, insurance claims should have been adjusted, and if there is an interest in employment opportunities outside the local area enough time will have passed to explore them.

The short-run effects of a natural disaster are summarized in Table II-1. The table is illustrative and indicates some of the more important events and actions that should affect the perception of variables relevant to the default decision. In addition to the events that affect perceived net equity, perceived cost of default, and perceived costs and benefits of moving, it is important to recognize influences on the certainty with which expectations are held. Prior to a disaster, perceptions of net equity (or $NE' = NE + C_D$) would be well defined and clearly understood, and the benefits and costs of a move poorly defined. After the disaster the certainties may be reversed. The following post-disaster scenario could be typical: property value will fall due to damage, but the magnitude of the reduction is uncertain; relief programs and disaster assistance are initially poorly understood and information on them not readily available, but gradually information flows and victims find programs especially suited to them; the benefits and costs of moving are at first no more clear than before the disaster, but in time new information is obtained, new

TABLE II-1

ITEMS AND EVENTS AFFECTING PROBABILITY OF DEFAULT

IN THE SHORT-RUN AFTERMATH OF A NATURAL DISASTER

Item or Event	Description
Property Value of Residence	Damage reduces property value which reduces net equity.
Neighborhood Property Value	General changes in neighborhood property value will affect net equity. May be particularly important for disasters that can be expected to recur: e.g., floods and volcanoes.
Property Tax Relief	If temporary, a reduction in property tax will have minor effect on net equity. Likely to be only available to current homeowner.
Federal Income Tax Relief	Casualty loss for amount of damage less $100, in excess of ten percent of adjusted gross income.
SBA Disaster Assistance Loans	Loans to homeowners by SBA. This is the principal federal government disaster assistance program to homeowners. SBA may provide relocation funds, or mortgage assistance for a new residence. Either of these would reduce the cost of moving.
Home Repair	Program has changed often during periods 1960-present. Loans have generally been at below market rates. Loan is non-assumable, hence benefit is limited to victim-homeowner. Can be viewed as an increase in net equity at par.
Mortgage Refinancing	Available at times at below market rates through SBA. Loan is non-assumable. Can be viewed as increase in net equity.

TABLE II-1

(CONTINUED)

Item or Event	Description
Individual and Family Grants	
	Federal/State Grant Program, for specific categories of need and less than $5,000. Often designated for emergency repair. Can increase property value and net equity if spent on desirable home repair.
Private Insurance	
	Typically limited to amount of damage. May include deductible. Often payable to victim-homeowner and independent of decision to repair. Should improve net equity if spent on repairs.
Financial Institution Assistance: Existing Mortgage	
	Generally done on a case by case basis. Could involve forgiveness or forbearance of interest or rescheduling of loan. This can increase net equity. Willingness to accept deed in lieu of foreclosure will affect C_D.
Financial Institution Assistance: Emergency Loans	
	Short-term loans to victim-homeowners, often at favorable rates. Should affect perceived relationship between victim and financial institution, and hence the perceived cost of default.
Awareness of Other Homeowners Defaulting	
	May lower expected cost of default.
Local Job Prospects	
	Will affect the cost of benefit of moving.
Effects on Neighborhood--Possible Elimination of Existing Community Structure	
	Will affect the cost or benefit of moving.

opportunities develop, and the perception of $(C_M - B_M)$ becomes improved. A graphic description of this scenario is shown as Figure II-6.

The scenario of Figure II-6 is somewhat arbitrary but there are elements of it that are common in post-disaster periods. It is easiest to consider the scenario by focusing on the individual elements. Begin with net equity.

Net equity is affected by property damage, by assistance tied to the property, and by changes in the mortgage balance due. The disaster causes property damage, but the magnitude of that damage may be poorly understood. For example, a flood may do extensive personal property damage and it may appear to have done substantial real property damage (ruined wall board and insulation are typical), but there may have been little structural damage. The damage that has occurred may be of the type that can be repaired by the victim-homeowner at a much lower cost than if done by a contractor.[14] Counter-examples could be provided of initial damage estimates that are too low rather than too high, but the point is that immediately after the disaster there may be a false sense of awareness of net equity.

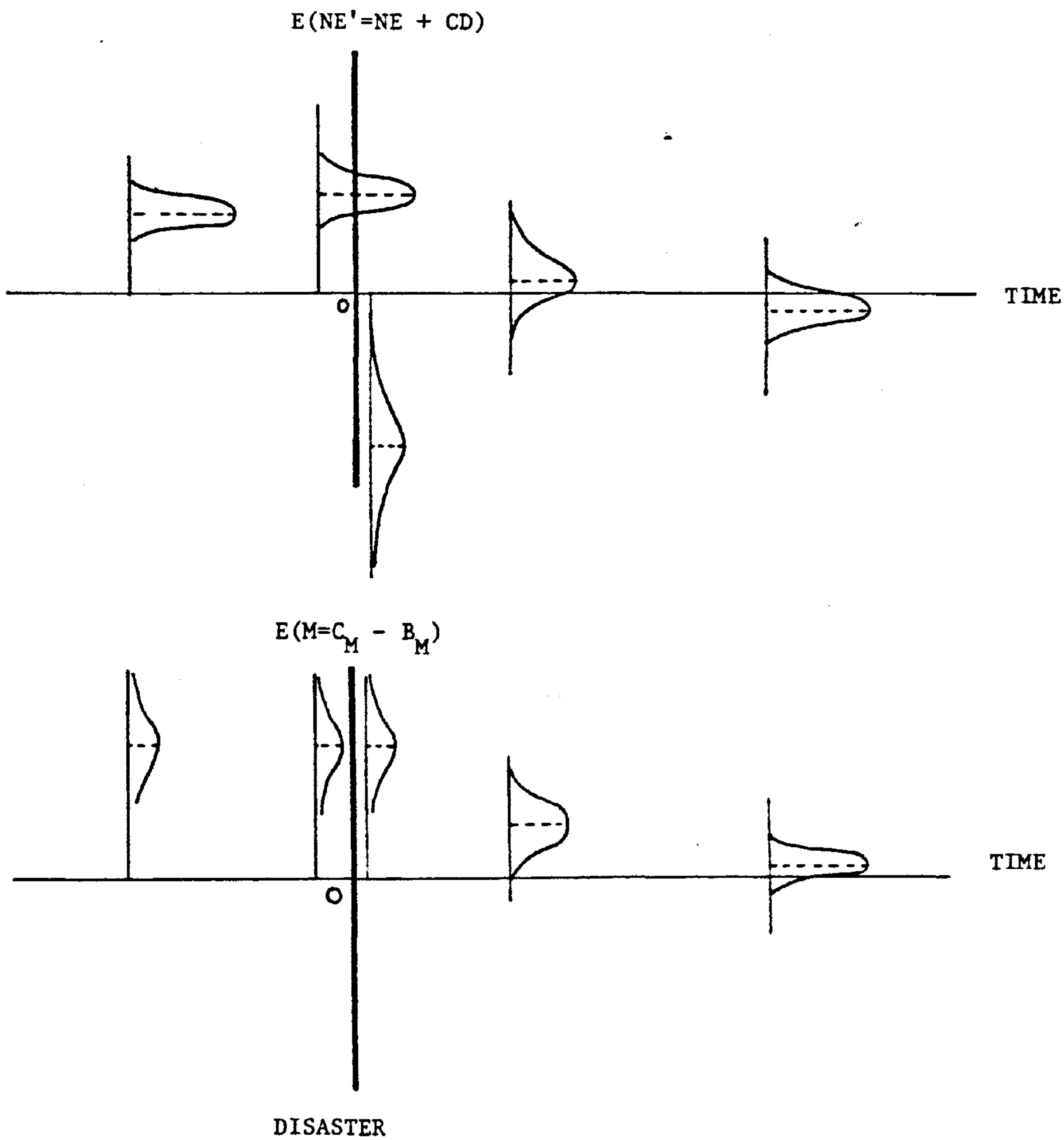
Assistance programs will at first be quite confusing both as to availability and terms. For example, the SBA disaster assistance program is the largest source of loans to victim-homeowners, but in each individual disaster the terms of the loan program may not be known for months. It is not unusual for the terms to be changed by Congress as a result of large scale disaster.[15] At present, SBA loans can carry different interest rates depending on whether the victim-borrower can obtain credit elsewhere. Consequently a homeowner will not know whether he is eligible for an SBA loan, the amount of the loan that will be granted, or the terms of the loan, for three to six months after the disaster.

Privately subsidized loan programs are often instituted following disasters and the most prevalent are associated with area financial institutions. These

FIGURE II-6

THE BEHAVIOR OF IMPORTANT DEFAULT RELATED VARIABLES

IN THE POST-DISASTER SHORT-RUN



can take the form of new loans (often "bridge loans" to provide funds in anticipation of SBA loans), deferral of mortgage payments (with or without interest being charged during the moratorium), or favorable recasting of existing loans. These private loans and loan programs generally develop on an ad hoc basis, and thus come as something of a surprise to the community, but also come rather quickly--perhaps within a week or two of the disaster.[16]

A final perceptual problem with net equity is that its calculation requires an estimate of what the property could bring in a market sale, and in the weeks or months following a disaster perceptions of property value are confused. Indeed, it is not unusual for speculators to come into a disaster struck community and purchase damaged homes during the weeks immediately after the disaster at prices that later are realized to be well below market.[17]

The comments on net equity indicate that in the period immediately following the disaster net equity will be underestimated, but that it will also tend to be uncertain. In some cases the uncertainty may be slow in developing, though, as in the immediate aftermath the victim-homeowner may only perceive the reasons for equity to fall and those perceptions may seem unequivocal.

The perceived cost of default, C_D, should affect default. In ordinary times C_D is a concept that receives scant attention, and can conveniently thought of as "high," but following an unusual event such as a disaster or a severe local recession it may receive considerable attention and there are at least three reasons to expect that it will fall.

First, the perceived cost will be conditioned by public opinion. If many homeowners are believed to be defaulting, the stigma of the action is reduced.[18] Second, the true C_D may drop in the aftermath of an event like a major earthquake. While it is unlikely that the lender who held the mortgage that was defaulted on would extend a new loan to the same homeowner, it would not be impossible for such an individual to obtain a mortgage loan from another lender, even in the same geographic area. Lenders are willing to take into account the very unusual circumstances of a major disaster on "credit worthiness."

Third, the lender on the existing mortgage may adopt a posture that encourages default, by allowing a deed in lieu of foreclosure. In addition, if a mortgage is federally insured or guaranteed, the FHA or VA may take action to allow borrowers to walk away from their mortgage obligations without prejudice. The critical question is, "How informed of the possibilities are mortgagors?". Since the actions lower C_D, one can understand that a lender would not want to publicize the information, but in a large scale disaster it is difficult to keep such actions secret.

If one were to guess how C_D should behave, post-disaster, it would be a fair guess that it should decline and that its associated uncertainty should also diminish.

The cost of default is a variable over which the lender can exercise considerable control (just as a lender can exercise control over net equity by recasting the outstanding mortgage). If the lender wishes to raise C_D in the eyes of the borrower, it might try to create or sustain a feeling of a personal tie between itself and the borrower. A second lender action is also interesting. Some natural disasters (such as tornadoes, some earthquakes and floods) will affect residential properties in a limited area or neighborhood. If there is a dominant lender on the properties in that area (such as would be the case in a housing development) the lender can affect the overall neighborhood climate of opinion. It is not unusual for the lender with the largest involvement in a community to make a special effort (such as by offering an unusually generous disaster assistance program) even though the lender may not be the largest of all area lenders. This is really a case of a single lender being able to internalize some externalities.[19]

The perceived costs and benefits of moving (C_M and B_M) should undergo a change following a major disaster. (Also shown in Figure II-6.) Individuals choose residential locations because of neighborhood characteristics (relative to their own utility functions), employment factors, and because of the location of friends and relatives. All of these can be altered by a disaster.

In the aftermath of a disaster housing patterns of neighborhoods can be upset considerably, both by the effects of the disaster and by government policy in disaster relief. (See Kates, et al., Douty dissertation & Bowdyn diss., & Dacey & Kunreuther.) In some instances the disruption may be temporary but in others relocation of families away from a previous neighborhood may be permanent. Once again, the quality and certainty of information as to just what is happening can be very different from one event to another. The effect of a change in neighborhood characteristics and location of friends and neighbors most likely will be to reduce C_M.

Some government and private assistance programs focus directly on C_M. For homeowners with substantial property damage, funds are generally available for relocation. This may include funds to search for new housing, temporary housing allowances, and/or funds to move belongings from one residence to another. Families of homeowners often assist in relocation.

The other important move related factor is employment. Since the focus in this section is the short-run, it is assumed that capital is fixed. If the employer of the principal wage earner is negatively affected by the disaster (at the extreme, closed down for the foreseeable future or closed down with uncertainty as to whether it will reopen) this will reduce C_M. It is possible that new local employment opportunities will arise, and consequently increase C_M. Such positive effects are true for the building trades, among other fields.[20]

Rather quickly after the disaster, the net costs of moving will fall, and uncertainty will diminish. Ultimately the homeowners situation may settle sufficiently that the net costs of moving rise to the old level, but in the short-run post disaster period the tendency will be decidedly for a reduction in the net costs.[21]

There is no simple conclusion to the short-run effects of a natural disaster. The effects will certainly differ from person to person and community to community. The most important thing that can be said is that the framework that has been used to describe the potential effects of natural disasters reveals the forces that come into play in causing mortgage default. Accordingly, it helps to elucidate the types of disasters that will cause large scale default, as well as the types of individuals who are likely to default.

The particular scenario described in the example of Figure II-6 highlights three important post-disaster short-run phenomena. First, the immediate aftermath of the disaster is a period of high uncertainty and confusion. To the extent that expectations about equity, default and moving are reformulated, these expectations will change quickly and be subject to much confusion and little precision. Second, the perceived net equity in residential property will most likely fall and then come back up. This will be the consequence of initial misinformation and gradual acquisition of information. Third, the perceived net costs of moving will probably gradually decline.

If this general pattern is born out, then one could predict that not all mortgage default will take place within a very narrow time slot, since the perceptions of different people will change according to their own personal factors, but neither will default be spread out over a very long period of time. Most default decisions should take place in the first few months of a disaster. There may be some delay in communicating such decisions to a lender, especially if there has been a payments moratorium granted, but the decision will most likely have been made. It is possible that a decision to default may be reversed but it is not highly likely. The reason is that after a default/move decision is made, new information will most likely reinforce the decision. This would be most true for the move decision. Only if new information contradicting initial information becomes available, is the default decision potentially reversible. This is conceivable but improbable.

For those who decide not to default, events will also tend to reinforce their decision. They probably will take out additional loans, subsidized and non-subsidized, which will raise net equity, possibly improve the quality of the property above available alternatives, and raise the cost of default. As time elapses, the cost of moving goes back up as the homeowner ceases to be eligible for subsidized moving allowances and as offers and opportunities grow stale. So a decision to stay, to not default, tends to be irreversible.

Final Comments

Some final comments are appropriate for borrowers who have exhibited a previous tendency to consider default. As has been pointed out above, the default decision is one that is potentially made on a periodic or even continuous basis. It depends on information, so if information changes the decision can change. Individuals who have been close to default in the past should be more likely to default in the wake of disaster than others. They have obtained information about default so they have less uncertainty than others. By having considered default in the past, they have revealed a perception of a thin equity position. In the face of new opportunities for financial assistance associated with default, diminished equity, and reduced costs of default--all consequences of a natural disaster--the scales may well tip to default.

Footnotes

[1]A good index of the amount of attention that has gone to the subject of mortgage default and natural disasters is the number of pages that Dacey and Kunreuther devote to the subject (15).

[2]There is one exception to this principle. It is conceivable that it would be rational to default on an existing mortgage and move to another owner-occupied residence--that is, to take out another mortgage. But, if there are systematic factors at work that would affect the net value of all residences (perhaps all in an area) in a predictable way, then it could be rational to delay default until the impact of the special factors is complete. The ciritical matter is that the process is understood, is predictable, and that it is incomplete. Two examples might be helpful. One would be a general decline in property value that is currently underway but that is expected to end. A second would be an expected change in the deductibility of mortgage interest from taxable income--a change that would have the effect of reducing property values if enacted. In both of the examples the crucial factor is not that the net value of the current residence will continue to fall but that the value of the prospective residence will fall. The delaying action is not a decision to avoid defaulting on the existing mortgage, but a speculative decision on the new residence.

[3]In the following discussion it is assumed that there is only one mortgage on the property--there are no junior liens.

[4]It should be emphasized that there is no reason to believe that everyone (or anyone) contemplating default in the wake of a disaster would go through the type of calculation being described. This is a description of an economically rational action, not necessarily one that everyone would engage in.

[5]A closely related matter to the real value of a mortgage is that of certain subsidized disaster loans, such as SBA home improvement loans. If the loan is offered at a below market rate to a homeowner, and the loan is non-assumable, then the real liability <u>to the existing homeowner</u> is less than the par value of the loan--even at the moment the loan is originated. This subsidy could, alternatively, be viewed as an add-on to the value of the house, but only to the existing homeowner. Thus a wedge is created between sales price and value to homeowner.

[6]The difference between $Prin_t$ and PV_t could be combined with the mortgage value in NE, but to highlight the factor it is separated out in equation (7).

[7]The focus has been exclusively on low coupon mortgages. If the interest rate on the mortgage is above market then the present value would be greater than the principal outstanding. However, this leads to the question of why the homeowner would not just prepay and refinance. In a rational world the maximum negative value of $(Prin_t - PV_t)$ should be the sum of prepayment plus refinancing charges.

[8]To simplify exposition, the case of a low coupon mortgage is eliminated in what follows. Therefore (5) is based on (3) rather than (4).

[9]If the simple decision rule for default of NE'>0 was still followed, then a positive balance for μ_M might tip the scale in favor of default, even when the move by itself would not be undertaken! This is not completely unreasonable, but it should be the consequence of a particular assumption about risk aversion of default versus move.

[10]Man-made hazards would be slightly different in that victims might have a different amount of time to consider their situation and in that victims might be better able to focus on the agent causing the situation to have come into existence.

[11]Douty (1972) summarizes and extends arguments for economically rational conduct of affairs in the aftermath of large scale disasters, in spite of apparent evidence to the contrary in the form of failure of many prices to rise sufficiently to clear markets of shortages. The essence of his argument is that it is in the long-run interest of large businesses and of individuals to act compassionately and with apparent altruism at the time of a disaster. Any short-run benefits of actions such as raising prices on necessities to clear the market would be overwhelmed by longer-run costs.

[12]The principal assistance for home repair comes from the Small Business Administration. SBA loan terms are known at the time of a disaster but they often change in the aftermath of a large scale disaster (Anderson, Weinrobe) and they are sometimes structured on a tiered basis such that the actual terms of loans granted can differ from one homeowner to another.

[13]Although some data may be available at this point in time, it is possible that the initial data may be biased. That is, there could be a systematic tendency for home sales prices in an area affected by a natural disaster to be either too low or too high relative to long-run market clearing levels. This is a very difficult matter to investigate (see Cochrane, 1974).

[14]It should be emphasized that while personal property damage can be very extensive and certainly distressing, by itself it should have no influence on the default decision.

[15]See Kunreuther (1973), for an excellent description of changes in terms of the SBA disaster loans between 1964 and 1972, which took place because of the disasters during the period.

[16]A description of private lender response to the Spring 1979, Pearl River flooding is provided in Anderson, Weinrobe (1970).

[17]It should be no surprise that many types of "disaster experts" follow disasters, as large scale ambulance chasers. The victims have little and imperfect knowledge of many facets of disasters while the "experts" know enough about disasters in general to benefit greatly.

[18]This is very similar to the perception of the costs of entering into bankruptcy. One explanation for the high rate of declaration of bankruptcy in 1981 and 1982 is simply that it became acceptable. Accountants and lawyers were offering consulting advice on whether to declare bankruptcy. That makes the action quite acceptable. See Thomas Petzinger Jr., "Business Failures Hit Post-Depression High; Tide Expected to Swell." Wall Street Journal, May 24, 1982, pp. 1, 16.

In some disasters there is evidence that in spite of severe financial hardships, individuals have foresaken the opportunity to declare bankruptcy (and to default on home mortgages), purely and simply because they viewed such as improper. (See J. Vinso.) "Financial Implications of Natural Disasters: Some Preliminary Indications." Mass Emergencies 2 (1977), pp. 205-217.

[19]The lender behavior described in this paragraph was observed by the authors in a number of communities. See Anderson and Weinrobe, and KSA.

[20]An excellent description of such microeconomic effects of a specific disaster can be found in Shink. Employment patterns differ greatly across employment classifications. They are affected by the nature of the disaster, but also by the industrial organization of the employing firm and by the extent of "exporting" to other (unaffected) areas done by the firm. See Douty (dissertation).

[21]Exceptions do not generally prove rules but they are often interesting in and out of themselves. The interesting exception here is the tendency for some individuals to take disasters as personal challenges. For these people the event of the disaster raises the net cost of moving and reduces uncertainty.

CHAPTER III

1971 SAN FERNANDO EARTHQUAKE

The San Fernando Earthquake occurred on February 9, 1971 at 6:01 in the morning. The magnitude of the earthquake on the Richter Scale was 6.6 and its intensity ranged from VIII to XI on the Modified Mercalli Scale. The epicenter was in the San Gabriel Mountains, eight miles Northeast of the city of San Fernando.

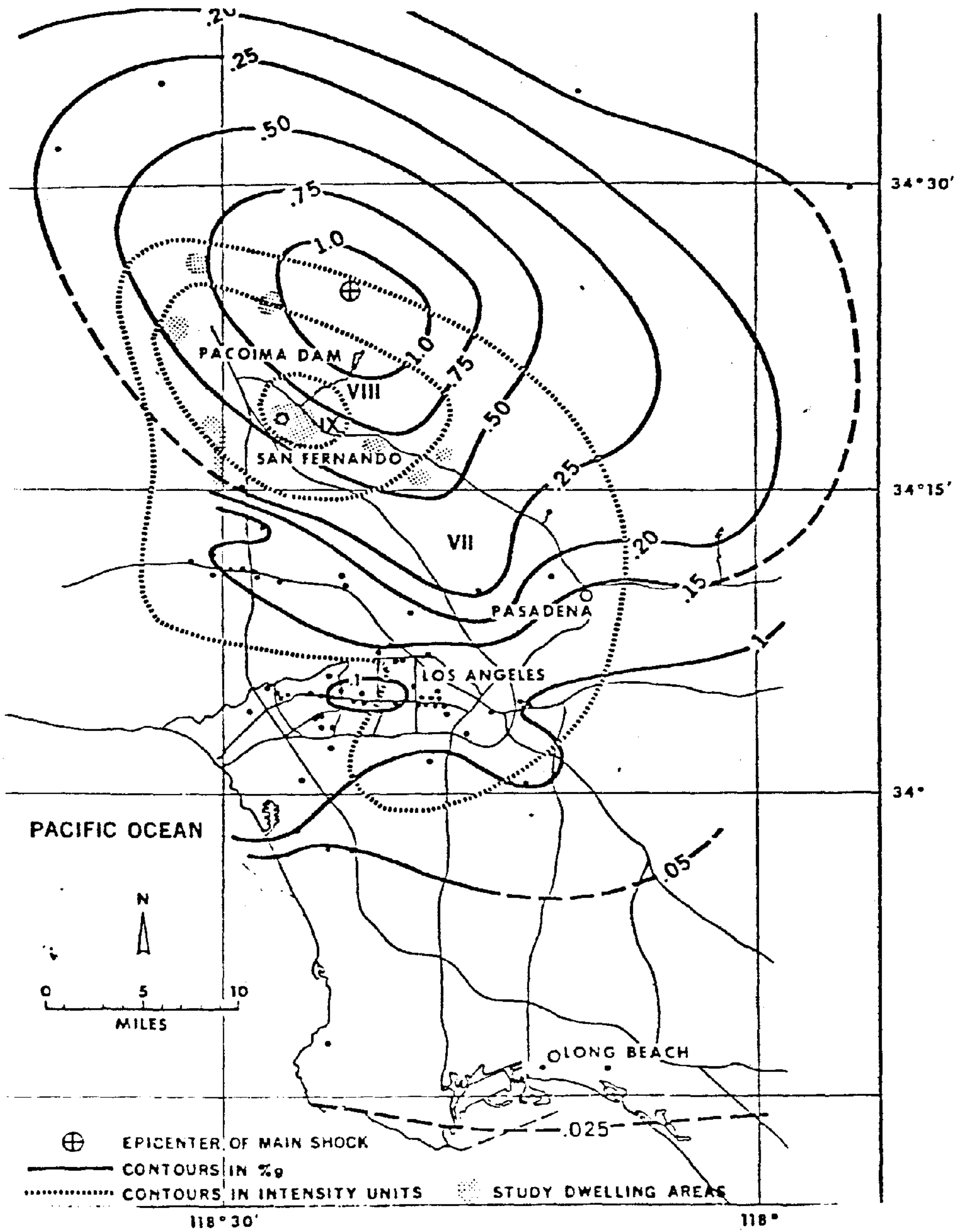
Most of the damage occurred in the San Fernando Valley. The area of heaviest shaking is roughly defined by Figure III-1. The northern limits are bounded by the base of the San Gabriel Mountains; the southern limits by the Santa Monica Mountains; the eastern limits by the Verdugo Mountains; and the western limits by the topographic changes in elevation of the Santa Susana Mountains and the Simi Hills.[1]

The heavily hit area of 289 square miles defined in Figure III-1 had a population of 1,284,200 in 1970. The Los Angeles County Coroner's Office reported 58 deaths directly attributable to the earthquake. Forty-seven of these lives were claimed in the collapse of the Veterans Administration Hospital at the base of the San Gabriel Mountains.[2]

Overall Property Damages

Total property damages have been estimated to be in the area of $550 million (in 1971 dollars). Some $500,000,000 is estimated to be damages to homes, commercial buildings and non-building structures, with the remaining $50,000,000 being damage to inventories, contents and other personal property. Table III-1 displays a breakdown of structural damages across various areas.

FIGURE III-1
DISTRIBUTION OF INTENSITY, SAN FERNANDO EARTHQUAKE



Source: Performance of Single Family Dwellings in the San Fernando Earthquake of February 9, 1971, Frank McClure, 1973, page 12.

TABLE III-1
BREAKDOWN OF STRUCTURAL DAMAGES BY SECTOR AND AREA

	Dollar loss
Private Sector:	
Buildings, excluding land and contents	
Los Angeles City	$154,000,000
San Fernando City	36,000,000
Elsewhere	15,000,000
Non-building structures, excluding land	35,000,000
Public Sector:	
Los Angeles City	180,000,000
San Fernando City	34,000,000
Los Angeles unincorporated	13,000,000
Other cities	24,000,000
Porter Ranch (after shock damage)	8,000,000
Utilities	12,000,000
Total	$511,000,000

Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 326.

Tables III-2 and III-3 show the number of buildings damaged and dollar losses for structures inside and outside of Los Angeles. Note that almost 28,000 (27,902) buildings are estimated to have been damaged by the earthquake. Of this number 1,169 (four percent) were classified as unsafe for human occupancy.

Property Damage to Single Family Dwellings

Of the total property damages of $550,000,000, about $115,000,000 is estimated to have occurred to single family dwellings. The total number of single family homes damaged in the entire area was estimated to be about 20,000. Of these, 730 were demolished or required major rehabilitation[3].

The Pacific Fire Rating Bureau made a detailed study of the damage to 12,037 single family dwellings throughout the most heavily hit area of the San Fernando Valley. Their results are summarized in Table III-4 and Figures III-2 and III-3.

Table III-4 shows the percentage of the total number of wood frame dwellings as a function of the type of damage. As can be seen, a relatively small percentage of the damages are classified as moderate or severe. The categories incurring the most moderate to severe damages were plaster interiors (17.4%) and brick chimneys (14.0%). The two major structural damage categories are foundation damage and frame damage. In these categories, 2.3% or 277 of the homes studied suffered moderate to severe foundation damage while 5.2% or 626 incurred comparable frame damage.

Figure III-2 displays the percentage of homes having various degrees of damages. As can be seen, about 75% of the homes studied incurred property damages of less than 5% of the pre-earthquake value of the home; about 90% incurred damages of less than 15% of the homes' values; and about 95% incurred damages of less than 25% of the home's value. Stated alternatively, 25% or about 3,000

TABLE III-2
BREAKDOWN OF DAMAGE BY EXTENT

From Los Angeles Department of
Building and Safety, as of June 28, 1971

	Units	Buildings	Estimated Dollar Loss
Unsafe for human occupancy--posted "unsafe":			
Single family dwellings	0	522	$ 13,100,000
Apartments	1,149	54	11,500,000
Non-residential commercial and industrial	0	190	19,000,000
Major and moderate damage--remaining occupied:			
Single family dwellings	0	2,469	24,700,000
Apartments	0	192	7,700,000
Non-residential commercial and industrial	0	883	17,700,000
Minor damage:			
Single family dwellings	0	13,711	6,900,000
Apartments	0	1,748	17,500,000
Non-residential commercial and industrial	0	5,698	5,700,000
Other damage (estimated):			
Unreported damage	0	0	30,000,000
Personal property and inventory	0	0	50,000,000
Totals	1,149	25,467	$203,800,000

Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 326.

TABLE III-3
BREAKDOWN OF DAMAGE BY AREA
Does not include publicly owned structures.
Data from various sources

City	Buildings damaged	Posted unsafe	Buildings demolished or to be demolished: Residential	Commercial	Churches and schools	Damaged chimneys	Estimated total dollar loss
Alhambra............	55	15	0	5	0	400	$ 2,000,000
Beverly Hills.......	135	0	0	2	0	1,000	800,000
Burbank.............	445	25	3	3	1	500	4,000,000
Compton.............	0	0	0	0	0	0	10,000
Glendale............	*	31	13	23	5	3,250	2,000,000
Long Beach..........	*	0	0	0	0	0	*
Pasadena............	10	4	0	0	1	2,000	2,500,000
San Gabriel.........	0	0	0	0	0	30	9,000
Santa Monica........	20	1	0	0	0	30	50,000
South Pasadena......	20	1	0	0	0	300	275,000
Vernon..............	30	5	0	0	0	0	100,000
Los Angeles County, including Newhall, Saugus and Valencia areas....	‡1,720	51	15	9	0	*	5,105,000
San Fernando City...	*	270	95	+123	3	390	35,500,000
....							$52,349,000
....							plus

*Not available.

+Posted "unsafe."

‡May include cases of "chimney only" damage

Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 326.

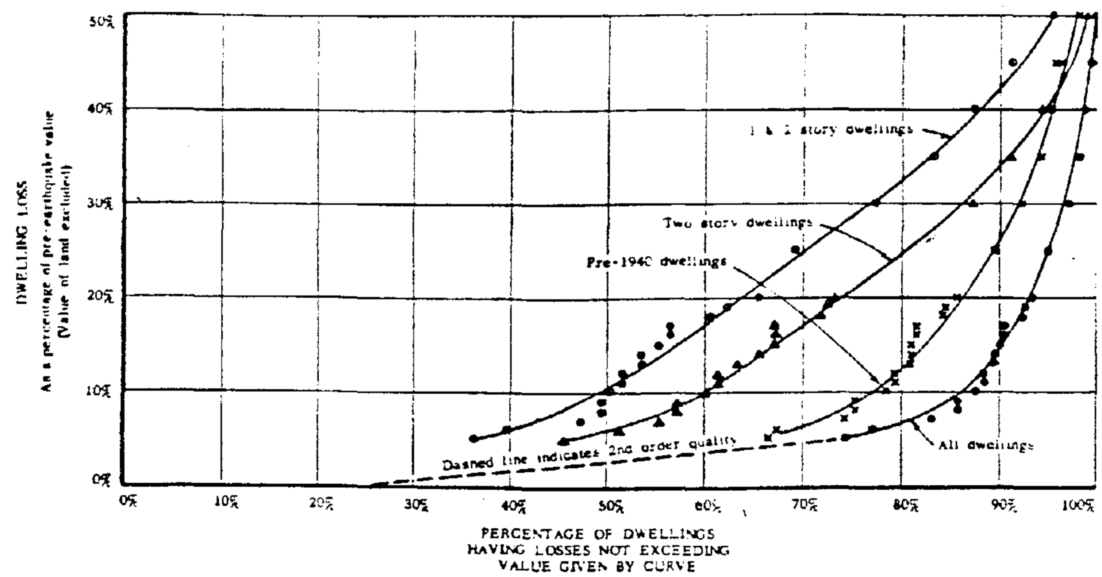
TABLE III-4
PERCENT OF TOTAL NUMBER OF WOOD FRAME DWELLINGS
AS A FUNCTION OF THE TYPE OF DAMAGE

Construction component	Damage: None	Slight	Moderate	Severe
Foundation	91.9%	5.8%	1.6%	0.7%
Damage to frame	78.8%	16.0%	3.3%	1.9%
Interior finish--plaster	4.2%	78.4%	11.1%	6.3%
Interior finish-gypsum board	12.1%	78.0%	6.5%	3.4%
Exterior finish--stucco (plaster)	20.7%	74.1%	4.0%	1.2%
*Brick chimney damage	67.6%	16.1%	6.6%	7.4%

*Total brick chimney damage was found in 2.3% of the cases. "Total" means exactly that; essentially no bricks were left standing, or the chimney was otherwise so damaged as to be non-repairable.

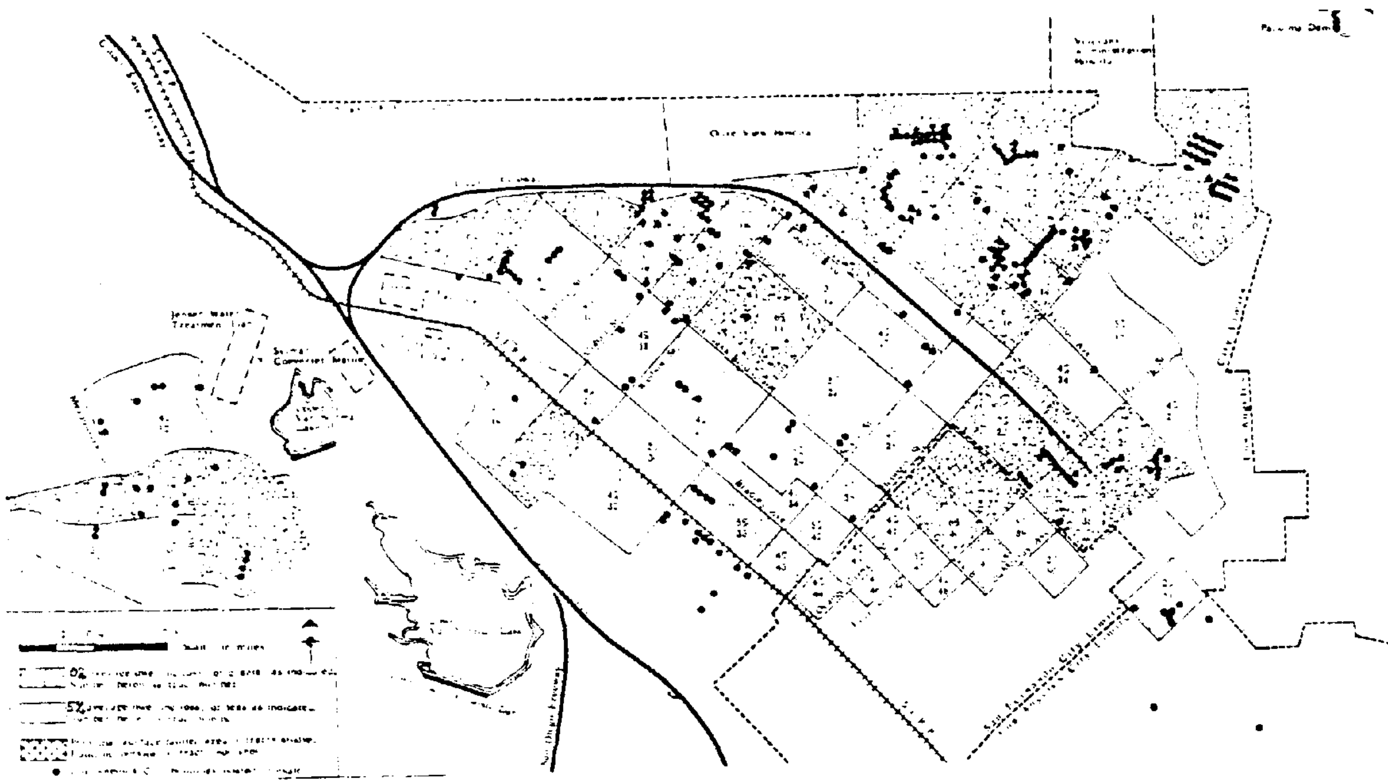
Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 332.

FIGURE III-2
PERCENTAGE OF HOMES WITH VARYING DEGREES OF DAMAGE



Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 333.

FIGURE III-3
MAP SHOWING TRACTS WITH GREATEST DAMAGE



Source: San Fernando, California, Earthquake of 9 February 1971, CA Division of Mines and Geology, Bulletin 196, page 329.

homes incurred damages which exceeded 5% of the pre-earthquake value of the home; about 10% or 1,200 homes incurred damages which exceeded 15% of the home's value; and about 5% or 600 homes incurred damages which exceeded 25% of the home's value.

Figure III-3 shows the geographical distribution of heaviest dwelling damage. The 12,037 dwellings studied by the Pacific Fire Rating Bureau were divided into 62 tracts. Figure III-3 shows the 51 tracts which suffered the greatest damage. Each tract is shown with the average loss per dwelling within the tract. The average loss for all tracts is 6.6% of the dwelling value.

Superimposed upon Figure III-3 with dots are all the structures posted unsafe by the city of Los Angeles (Note: no such posting was carried out by the city of San Fernando). Both those tracts with the highest average loss per dwelling and the concentration of unsafe structures show that the greatest amount of damages occurred in two specific areas - the "one contingUous with the zone of faulting in the San Fernando Valley and the other along the base of the San Gabriel Mountains."[4]

Figure III-4 shows a map which displays the number of residential structures which had to be evacuated following the earthquake. As one might expect, the locations of these evacuated structures correspond closely to the locations of structures posted unsafe in Figure III-3.

Reference will be made to Figures III-1 - III-4 and Tables III-1 - III-4 when the defaults of specific mortgagors are discussed in latter sections. Of particular interest will be the comparison of the locations and damages of the defaulted properties with the entire population of damaged properties.

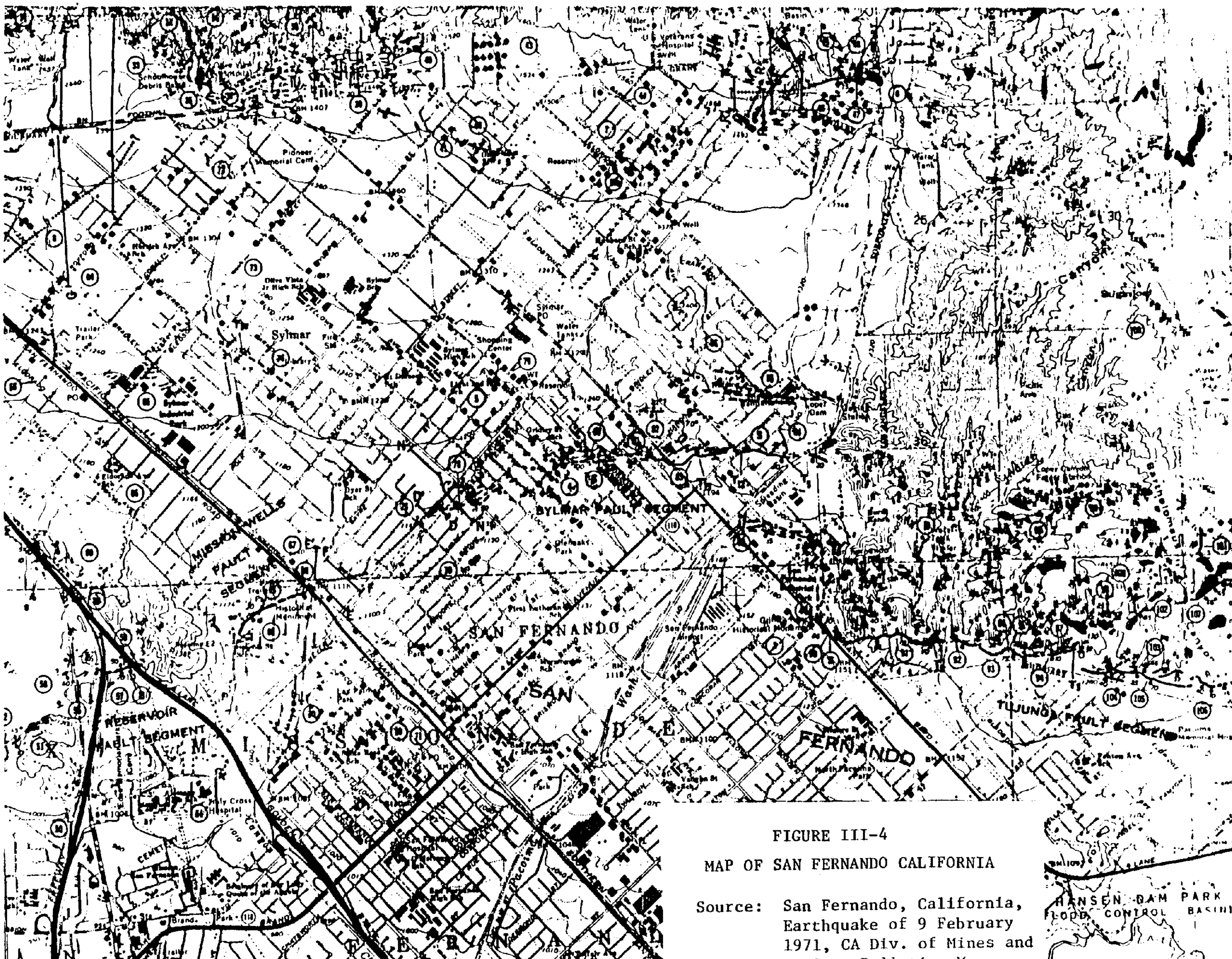


FIGURE III-4

MAP OF SAN FERNANDO CALIFORNIA

Source: San Fernando, California, Earthquake of 9 February 1971, CA Div. of Mines and Geology Bulletin, Map

Footnotes

1 California Division of Mines and Geology, "San Fernando, California Earthquake of 9 February 1971, Bulletin 196" (Sacramento, California, California Division of Mines and Geology Resources Building) p. 323.

2 Ibid, p. 325.

3 McClure, Frank E., Performance of Single Family Dwellings on the San Fernando Earthquake of February 9, 1971 (U.S. Department of Housing and Urban Development and U.S. Department of Commerce, May 1973) p. 10.

4 Op. cit. CA. Division of Mines, p. 334.

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Douty, Christopher M. "Disasters and Charity: Some Aspects of Cooperative Economic Behavior." American Economic Review, September 1972, LXII, pp. 580-590.

__________. The Economics of Localized Disasters: An Empirical Analysis of the 1906 Earthquake and Fire in San Francisco." Unpublished doctoral dissertation, Stanford University, 1969.

CHAPTER IV

STUDY OF MORTGAGE DEFAULTS FOLLOWING 1971 SAN FERNANDO EARTHQUAKE

The 1971 San Fernando earthquake presented a unique opportunity to study mortgage defaults associated with a natural disaster. In this chapter data sources used in the study to generate a sample of damaged properties will be discussed. The specific information that the authors were able to collect will be described. The main hypothesis of the study will be set forth. Finally, the construction of the net equity variable will be discussed.

DATA SOURCES

The most logical source of data on defaults was the various financial institutions that issued residential mortgages in the area affected by the earthquake. Previous research gave the authors an indication of which financial institutions had incurred the most defaults.[1] In this previous research, three savings and loan associations were identified as having had a significant number of loans on earthquake damaged properties.

In an effort to identify other affected financial institutions, letters were sent to all financial institutions that had residential lending experience in the greater Los Angeles area. The lenders addressed included savings and loans and commercial banks.

The responses indicated that no other financial institutions with offices in the greater Los Angeles area incurred more than a few defaults related to the earthquake. Thus, the authors concentrated their efforts on the three previously identified savings and loan associations. They are confident that the defaults that occurred at these three institutions are representative of all defaults that took place following the earthquake, and that the behavior of the lenders is typical of the behavior of other lenders. A second data component is on properties that experienced earthquake damage but that did not eventuate in default. Extensive data were also available on these types of properties and their borrowers from the same three lenders.

Loan File Data

Much of the data used in the empirical analysis of this study came from the loan files of the three savings and loan associations referred to above. Because of the unusual nature of the earthquake related defaults, the three savings and loan associations separated out and preserved the loan files of those residential mortgages which defaulted following the earthquake. This made the data more accessible to the authors. Under normal procedures, once a loan file is closed through payment or default, it is discarded after approximately seven years. Had the three savings and loan associations followed this procedure, the files of most of the defaulted mortgages would have been destroyed.

The three savings and loan associations also identified the loan files of those properties which were damaged by the earthquake, but whose mortgages did not go into default. The loan files of these mortgages were available if the mortgage was still outstanding or if the mortgage had been paid off in the last seven years.

We were able to obtain from one of the three savings and loan associations a file on Real Estate Owned (REO), which included information on properties damaged by the earthquake that became REO. The file proved useful in providing additional data for the analysis.

In addition to the usual information contained in loan files, additional data often was included because of the earthquake. This additional data included estimates of earthquake damages, appraisers reports on post-earthquake property values, rescheduling terms, and correspondence following the earthquake.

It is most important to note that the information taken from the loan files was de-personalized. That is the names of the individual mortgagors were not included. Thus none of the personal and financial information used in the analysis could ever be traced back to specific individuals and families.

It should also be noted that data gathering was not always exact. This holds for both "quantitative" and non-quantitative variables. For example, we recorded information on the income of borrowers at loan origination. During the time period for which these loans were originated it was not uncommon for lenders to discount the earnings of working wives in underwriting residential loans. When we went back over the loan records it was necessary to do a bit of reconstruction of information to be systematic and consistent (i.e., treat borrowers across lenders and over time similarly). Similar problems arose in trying to ascertain a variety of behavioral variables.

<u>Data Collection</u>

From the loan files and other sources mentioned above, a number of variables were extracted for the statistical analysis. The variables included the following:

A. <u>Default Information</u>

   1. Mortgages that went into default.

      a. foreclosures.

      b. deeds in lieu.

   2. Mortgages whose properties were damaged but did not go into default.

B. <u>Information on Mortgage</u>

   1. Date of mortgage origination.

   2. Amount of the mortgage at origination.

B. Information on Mortgage (Continued)

3. Interest rate of the mortgage.
4. Term of the mortgage.
5. Principal and interest payment of the mortgage.
6. Mortgage balance at earthquake.
7. Secondary financing.
8. Date of secondary financing.
9. Amount of secondary financing.

C. Personal Information on Mortgagor

1. Age of the mortgagor.
2. Marital status of the mortgagor.
3. Type of employment (occupation) of the mortgagor.
4. Number of years in occupation at mortgage origination date.
5. Number of years in California at mortgage origination date.
6. Number and ages of children.

D. Financial Information on Mortgagor

1. Monthly income of the mortgagor.
2. Assets of the mortgagor.
3. Net worth of the mortgagor.
4. Prior delinquency history of the mortgagor.

E. Property Information

1. Appraised value of the property at the time the mortgage was originated.
2. Value of the land at the time the mortgage was originated.
3. Construction type of property.
4. Estimated damage caused by the earthquake.

F. Other Information

1. Number of years between mortgage origination date and time of earthquake.

F. Other Information (Continued)

2. Divorces subsequent to loan origination.
3. Financial problems following earthquake.
4. Emotional problems following earthquake.
5. Relocations immediately preceding or following the earthquake.
6. Other special considerations.

One important piece of data that was not available in the loan files was the value of the house just prior to the earthquake. The value is critical since it is needed to calculate the net equity of the property following the earthquake. The procedure used for this calculation is discussed below.

Sample of Damaged Properties

The three savings and loan associations identified earthquake damaged properties on which they held mortgages. The total number of such identified properties is 510. From this total set of properties, complete information was available on a smaller set of approximately 320. Depending on the actual analysis or tests performed, the number of observations could vary between three hundred and five hundred. For many questions there were approximately 370 usable observations.

NET EQUITY HYPOTHESIS

It is a basic hypothesis of this study that net equity is a principal determinant of the default decision. Indeed, one would go further and say that net equity has such a high probability of being important that the real question is whether other variables add to the explanation of the default decision. It is helpful to begin the analysis with an examination of the simple relationship between net equity and default.

Net equity is defined as the property value less the outstanding mortgage balance. More precisely, the property value would be the net proceeds gained from the sale of the property, i.e., sales price less transaction costs (real estate commissions, closing costs, etc.).

When net equity is positive, a homeowner wishing to dispose of his property is much more inclined to sell the property rather than default. Selling the property allows the homeowner to acquire the positive equity value, whereas default would allow that value to pass to the financial institution. On the other hand, when the net equity is negative, the inclination for the property owner is to default and pass this negative value onto the financial institution.

Assuming a proper appraisal and an initial downpayment, the net equity at the point of the initial sale is positive. If property values remain constant or increase and no additional financing is obtained the net equity will increase over time (see Figure IV-1). Net equity decreases when property values fall and/or mortgage balances increase (additional financing or refinancing). Once net equity falls below a certain value, any further downward movement would in most cases be caused by drops in property values. That is, it is highly unlikely that a financial institution would offer additional financing once net equity falls below a certain minimum value.

Defaults following a natural disaster are set in motion when damage to the property decreases the property value and hence the net equity (see Figure IV-2). Existing insurance is a major mitigating factor because it can be used to restore the property value and the net equity. The virtual lack of earthquake insurance on residential property is undoubtedly a key factor in the large number of defaults following the 1971 San Fernando earthquake.

FIGURE IV-1

Net Equity Without Natural Disaster

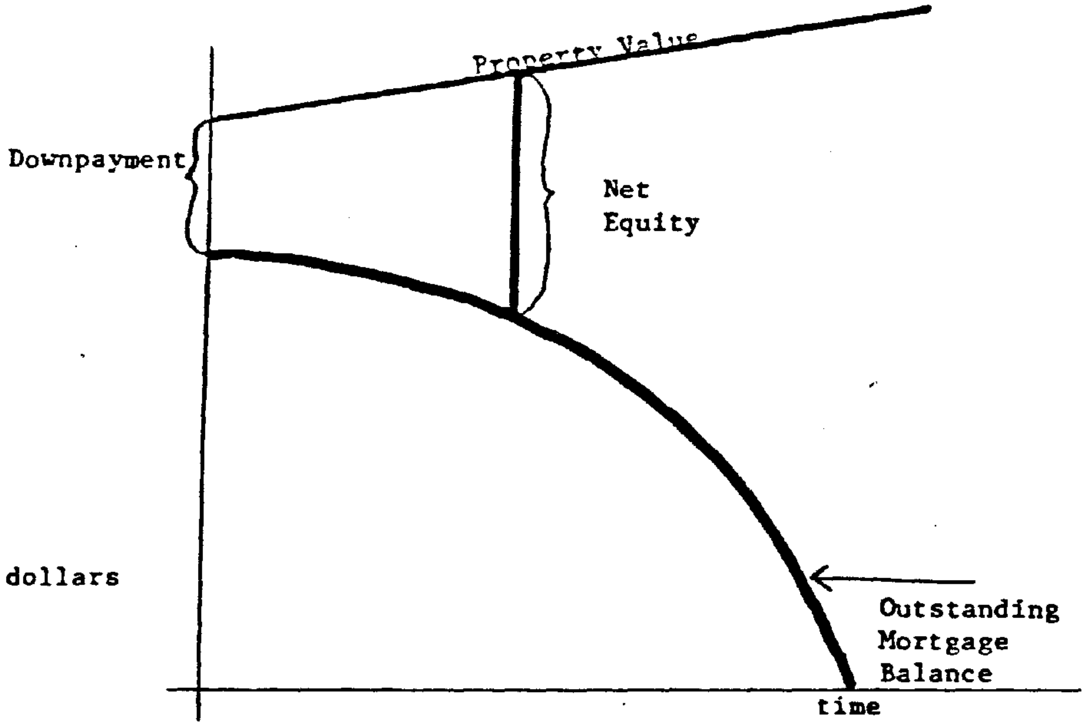
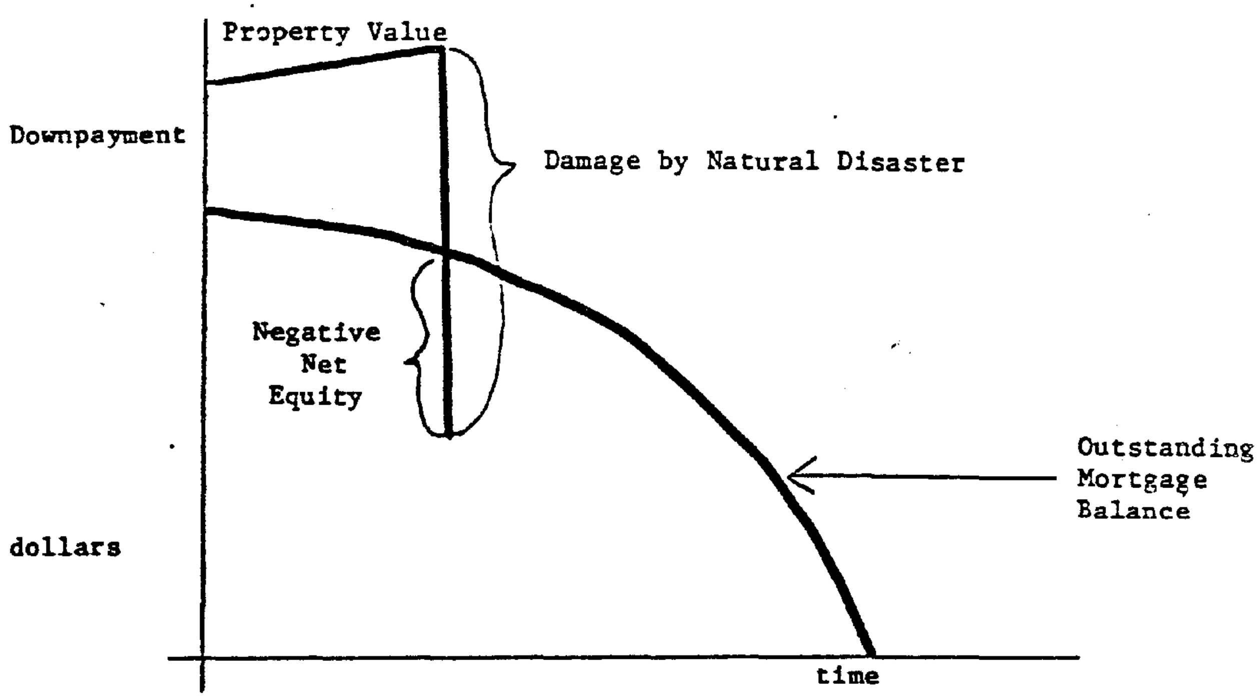


FIGURE IV-2

Net Equity With Natural Disaster



THE CONSTRUCTION OF THE NET EQUITY VARIABLE

It is one thing to talk about net equity and its hypothesized effects, but quite another to fashion a specific variable for net equity. Conceptually, net equity for a residence is the difference between the value of the property and any liens or debt against the property. The practical problems of specification involve both property value and debt.

Property value can be viewed as either the value put on a property by the market or as the value put on the property by its owner. The value that should lead a property owner to react to any stimulus would be the value as perceived by that owner. This value is obviously a very difficult one for a property owner to quantify, much less for an observer to estimate. The main problem for the property owner in quantifying property value is that the value is inherently an uncertain amount. There really is no specific value for a given property as much as there is a range of possible values. The only point value of a property is that resulting from a sale. From the outside observer's perspective the problem is that of approximating what the owner perceives as the property value, which in turn is a function of what the property would bring in the market. As a second best solution, the observer can at least estimate the market value of a property. The estimated market value is really a proxy for the subjective value of the owner.

In the case of properties involved in a natural disaster the problems of value estimation go even deeper. Residences damaged by the event would have value affected both by the physical damage experienced (as perceived by the owner) as well as by any neighborhood effects on value resulting from the disaster. The neighborhood effect would come about for three reasons. First, for some types of disasters (both natural and man made), the fear of a repeat of a similar event would depress neighborhood property values--at least in the short run, if not permanently. Second, it is quite possible that damage to certain properties will lead to a decline in the value of neighboring properties, because the neighborhood will be blighted by the damage. This would be especially true if there was property abandonment. Third, it is possible that in the short-run there could be an increase in property values. This would be the outcome in a community that was sufficiently small relative to the disaster that the event produced an excess demand for housing.

The estimation of damage is, if anything, even more difficult than the estimation of the pre-disaster property value itself. The effects of events on neighborhood property values are also quite difficult to quantify, and may differ appreciably from one area to another and change radically from one month to the next.

For estimates of property value in this study we combined data on estimated damages with data on estimated property value as of approximately January 1971. The damage estimates were obtained from loan file records of the lenders.

The three lenders differed in the manner in which they obtained damage estimates. The lender with the smallest portion of loans in the sample obtained damage estimates from property examinations done by office personnel. This damage survey was done within one week of the earthquake and the estimates were in ranges of damage rather than precise amounts. The damage categories were: less than $2,500; $2,500 to $10,000; and, more than $10,000. On a few properties more precise estimates from contractors were subsequently obtained.

The other two lenders had specific damage estimates. These estimates were generally obtained from lender staff appraisers and from contractors. The lender staff estimates were very early estimates, done within two weeks of the earthquake. In the case of the largest lender we were often able to compare damage estimates for a given property. Staff estimates could be compared with estimates of at least one contractor. It was common for damage estimates to vary considerably, and without a particular bias. Some early estimates of

$10,000 or $12,000 were subsequently diagnosed as total losses (structural loss of $30,000 or more) and some were subsequently revised downward to $6,000 or $7,000.

The pre-earthquake property values were difficult to estimate. We began with property value at the point of loan origination. We believe that these numbers are accurate descriptions of origination value. From this point forward, two major difficulties arise. First, some properties underwent improvements and additions to the structure or the lot. The most common such improvement seems to have been the construction of a swimming pool. Second, different areas of the San Fernando Valley experienced different rates of appreciation during the late 1960s and early 1970s.

With respect to the additions and improvements matter, we had very little information on such changes in value. Occasionally we were able to determine from loan file information that a second mortgage had been negotiated (with a lender different from the originator of the first mortgage) for the purpose of something as specific as the construction of a swimming pool. This kind of information was available infrequently, and there is little reason to believe that the number of instances we were able to document really represented all of the seconds on the properties we were following. Of equal importance, if a family added to the value of a property but at the same time added to the debt against the property, the impact on net equity would only be the difference between the two figures. Going forward, net equity change would depend on the rate of payoff of the second mortgage. Consequently, we decided to ignore both the improvement and the junior mortgage in our estimation of net equity.[2]

With respect to neighborhood values, we were industrious. An initial examination of origination dates and price indexes clearly indicated that some changes in property value would have occurred for many of the properties in our sample. For example, between 1967 and 1971, a constant characteristics price index for the Western States increased by 15 percent, and over half of the homes in the sample (52 percent) had mortgage origgnination dates of 1967 or earlier. But data for the Western States is far too rough to represent a small portion of one state, and examination of some San Fernando area price data indicated that it was not very similar to the broader data.[3]

In order to better understand local conditions we collected information on housing characteristics and prices for approximately 850 transactions in the area affected by the San Fernando earthquake, for the time period 1968-1971.[4] These data were used to estimate price indexes for four are of the Valley. The method of index construction was as follows.

Regression equations were run for each of the four geographical areas with transactions value (i.e., sales price) as the dependent variable. The independent variables included the square footage of the building, the square footage of the lot, the presence or absence of a swimming pool (a dummy variable), the presence or absence of central air conditioning (a dummy variable), age of the structure, condition of the structure, and the number of bathrooms.[5] In addition, dummy variables were included for six month periods from the second half of 1968 (1968:2) through the first half of 1971 (1971:1). From the coefficients of the variables, a transactions value was estimated for 1968:1, and the date dummies were used to estimate a transactions value for 1968:2 through 1971:1. This procedure was repeated for each of the four geographical areas, as well as for all areas combined. The all combined areas equation was used to create an index for the few properties included in our damage sample that were not in one of the other four designated areas.

The estimated transactions values were used to fashion an hedonic price index or constant characteristics price index for the 1968-1971 period. For the purpose of the price index, semi-annual values for 1968-1970 were combined in order to derive an annual price index. The values of the coefficients of the dummy variables are displayed in Table IV-1. The estimated transactions values are shown as Table IV-2.

For the years 1964 to 1968, price changes were taken from the "Residential Research Report" of the Residential Research Committee of Southern California (various issues). For these years it was assumed that all areas of the San Fernando Valley experienced similar rates of property value change.

For properties on which the mortgage origination was earlier than 1964, we assumed that no change in property value took place from origination to 1964.

The distribution of origination dates on the loans in the sample was as follows. Approximately 5 percent of the loans used in the default analysis (described below) were pre-1964 originations, 42 percent were originated from 1964 to 1967, and 52 percent were originated after 1967.

It is rather interesting to note that the rate of property appreciation between 1968 and 1971 in the different geographical areas are substantially different. Also it is of special interest that the data reveal that there was little, if any, appreciation between the first half of 1970 and the first half of 1971. Only the relatively low valued homes located in the city of San Fernando seem to have risen in value very much in the half-year prior to the earthquake. Hence, one might describe the overall housing market in the San Fernando Valley as somewhat depressed at the time of the earthquake.

The price indexes used in the study are converted into appreciation indexes, and are shown in Table IV-3. The property appreciation factors can be combined with outstanding loan balance to estimate net equity prior to the earthquake.

In order to estimate post-quake net equity one must have an estimate of damage. Our damage estimates come from the loan files and records of the lenders. Damage estimates are extremely sensitive and unreliable data. Our estimates come from loan records of lenders, and are a combination of field apprais-

Table IV-1

Information Used to Create Area Price Indexes

Regression Coefficients on DATE DUMMY,
From Regression of SALEPRI on Housing Characteristics
(t statistic shown below coefficient)

Date Dummy	All Areas	Sylmar	San Fernando	Lakeview Terrace	Grenada Hills
1968:2	1.356 (0.29)	-2.094 (-0.32)	5.351 0.51)	1.974 (0.15)	3.909 (0.45)
1969:1	6.491 (1.44)	7.339 (1.13)	4.372 (0.46)	-0.663 (-0.05)	13.443 (1.56)
1969:2	12.409 (2.60)	18.158 (2.66)	6.681 (0.70)	-3.388 (-0.20)	20.399 (2.04)
1970:1	21.543 (4.54)	23,972 (3.55)	14.243 (1.51)	18.112 (1.08)	40.295 (3.93)
1970:2	22.489 (4.61)	26.630 (3.76)	22.048 (2.210	13.097 (0.95)	31.297 (3.15)
1971:1	22.989 (4.35)	27.985 (3.47)	19.501 (1.80)	10.953 (0.63)	33.078 (3.42)
R^2 for entire equation	0.88	0.91	0.75	0.80	0.83
N of cases	845	328	253	60	204

Table IV-2

Calculated House Value from Estimated Equations

Date Dummy	All Areas	Sylmar	San Fernando	Lakeview Terrace	Grenada Hills
1968:1	$24,492	$25,501	$19,522	$25,896	$28,132
1968:2	24,628	25,292	20,057	26,093	28,523
1969:1	25,141	26,235	19,959	25,830	29,476
1969:2	25,733	27,317	20,190	25,557	30,127
1970:1	26,646	27,898	20,949	27,707	32,162
1970:2	26,741	28,164	21,727	27,206	31,262
1971:1	26,791	28,300	21,472	26,991	31,440

Table IV-3

Appreciation Indexes for San Fernando
Valley Area Properties

Date of Origination	All Areas (Other)	Sylmar	San Fernando	Lakeview Terrace	Grenada Hills
1971	1.0000	1.0000	1.0000	1.0000	1.0000
1970	1.0037	1.0096	1.0064	0.9830	0.9914
1969	1.0532	1.0569	1.0696	1.0505	1.0542
1968	1.0908	1.1143	1.0850	1.0383	1.1099
1967	1.0989	1.1226	1.0931	1.0460	1.1182
1966	1.1072	1.1311	1.1013	1.0539	1.1266
1965	1.1241	1.1483	1.1181	1.0700	1.1438
1964 or before	1.1876	1.2131	1.1813	1.1304	1.2084

Note:

1968-1970, calculated from regressions of sales price on property characteristics. Average house price is calculated by year and annual index values are calculated from average house prices.

1967 and earlier, based on "Residential Research Report." Residential Research Committee of Southern California. Various issues.

als and contractor repair estimates. In virtually any disaster one finds that damage estimates (in the aggregate and with respect to individual properties) range widely. We can do little more than report that these estimates are probably shaky, and they go ahead and adopt them as point values (without a confidence band).

FOOTNOTES

1. Kaplan, Smith and Associates, Geographic Mortgage Risk: An Empirical Analysis of the Federal Home Loan Mortgage Corporation's Portfolio, A Report Prepared for the Federal Home Loan Mortgage Corporations with D. Anderson and M. Weinrobe serving as principal consultants. (Washington, D.C.: Kaplan, Smith, and Associates, 1978).

2. We did include a binary variable for the statistical analysis indicating whether or not junior financing existed.

3. The San Fernando data were based on a small sample and we do not believe they are sufficiently reliable to be the basis for our property value calculations.

4. The single family residential sales data were very generously supplied by the SREA Market Data Center, Inc. All transactions were identified by area map codes, and transactions used in the regression equations were selected from coded areas of known earthquake damage. That is, all transactions chosen were in one of four areas in which the earthquake would subsequently do considerable damage.

5. Other variables were used in trial regression runs, but the above mentioned were those in the final variable list.

CHAPTER V

RESULTS OF STATISTICAL ANALYSIS

The results of the statistical analysis will be presented in this chapter. In the first section, a general presentation of the data will be made. In the second section, the relationship between net equty and default will be discussed with particular emphasis on the differences between foreclosures and deeds in lieu of foreclosure. The final section will be devoted to the empirical default analysis where all the studied variables will be examined using discriminant analysis and probit models.

GENERAL PRESENTATION OF THE DATA

Before presenting the analysis of the default process, a more general discussion of the data will be made. To the authors' knowledge, this is the first time that specific default-related data have been collected following a natural disaster. Because of the uniqueness of this data set, various general statistics will be presented and discussed.

The Number of Defaults

The total number of earthquake-related defaults incurred by the three savings and loan associations was 134. The remainder of the sample did not go into default. Of the 134 defaults, 77 were deeds in lieu of foreclosure and 57 were foreclosures.

Earthquake-related defaults are defined as those defaults which occurred within one year of the earthquake to those mortgagors whose properties were damaged by the earthquake. One might raise the question of whether some mortgagors might not have defaulted regardless of the earthquake.

In one letter to area lenders seeking additional data on earthquake defaults, we also asked for information on defaults unrelated to the earthquake. The uniform response was that residential mortgage default was not a problem at this time. In Table V-1 , data are exhibited on foreclosures at FSLIC insured savings and loan associations. It is clear that foreclosures were not a major or common occurrence at the time of the earthquake. In early 1971 the economy was recovering from a mild recession, and this had affected Southern California, but it did not have major effects on mortgage default. Property values had been increasing up to and through 1970 and this no doubt had the usual effect of protecting lenders against default.

The authors are confident that the primary motivations and rational of the studied group of mortgagors were related to the earthquake.

Timing of the Defaults

All the defaults studied occurred within a year of the earthquake. Table V-2 shows the number of defaults, broken into deeds in lieu and foreclosures, related to the timing of the defaults, i.e., the number of months between the earthquake and the acquisition of the property. Note that only 112 of the 134 defaults are included. Dates were unavailable for the other 22 defaults.

As can be seen, there is a fairly even distribution of defaults over the months following the earthquake. The larger number of deeds in lieu tended to be concentrated in the early portion of the period, while the larger number of foreclosures occurred in the latter portion. This observation is understandable given the fact that foreclosures require certain time consuming procedures while deeds in lieu can be executed within a short period of time.

TABLE V-1

FORECLOSURES OF FSLIC INSURED SAVINGS AND LOAN ASSOCIATIONS
LA, LONG BEACH, CALIFORNIA BY QUARTER

TOTAL MORTGAGE LOAN BALANCES ($ THOUSANDS)

	Foreclosure Rate (in percent)
1966-I	0.71%
II	0.56
III	0.66
IV	0.71
1967-I	0.71
II	0.74
III	0.65
IV	0.47
1968-I	0.44
II	0.34
III	0.26
IV	0.19
1969-I	0.15
II	0.15
III	0.10
IV	0.11
1970-I	0.11
II	0.11
III	0.11
IV	0.08
1971-I	0.08
II	0.21
III	0.22
IV	0.11

TABLE V-2

BREAKDOWN OF DEFAULTS BY DEEDS IN LIEU
AND FORECLOSURE

# of Months Between Earthquake and Property Acquisition	Deeds in Lieu	Foreclosures
1	0	0
2	10	2
3	12	0
4	11	1
5	9	6
6	8	5
7	5	4
8	4	4
9	10	5
10	1	6
11	2	7
Total	72	40

Origination Dates of the Mortgages

Table V-3 shows the mortgages examined in this study categorized by the year in which the mortgage was originated. Most of the mortgages were originated within a few years before the earthquake occurred. Over 50 percent were originated within three years of the earthquake (1968 and after), 90 percent originated within six years (1965 and after). This time period also represents the time the mortgagors had been in their specific homes when the earthquake occurred. As far as we are aware, none of the mortgages involved refinancing.

Mortgage Interest Rates and Terms

Table V-4 shows the mortgage interest rates of the damaged properties. About 60% of the rates are between six and seven percent. The five to six year period prior to the earthquake was one of relatively stable interest rates. This stability extended throughout the months following the earthquake. Given these observations, interest rates are not expected to be a key causal factor in the mortgagors' decisions to default. The vast majority of the mortgages were written with a term to maturity of 29 or 30 years, so the term of the mortgage will also be expected to have little effect.

Personal Characteristics of the Mortgagors

The group of property owners, whose homes incurred earthquake damage, appeared to be a relatively representative group of the general Southern California population. Two-thirds of the mortgagors were between 25 and 40 years of age when they took out their mortgages. Ninety-four percent were married. Eighty-four percent had children, with one to three children being the most common number of offspring.

TABLE V-3

MORTGAGES BY YEAR OF ORIGINATION

Year Loan Originated	Frequency	%
1957	1	3
1958	1	3
1959	4	1
1960	2	1
1961	3	1
1962	1	3
1963	7	2
1964	20	5
1965	30	8
1966	43	11
1967	69	18
1968	70	19
1969	84	22
1970	42	11
	377	100%*

*Numbers do not total to 100% due to rounding.

TABLE V-4

MORTGAGE INTEREST RATE OF DAMAGED PROPERTIES

Interest Rate	# of Mortgagors	# of Mortgagors
5.25	1	.3
5.50	2	.6
5.75	12	4
6.00	48	15
6.25	73	22
6.50	36	11
6.60	8	2
6.75	42	13
6.90	30	9
7.00	9	3
7.25	7	2
7.50	24	7
7.75	11	3
8.00	4	1
8.25	10	3
8.50	4	1
8.75	8	2
	329	100*

*Numbers do not total 100% due to rounding.

Table V-5 shows a breakdown of the occupations of the mortgagors. Over two-thirds had been in their occupations for three years or more (at loan origination) so a certain degree of job stability existed among the studied group.

Table V-6 shows the number of years that the mortgagors had been in California at the mortgage origination date. Over half had been in California seven years or more. Some thirty percent had been there over 10 years. Note that these are minimum numbers, i.e., from the loan files, the authors could ascertain that a mortgagor had been in California in at least a certain number of years; but the mortgagors may have indeed been there longer. In addition, when the time period between the mortgage origination date and the earthquake is added in, the total time of California residency at February, 1971, is longer by one to six years.

Financial Characteristics of the Mortgagors

Two key financial characteristics of any group of individuals are earnings and wealth. In the present case of mortgagors with damaged properties, monthly income and net worth were the two key financial statistics that were collected.

Chart V-1 displays the distribution of monthly income of the mortgagors at the time the mortgage was originated. The majority (72 percent) of mortgagors' incomes (of husband and wife combined) are concentrated between $700 and $1,600 per month. The average income of all mortgagors is $1,308 while the median monthly income is $1,250.

Chart V-2 displays the distribution of net worth of the mortgagors at the time the mortgage was originated. Over 70 percent of the net worths are $30,000 or under. The average net worth of $30,855 is distorted by seven mortgagors with net worths over $100,000, and ranging up to $1,000,000. The median net worth of $20,000 is more representative of the sample.

TABLE V-5

OCCUPATIONS OF MORTGAGORS

Occupation	Frequency	%
Self-employed	50	15
Engineers	38	11
Construction	14	4
Unskilled	63	19
Skilled	23	7
Low Level Managers	51	15
Upper-Middle Level Managers	54	16
Other Professionals	39	12
	332	100*

*Numbers do not total to 100% due to rounding.

TABLE V-6

NUMBER OF YEARS IN CALIFORNIA BEFORE LOAN DATE

# of Years in CA Before Loan Date	Mortgagors	%
0-1	21	6
2-3	55	17
4-5	44	13
6-7	46	14
8-9	32	10
10-11	56	17
12-13	20	6
14-15	15	5
16-17	11	3
18-19	5	2
20-21	12	4
22-23	2	.6
24-25	3	1
26-27	2	.6
28-29	1	.3
30 and over	8	2
	333	100*

*Total do not add to 100% due to rounding.

CHART V-1

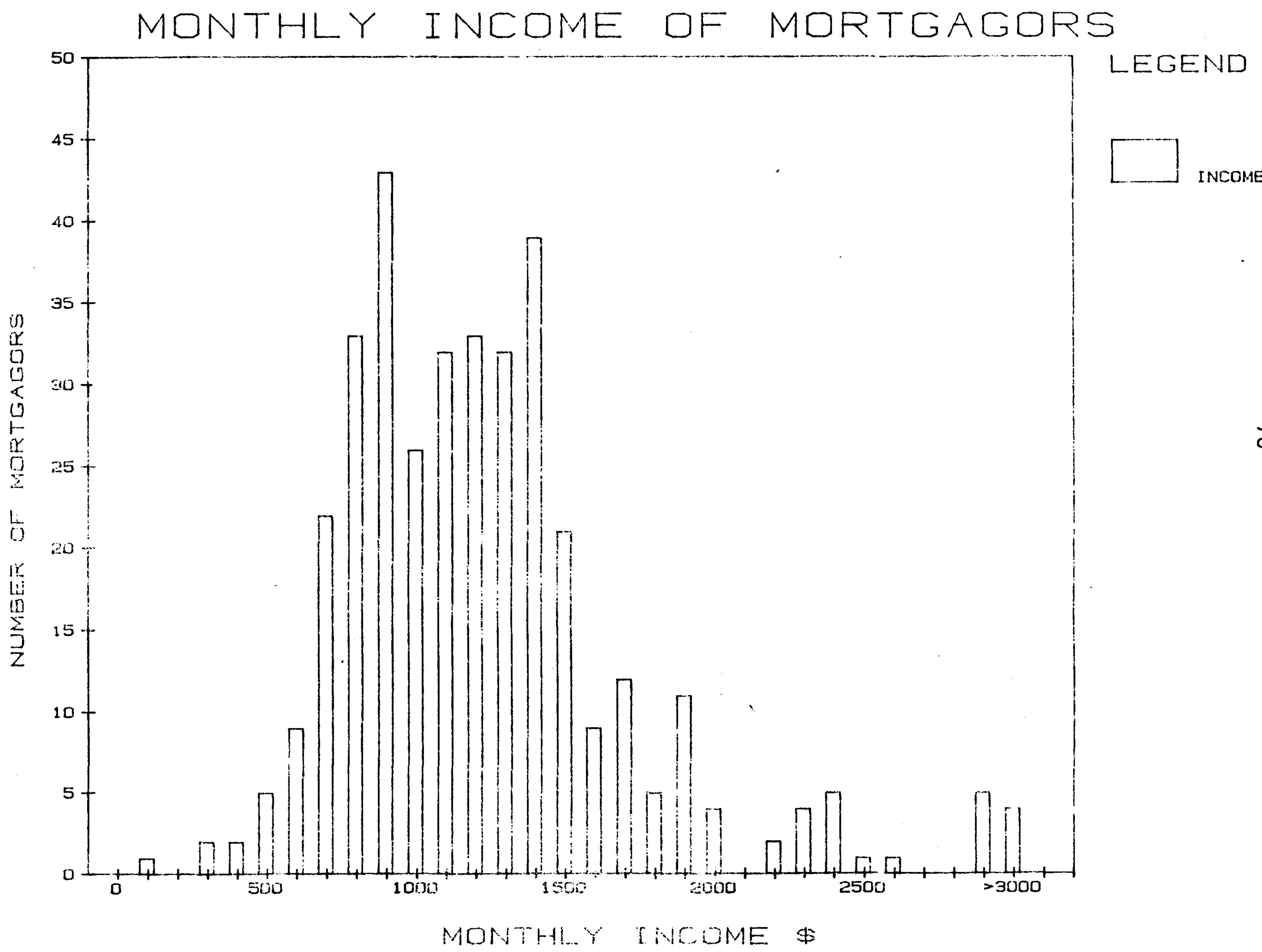
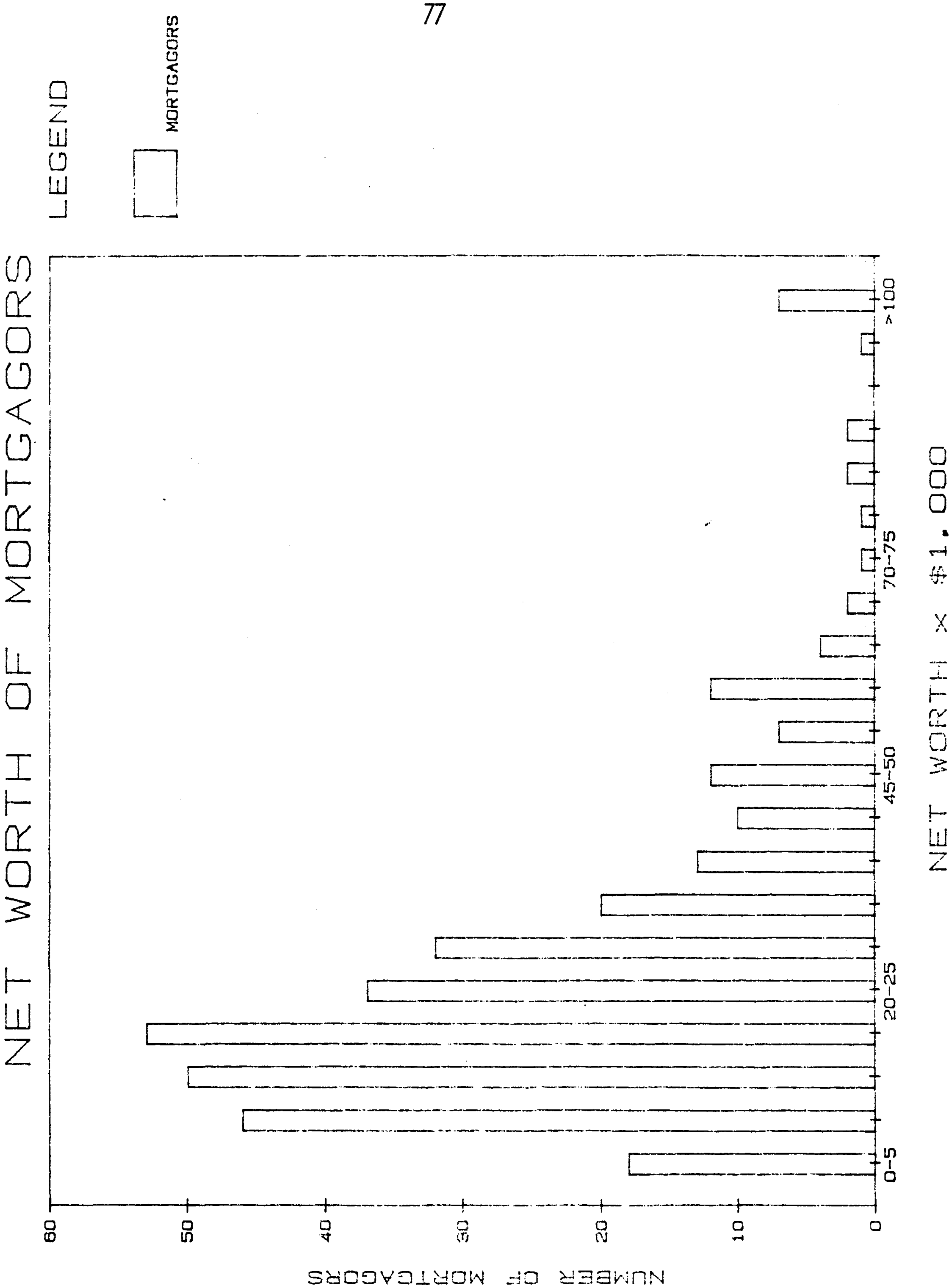

MONTHLY INCOME OF MORTGAGORS
LEGEND
INCOME
NUMBER OF MORTGAGORS
0
5
10
15
20
25
30
35
40
45
50
0
500
1000
1500
2000
2500
>3000
MONTHLY INCOME $

CHART V-2


NET WORTH OF MORTGAGORS
LEGEND
MORTGAGORS
NUMBER OF MORTGAGORS
0
10
20
30
40
50
60
0-5
20-25
45-50
70-75
>100
NET WORTH x $1.000

Ideally it would be nice to have monthly income and net worth at the time of the earthquake rather than when the mortgage was originated. If one assumes that inflation and monthly incomes increased at about the same rate, the real monthly income of the borrower would not be changed. This, however, would be a rather tenuous assumption. Little can be done with the net worth figure except to recognize its possible limitations.

Property Values and Construction Types

Chart V-3 shows the values (including land value) of damaged properties just before the earthquake. These values were arrived at by taking the appraisal at the mortgage origination date and adjusting it by a price index.* As can be seen, most of the values (70 percent) were concentrated between $27,000 and $51,000. The average value of homes was almost $39,000 with the median value at about $38,000.

Table V-7 categorizes the various construction types of residential properties. Virtually all the homes were of wood frame construction, which is characteristic of all California. Most of the homes were relatively new, having been built between 1965 and 1970. Many of the dwellings were tract homes, i.e., parts of large development plans.

Dollar Amounts of Damages

The three savings and loan associations collected data on the earthquake - caused property damages of their mortgagors. Most of the data was in the form of specific estimates from contractors. Some of the data originated from estimates made by savings and loan personnel. Certain inconsistencies result from the fact that the financial institutions were not required to collect damage

CHART V-3

PROPERTY VALUES JUST BEFORE EARTHQUAKE

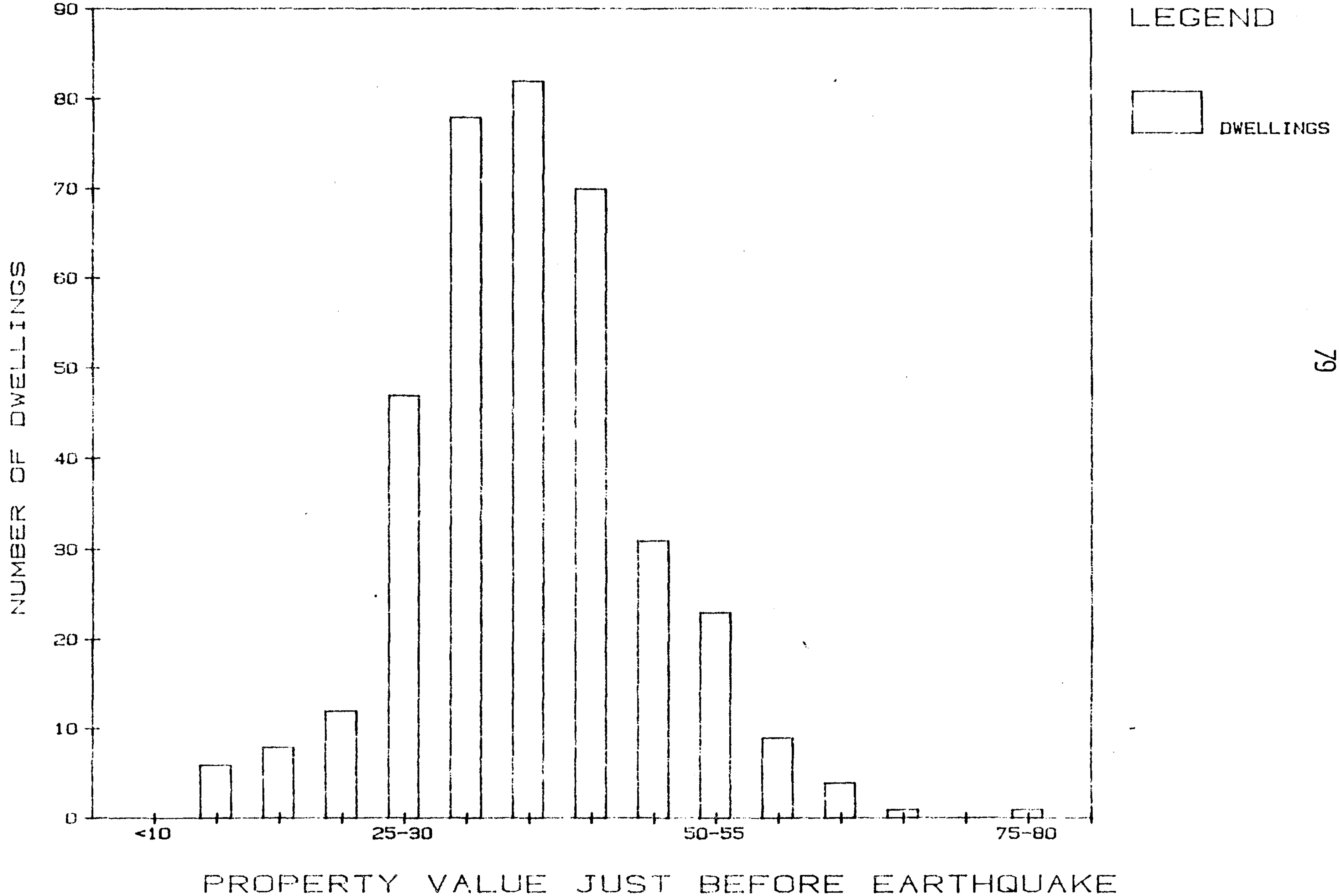


TABLE V-7

CONSTRUCTION TYPES OF RESIDENTIAL PROPERTIES

Outside Veneer	Foundation	Walls	# of Homes
Stone, brick	Concrete slab	Dry wall/ sheet rock	25
Stone, brick	Concrete slab	Paint and plaster	63
Stone, brick	Stone, stone and concrete slab	Dry wall, sheet rock	8
Stone, brick	Stone, stone and concrete slab	Paint and plaster	46
All other	Concrete slab	Drywall, sheet rock	63
All other	Concrete slab	Paint and plaster	100
All other	Stone, stone and concrete slab	Dry wall, sheet rock	4
All other	Stone, stone and concrete slab	Paint and plaster	38
			344

information nor were they obligated to follow any particular form. In the case of one lender, property damage estimates were often reported in categories. We have used the midpoint of each category as our measure of damage. This S&L had the smallest number of loans in our sample.

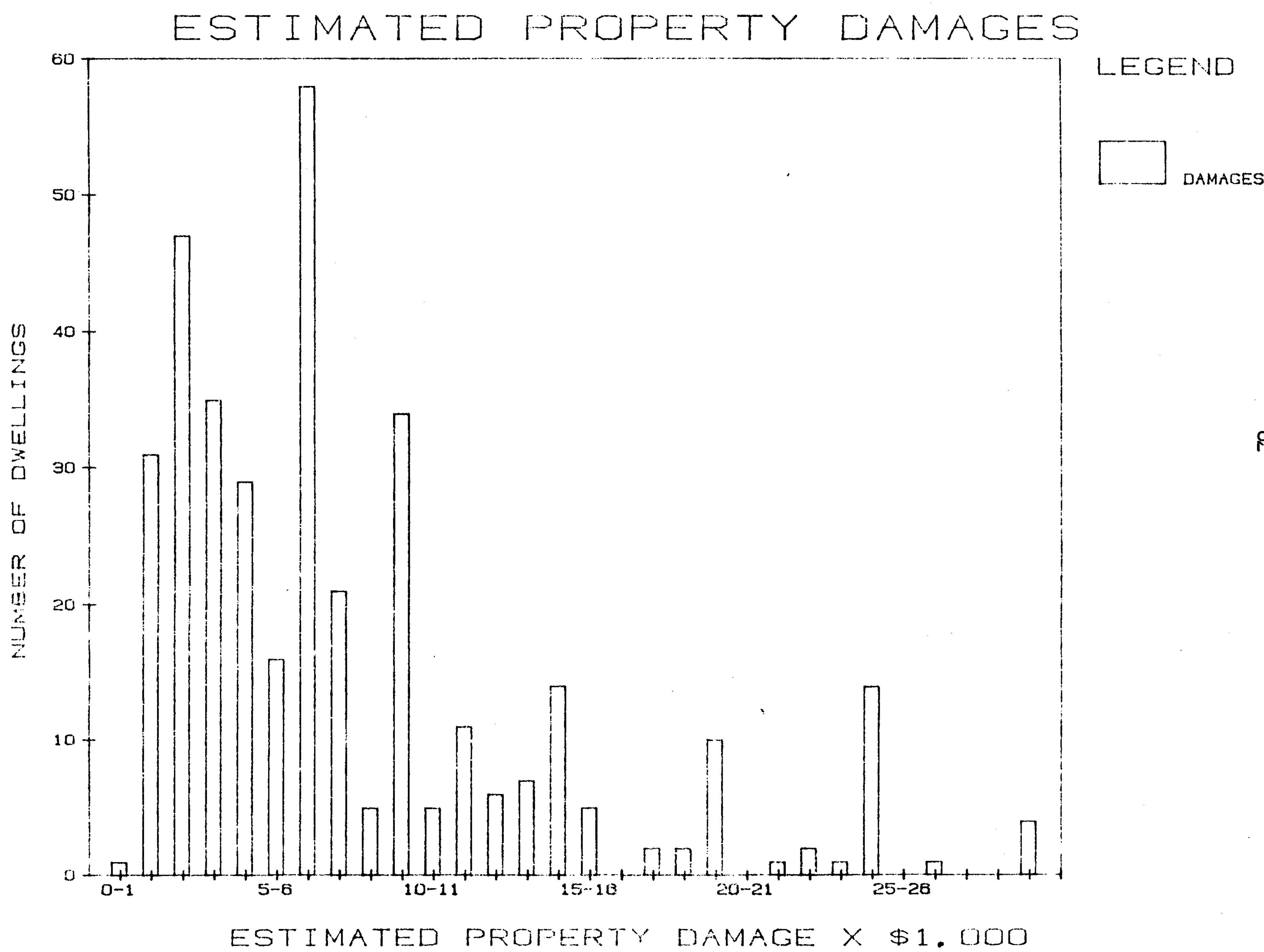
Chart V-4 is constructed to illustrate the distribution of property damages. As can be seen, most of the dwellings incurred property damages less than $10,000. Of the 372 dwellings in the sample with damage data, 287 (77 percent) reported damages under this amount. The mean of damages is $8,112 per damaged dwelling and the median is $7,000 per dwelling.

Relation of Damages to Different Variables

Chart V-5 depicts the relation between damages and the outstanding mortgage balance at the time of the loss. This chart was constructed using the same data set employed in Chart V-4. It allows one to gain some idea of how monthly mortgage payments might be increased due to the earthquake damage. For instance, assume a pre-earthquake outstanding mortgage balance is $20,000, and consider a case where uninsured earthquake damages were equal to $10,000. If one had to borrow $10,000 to pay for earthquake losses and the terms of the loan were the same as the original mortgage (same interest and maturity date), then monthly payments of principal and interest would increase by 50 percent. Of course individuals would probably use other sources besides borrowed funds to make repairs and it is unlikely that the terms would be the same as the original loan. Yet the data in Chart V-5 can lend some insight into the potential financial burden that the typical damaged property owner would face.

Damages as a percentage of pre-earthquake outstanding mortgage balances were concentrated between 0 and 50 percent. For the 372 damaged properties in the sample, the average damage to mortgage balance ratio was 35 percent. For those individuals without adequate personal savings, a substantial increase in

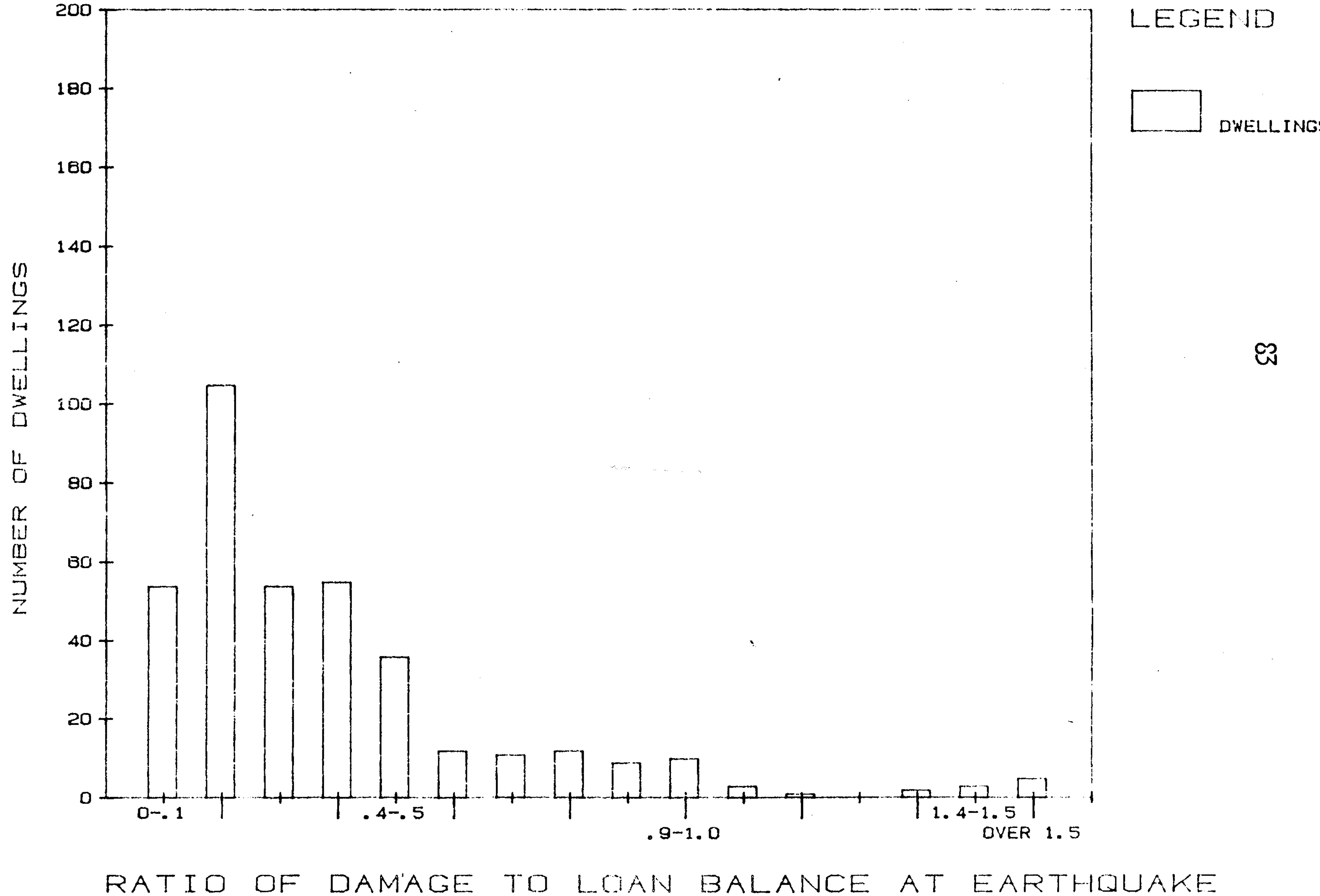
CHART V-4



ESTIMATED PROPERTY DAMAGES
LEGEND
DAMAGES
NUMBER OF DWELLINGS
0
10
20
30
40
50
60
0-1
5-6
10-11
15-16
20-21
25-26
ESTIMATED PROPERTY DAMAGE X $1,000

CHART V-5

RELATION BETWEEN DAMAGE AND OUTSTANDING MORTGAGE BALANCE



total mortgage payments as a percentage of disposable income could be expected. Even if low interest SBA disaster loan funds were obtained to repair the damage, the typical property owner would incur a significant increase in total mortgage payments (principle and interest) to keep and repair the property.

Another measure of the relative severity of earthquake damage is the ratio of damage to the property value. In Chart V-6 that information is displayed. As can be seen in Chart V-6, over 90 percent (336 of 372) of the damaged properties had damages ranging up to 50 percent of the pre-earthquake value of the property. The average percentage of damages to property value was 22 percent.

Since the property values include the land value, these damage percentages underestimate the degree of damage to the dwelling itself. For instance, if land value is assumed to be 25 percent of the property value, the damage ratios in Chart V-6 would need to be increased by a third to produce damage percentages to the dwelling.*

We constructed Chart V-7 to illustrate the adjusted damage ratios. The adjusted ratios reveal that 90% of the dwellings had damages up to 67 percent of the dwelling value. The average percentage of damage to dwelling value was 29 percent.

Chart V-8 plots the damage percentages in Chart V-6 in a different form. It relates the extent of damage to the percentage of properties incurring a particular damage level. A large percentage of the damage would be classified as minor to moderate. For instance 50 percent of the properties suffered damage amounting to 17 percent of the property value or less. Only 10% of the properties

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*In almost all cases damage was limited to the structure. There were a few cases, however, where there was also damage to the land. In one case the lot was actually cracked, and the post-earthquake value of the lot was estimated at five hundred dollars.

CHART V-6

RATIO OF DAMAGE TO PROPERTY VALUE

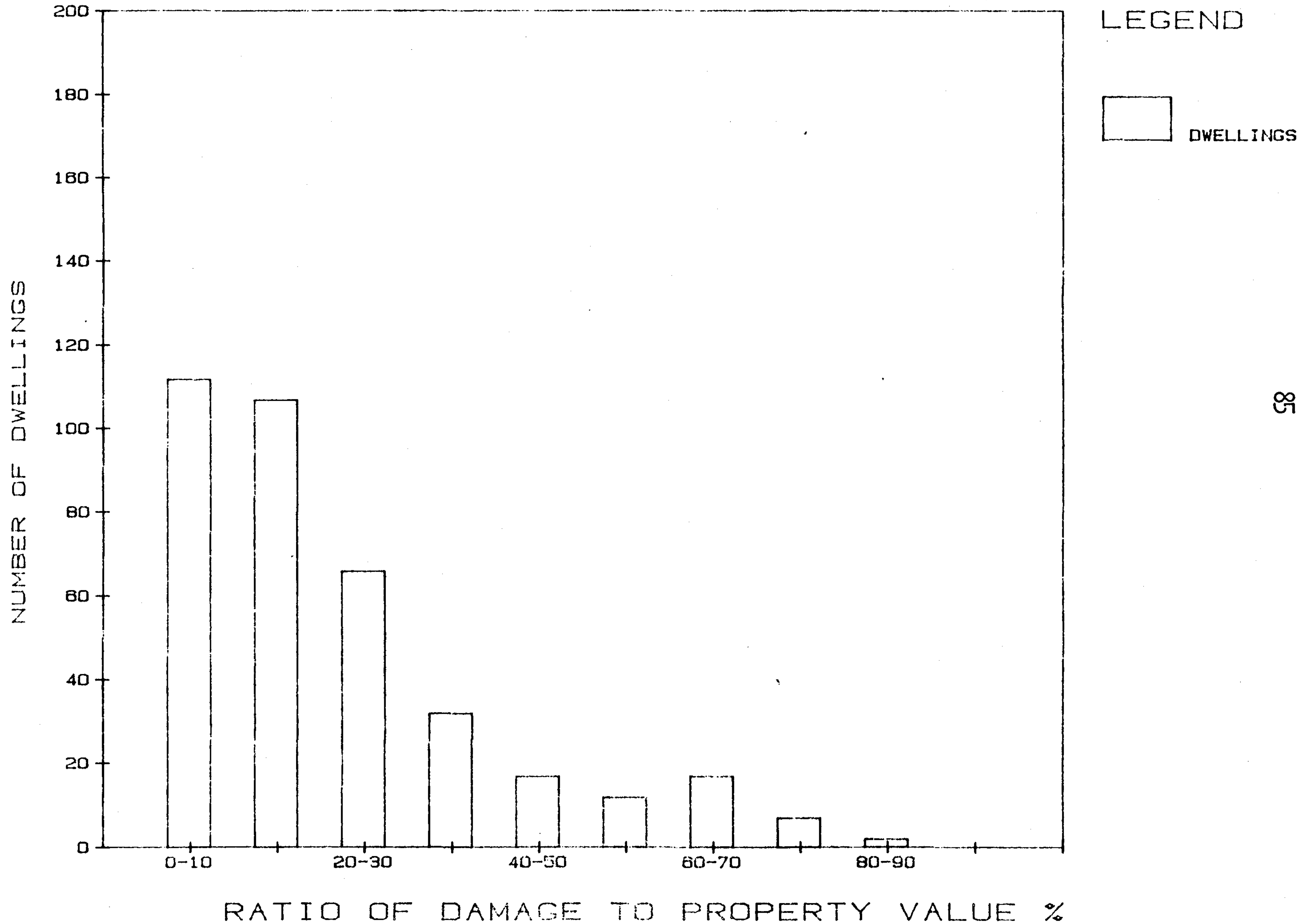


CHART V-7

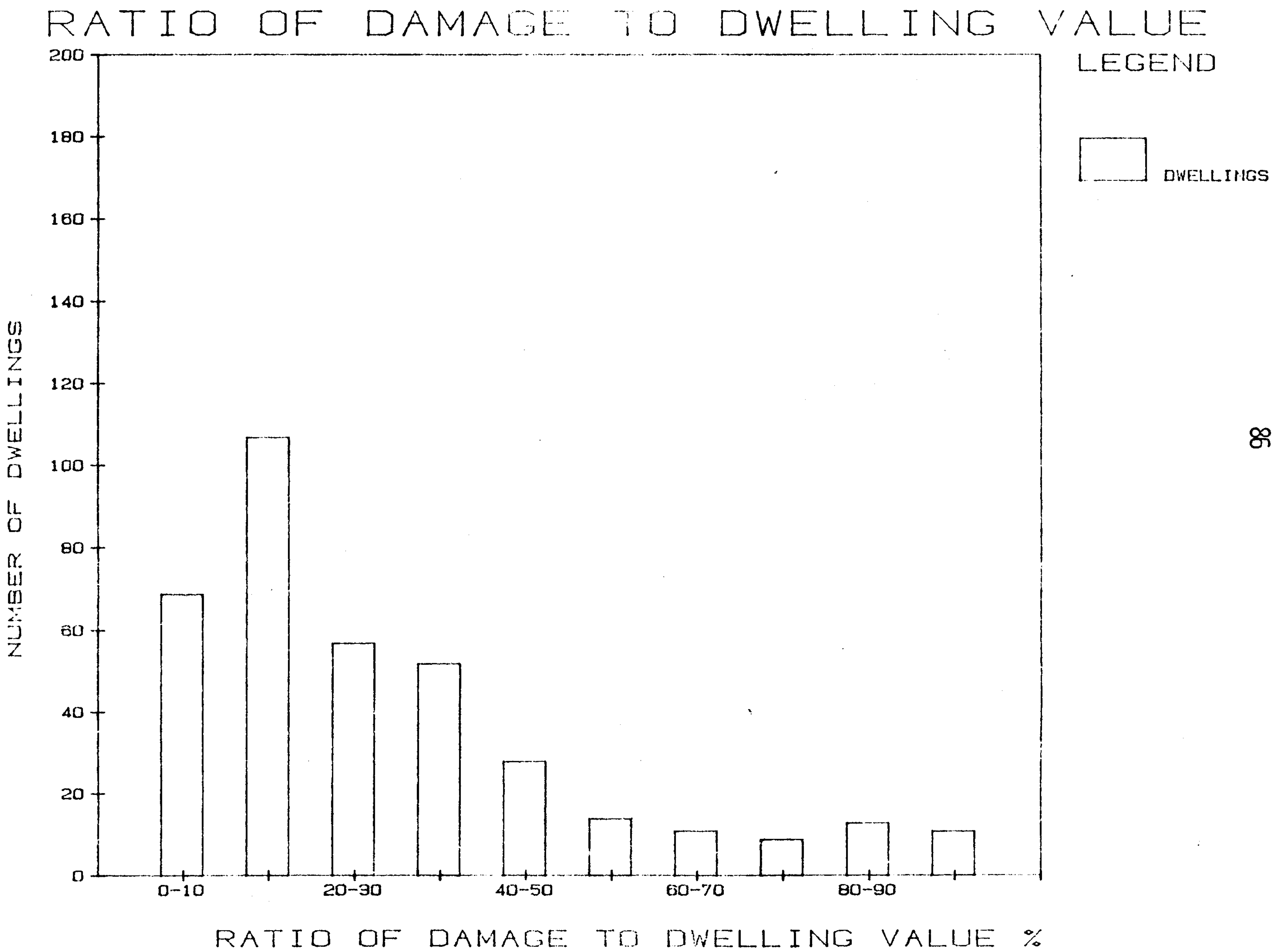
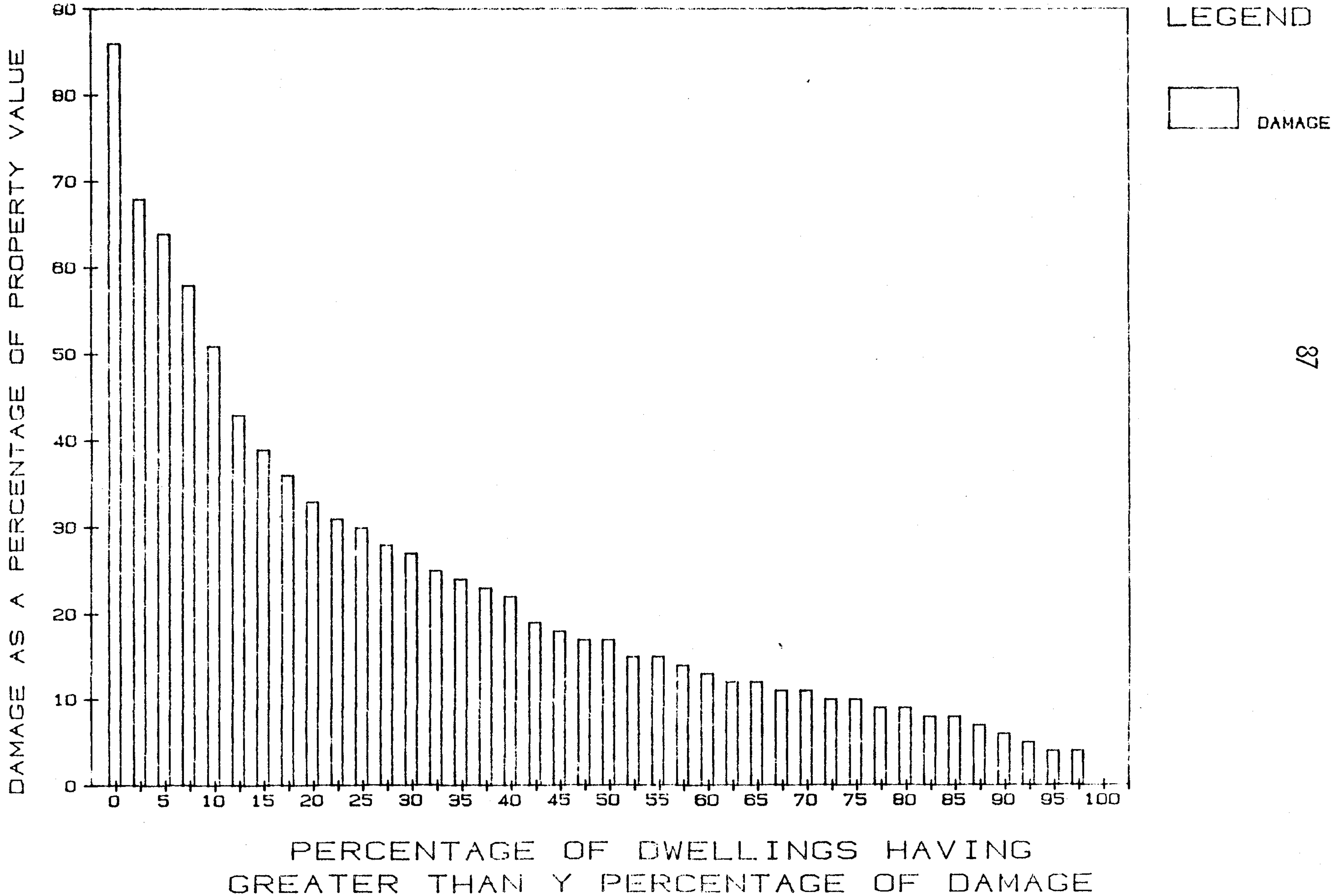

RATIO OF DAMAGE TO DWELLING VALUE
LEGEND
DWELLINGS
NUMBER OF DWELLINGS
0
20
40
60
80
100
120
140
160
180
200
0-10
20-30
40-50
60-70
80-90
RATIO OF DAMAGE TO DWELLING VALUE %

CHART V-8

DAMAGE AS A PERCENTAGE OF PROPERTY VALUE



incurred damage greater than 50 percent of the property value. It should be noted that since this figure is based on Chart V-6, the value of the land is included in property values for this reason the actual damage to dwellings themselves are higher.

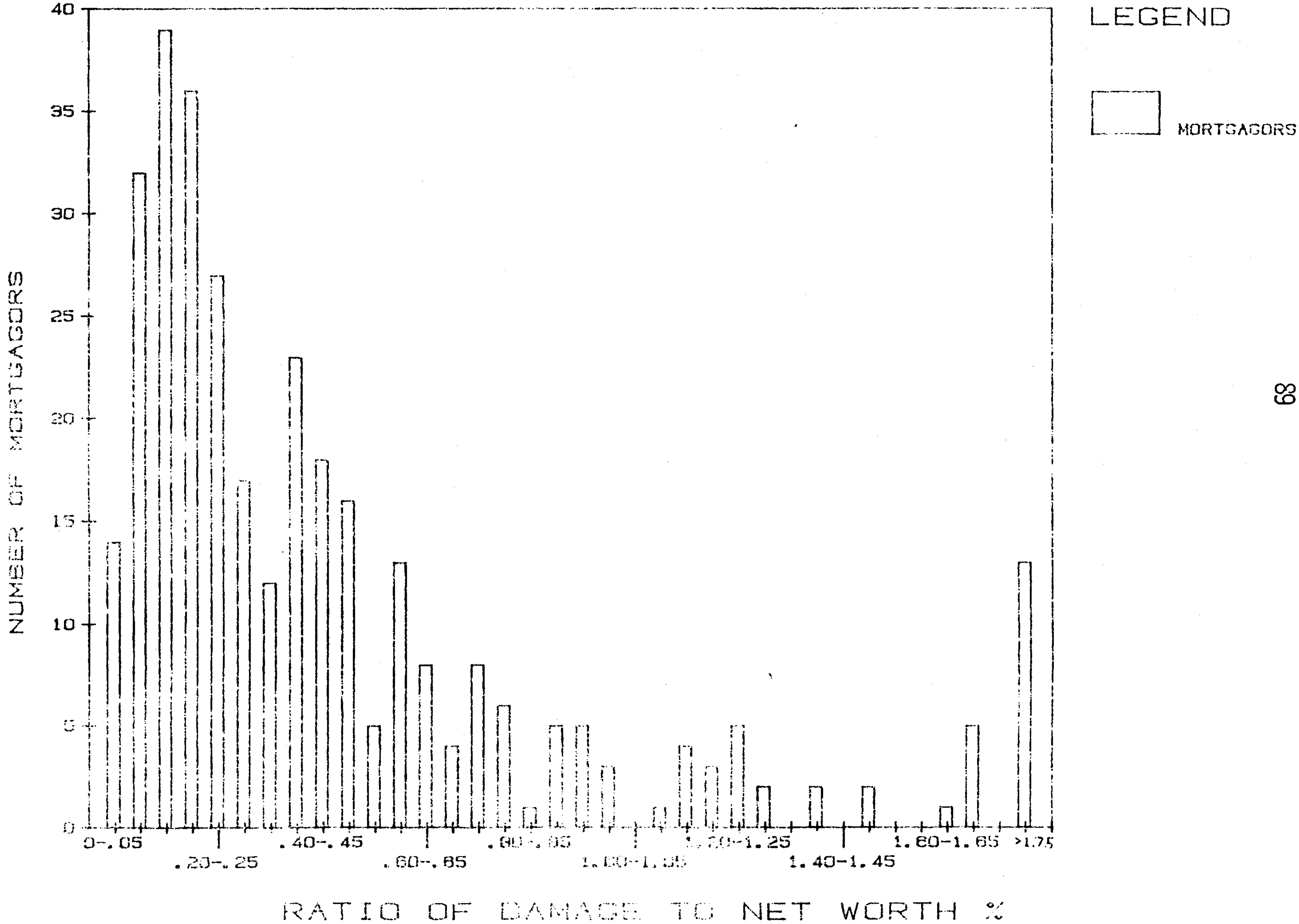
Chart V-9 displays the ratios of earthquake damages to the net worth of the mortgagors. The purpose of this exhibit is to obtain a sense of the degree to which the earthquake damage decreased the wealth of the mortgagors. Note that since net worth is measured prior to the mortgage origination date, it does not include any equity from the damaged property.

About 30 percent of the mortgagors incurred damages that exceeded half of their net worth. The mean value of the damage to net worth ratio was 55% while the median value was 30%. It seems justifiable to conclude that the earthquake damages as measured against net worth did put a severe strain on the mortgagors wealth.

It should also be mentioned that net worth usually included household furnishings and personal property. These items are not only illiquid, it is questionable that they could be sold in a short period of time for their stated values. Further, the items themselves would have been damaged in the earthquake. Damage estimates are limited to damage to the real property. Thus the damage to net worth ratios in Chart V-9 may understate the financial strain that the earthquake had on the mortgagors.

CHART V-9

RATIO OF DAMAGE TO NET WORTH



THE RELATIONSHIP BETWEEN NET EQUITY AND DEFAULT

It is clear that one of the first reasons for default to become even a consideration is negative net equity.[1] It is interesting to make a first pass at the data simply to observe what fraction of negative net equity loans resulted in default, and also what fraction of positive net equity loans resulted in default.

In Table V-8, a cross-tabulation of loan action by net equity is shown. For this first cross-tab the action is simply a default or not. There are a couple of things to be noted in this table. First, it is very clear that the more negative is net equity, the more likely is default. Second, most defaults were associated with very low, if not negative, net equity. Two-thirds of total defaults had negative net equity, and the number of defaults with low but positive net equity is also substantial. A bothersome matter, though, is that thirteen of the 133 defaults had substantial positive net equity. Why should large positive net equity be associated with default? This question will stay with us, but more can be seen by dividing defaults into foreclosures and deeds in lieu of foreclosure.[2]

Foreclosure

Foreclosure is a rather different phenomenon from the taking of a deed in lieu of foreclosure (DIL). A foreclosure is an action taken by a lender (actually an agent of the lender, or a trustee) to take title to a property on which the borrower (the trustor) is in default.[3] There are rules of procedure governing foreclosures. These rules specify the amount of time that must be allowed to pass before a foreclosure sale can take place as well as the rights of the parties involved. A foreclosure action ultimately leads to either the borrower

TABLE V-8

CROSS-TAB OF ACTION BY NET EQUITY

ACTION

Net Equity	Note Acquired	Default	Row Total
low to $-7888	0	37	37
-7888 to -2100	11	29	40
-2100 to 0	22	20	42
0 to 1365	20	12	32
1365 to 2950	24	11	35
2950 to 4625	27	11	38
4625 to 6750	33	3	36
6750 to 9000	35	5	40
9000 to 12,000	33	4	37
12,000 to high	35	1	36
Column Total	240	133	373

curing the default or to a foreclosure sale. At a foreclosure sale the lender (as the beneficiary of the deed of trust) bids an amount equal to the balance due on the loan plus costs of foreclosure as an opening bid. If the lender is overbid, then the lender is entitled to the amount that it bid out of the total bid of the buyer (the overbidder). Any remainder goes to the borrower. Generally, the lender is not overbid.

The results of a foreclosure action (in which the lender is not overbid) are that the borrower has had a public default which will become part of his credit record, and the lender has gone through a time-consuming and expensive property acquisition. It is no surprise that both parties may wish to avoid the process of foreclosure. This is where the DIL comes into favor.

Deeds in Lieu of Foreclosure

The DIL allows property acquisition without foreclosure. With a DIL the borrower and lender agree on specific terms for the transfer of title to the lender, in exchange for cancellation of the debt. The DIL represents a transaction, and if both parties feel that there is equity in a property it is perfectly reasonable that the lender would be willing to pay the borrower for the transaction. Similarly, if there is negative equity a borrower might be willing to pay an amount that he feels would be equal to the cost of avoiding foreclosure. "The advantage to a beneficiary in accepting a lieu deed is that the delays and costs of foreclosure are avoided. Instead of paying trustee's or attorney's fees and waiting four months for a sale, title passes immediately to the beneficiary with only negligible transaction costs. In those cases where the value of the property exceeds the debt, the beneficiary obtains more than it would expect from a public sale with competitive bidding. On the other hand, to a trustor irretrievably in default and holding property with no appreciable equity, a lieu deed spares him the embarrassment and impaired credit rating of a public foreclosure sale, and also gives him immunity from any possible deficiency judgment.[4]" There are two major problems with a DIL. First, it is possible that a former borrower (grantor-trustor) may subsequently have a change of mind, and may sue to set aside the deed. Second, "junior lienors may claim that the deed was not effective to extinguish or impair their claims.[5]" While both of these potential problems are a concern, it was the existence and actions of junior lienors (second mortgagees) in the San Fernando Valley that proved to be important.

As was noted above, many of the properties in the sample had second mortgages, either for initial financing or for later improvements. (Taking out a second to tap existing home equity does not seem to have been done by any of the borrowers.) In order to avoid the potential problem of a junior lienor making a claim on the senior, and the attendant legal expenses of a foreclosure action, lenders were unwilling simply to accept a DIL from a borrower where a second mortgage was present. The senior lender insisted on a letter from the junior indicating that the junior would relinquish any claim to the property. In some cases the second mortgageholder did what the senior requested. In a number of cases, however, the junior lienholder refused to go along with the senior's request. In those cases, the lender was unwilling to accept a DIL and foreclosed instead. We have no information on what transpired between borrowers and holders of second mortgages, but there is reason to believe that the willingness of the holder of the second to go along with the request to relinquish a claim on the property may have been connected with the overall asset position of the borrower. A second mortgage that is not a purchase money second is a recourse loan. In the case of a recourse loan the junior lender can look to assets other than the residence to satisfy the loan obligation. It follows that a second lender in this position possibly would be unwilling to go along with a senior lender's request to relinquish a claim to the amount due on the second. The second lender would presumably base this decision on the perceived other assets of the borrower. If the lender believed the borrower was financially sound, it would be reluctant to forgive the debt. There were other instances of lenders choosing foreclosure rather than DIL, but the greatest frequency seems to have been in cases of loans with recalcitrant seconds.[6]

This DIL versus foreclosure discussion indicates that the observed foreclosures quite possibly would include a disproportionately high share of the mortgages with a large calculated net equity. This would be because it was these loans on which a second mortgage existed, which was not included in the calculation of net equity.[7] Hence, the calculated net equity would be larger than the actual or perceived (by the borrower) net equity. In Table V-12 a cross-tab is displayed of category of default (DIL or foreclosure) by net equity. As predicted, the high net equity loans did in fact tend to be foreclosures rather than DILs. This is particularly true for the loans with calculated net equity above $4,625. Of this group, only two of the thirteen defaults were DILs.

Foreclosures and deeds in lieu of foreclosure are different. While both reactions involve the termination of homeownership, one can expect that they arise from sufficiently different circumstances and that they have sufficiently different effects that an explanation of the two actions may require sample separation. As we begin our empirical analysis we will combine the DILs and foreclosures as defaults, but we will later separate them in the analysis in the hope that more will be understood from looking at them apart from one another. We now turn to the empirical analysis of default in the aftermath of the 1971 San Fernando earthquake.

TABLE V-9

CROSS-TAB OF DEFAULT BY NET EQUITY

TYPE OF DEFAULT

Net Equity	DIL	Foreclosure	Column Total
low to $-7888	26	11	37
-7888 to -2100	17	12	29
-2100 to 0	14	6	20
0 to 1365	5	7	12
1365 to 2950	7	4	11
2950 to 4625	6	5	11
4625 to 6750	0	3	3
6750 to 9000	0	5	5
9000 to 12,000	1	3	4
12,000 to high	1	0	1
Column Total	77	56	133

EMPIRICAL DEFAULT ANALYSIS

Our primary interest in this study is to identify the causes of mortgage default in the aftermath of the San Fernando earthquake. We treat two events as mortgage default: foreclosure or the acceptance of a deed in lieu of foreclosure. (See above for a discussion of the difference between these two actions and the motivations for one rather than the other to occur.) The empirical analysis was conducted in two stages. In the first stage discriminant analysis was used and in the second, probit regression equations were run. The techniques and results will be discussed in that order.

Discriminant Analysis

The first statistical analysis of the earthquake data was done using discriminant analysis. This technique was used for two reasons. First, the discriminant analysis allowed a large number of variables to be considered as potential influences on default. This allowed us to make some early decisions on which of a large number of variables to remove from serious consideration. Second, the discriminant analysis program used was part of SPSS, and the overall SPSS was a convenient data base manager.[8] The results of a few discriminant analyses will be presented, to develop an idea of the general information that was obtained.

Discriminant analysis is a method of identifying variables that have an influence on a decision (a binary variable), or on some other type of grouped variable. Discriminant analysis is concerned with the following problem. We are given a matrix X of order nxm; it contains n observations on each of m variables. Further, X is partitioned by rows into subgroups of observations.

> '. . . discrimination analysis enables one to find out whether there is a compound score of the variables that differentiates optimally between the subgroups, to specify this compound score, and to find out how far it can be used to decide which subgroup an individual probably belongs to.'[9]

Discriminant analysis fits a discriminant function, where the weights on variables in the function are measures of the impact of each variable on the discriminant score. The raw weights of the variables can be standardized by multiplying them by their own pooled standard deviation. The resulting standardized canonical discriminant function coefficient (SCDFC) is a convenient measure of the association between a given variable and the decision variable. The SCDFCs allow comparison of the impact or importance of different variables, and in addition, they indicate the sign of the effect. In this study, the decision to default is coded to equal one, so a positive sign on a variable indicates a positive relationship between a given variable and the decision to default.[10]

The discriminant function can be used to predict group membership, and the percentage of grouped cases correctly classified is one measure of the overall quality or fit of the discriminant function. Other summary measures of the goodness of fit are the canonical correlation coefficient and Wilks' Lambda. "The canonical correlation is a measure of association between the single discriminant function and the set of (g-1) dummy variables which define the g group memberships. It tells us how closely the function and the 'group variable' are related, which is just another measure of the function's ability to discriminate among the groups. . . .[Wilks'] Lambda is an inverse measure of the discriminating power in the original variables which has not yet been removed by the discriminant functions--the larger lambda is, the less information remaining.[11]"

The discriminant program used is a stepwise program, with inclusion of a variable contingent on the additional information or additional discriminating power contributed by that variable. Variables are added to the set one by one according to the criterion of minimization of Wilks' Lambda. A variable can be removed, after it has been added, if its F statistic is less than 1.0. Similarly, variables continue to be added as long as their F statistics are greater than 1.0. When no remaining variable in a specified set has an F statistic greater than 1.0, the process ends and the canonical discriminant function is fit. Only the "included" variables are used to fit the discriminant function. Hence, all variables in the set have F statistics, but only included variables have discriminant function coefficients.

In Table V-10 the results of fitting three discriminant functions are displayed. The dependent variable is ACTION, which is either default (1) or no action (0). A default is either a foreclosure or a DIL. In these discriminant runs there were 319 observations: 115 defaults and 204 damaged properties that were not acquired. Because of incomplete data a few properties had to be discarded.

Discussion of Individual Variables

We will discuss the individual variables in three groups: socio-demographic; financial; and property/property ownership variables. All variables are defined in the glossary at the end of this chapter.

Socio-Demographic Variables: Some variables in this group characterize the borrower or borrowers; others relate to the borrower's behavior. The age of the head of household and marital status, are measured at the time of loan origination. There is no prior expectation on the sign of effect of either of these variables.

In some instances we were able to collect information on the behavior of the borrower following loan origination. This type of information was then categorized into a few variables, one of which was EMOPRO, and another MOVE. These two variables are loosely defined, but are intended to pick up the influence of family and personal problems associated with the earthquake - (EMOPRO), and the occurrence of a move either shortly before or subsequent to the earthquake (MOVE).

TABLE V-10

DISCRIMINANT ANALYSIS--ALL DEFAULTS VS. NOT ACQUIRED

	Run (10-1)		Run (10-2)		Run (10-3)	
Variable	SCDFC	F	SCDFC	F	SCDFC	F
ASSOC	0.28	12.11	0.27	10.38	0.29	12.67
MARITAL	-0.14	3.21	-0.16	3.93	-0.13	2.88
BALATEQ	-0.52	8.94				
SECFIN	0.10	1.62				0.77
PRIORDEL	0.09	1.32	0.15	3.37	0.12	2.07
DIVORCE	0.29	13.99	0.26	10.54	0.29	14.18
FINPRO	0.24	7.99	0.38	21.29	0.24	7.91
MOVE	0.41	26.32			0.41	26.44
EMOPRO	0.20	6.31	0.19	5.33	0.19	5.72
MOPRATIO	0.13	2.55		0.95	0.12	2.11
HOUSVAL	1.08	32.37	0.56	44.71	0.61	47.71
NWRATIO	0.11	2.16	0.11	1.98	0.12	2.36
NETEQ	-1.15	176.84	-1.07	183.33	-1.12	189.84
ORIGDATE		0.02		0.36	0.11	1.50
LTV		0.48	-0.21	4.71	-0.26	7.23
AGE		0.43		0.00		0.27
TYRSINLA		0.19		0.27		0.42
SUMMARY STATISTICS						
Canonical Correlation		0.759		0.732		0.758
Wilks Lambda		0.423		0.464		0.425
% of Grouped Cases Correctly Classified		85.80		85.20		86.40

NOTE:
SCDFC is STandardized Canonical Discriminant Function Coefficient.
F is the F statistic to remove or enter the variable.

The biggest problem with these two variables is measurement bias. It is impossible to discern whether the mention in a loan record of such behavior automatically would be associated with default, or at least delinquency. If a family chose to move just prior to or after the earthquake and sold the property, the move probably would not merit any attention in the loan file. It is possible that there would be a note placed in the loan file if the lender was aware of the move and concerned about its potential effect on a damaged property, but there is no way of knowing for sure how many of such moves there might have been. As it turned out, all moves recorded by us were in fact associated with defaults. The same type of comment holds for EMOPRO. We just do not know how many families had psychological problems (such as an unwillingness to remain living in the area following the earthquake, or difficulties on the job somehow linked to the earthquake), but we feel that our observations of this type of behavior are likely biased towards defaults.

DIVORCE refers to any divorce following loan origination. Mortgage default is often associated with family breakup. We expect that in cases where a borrowing couple divorced (or separated), default would be more likely.

The last variable in this set is TYRSINLA. We speculate that the longer borrowers lived in the Los Angeles area, the less likely they would be to default. It should be noted that this variable is subject to measurement error. In many instances information on how long the borrower had lived in the Los Angeles area was incomplete in the loan files.

Financial Variables: The financial variables include characteristics of the borrower's behavior, the borrower, and the mortgage. The two behavioral variables are a record of prior delinquency (PRIORDEL) and a record of experience of financial problems subsequent to the earthquake (FINPRO). The financial problems included job loss and other financial problems, related or unrelated to the earthquake. Borrowers who become delinquent on their payments are routinely noted as such in their loan records. Thus, there is no bias towards default in the measurement of PRIORDEL. We believe that a previous record of delinquency should be associated with a tendency to default in the aftermath of the earthquake. FINPRO, however, is another variable that would most likely be noted if there were other problems with the loan. We believe that the existence of financial problems around the time of the earthquake would be positively associated with default. Other financial problems would lead to delinquency, and perhaps to a belief by the borrower that less is to be lost with a default, than if the financial problems were not there.

Financial characteristics of the borrower were income and net worth (calculated from balance sheet data). Both of these variables were measured at loan origination. It would not be helpful to enter these variables in the analysis simply as they are measured. To the extent that one might expect income and wealth to play a role in the default decision, it would most likely be in relationship to mortgage characteristics. Income appears in the analysis as the denominator of the ratio of monthly mortgage payments to income (MOPRATIO). Net worth is the denominator of the ratio of the appraised value of the property to net worth (NWRATIO). Our expectation is that the greater the "strain" on the borrower the more likely to default. (As noted in the default model discussed above, this does not necessarily follow rational behavior of the borrower.) Thus, the larger MOPRATIO, the more likely would be default. The role of the net worth ratio is even less clear. A high origination ratio of property value to net worth might imply potential weakness in the face of a reduction in property value, but it certainly does not follow that this should precipitate default. A more interesting hypothesis is that a borrower with a weak balance sheet might feel as if there is less to lose in default, and it also might imply that there would be less in the way of other assets for a junior lienor to feel that he could go after (if there was a second mortgage). We expect a high value for NWRATIO to be associated with default.

The other financial variables are the loan balance at the time of the earthquake (BALATEQ), the presence of secondary financing (SECFIN), and the loan-to-value ratio (LTV). The loan balance at the time of the earthquake is a variable that might be expected to be positively associated with default. Casual analysis could lead one to believe that a large loan balance would in itself be sufficient to encourage default, other things equal. The existence of secondary financing is a variable we have already discussed. It might or might not induce default--by itself it decreases net equity, but if it is connected with property improvement it would leave net equity approximately unchanged. A high loan to value ratio has been associated with default in other studies. The inclusion of net equity, however, should diminish the role of LTV.

Property and Property Ownership Variables: We include two variables relating to the property value at the time of the earthquake: The current house value (HOUSVAL, the construction of which was discussed extensively, above) and net equity (NETEQ, also discussed earlier). HOUSVAL does not have an expected sign. To the extent that borrowers are unaware of increases in property value a high HOUSVAL might actually be associated with default. NETEQ is our key variable, and its expected sign is negative.

There are two other variables included in this section: the specific lender (ASSOC) and the length of time from mortgage origination to the earthquake (ORIGDATE). We were interested in whether different lender policies might be related to default. With respect to ORIGDATE, we expect a negative sign as we believe a long period of time as homeowner should be associated with a reluctance to default.

Discriminant Analysis Results

In Table V-10 we display three discriminant runs. Discussion will be focused on the first run which includes all of the variables. The overall function correctly classifies approximately 85 percent of the observations.

Socio-Demographic Variables. The first group of variables discussed was the socio-demographic variables. The marital status variable (MARITAL; 1=single, 2=married) indicates that single (at origination) borrowers were more likely to default than married. The DIVORCE variable performs as expected--divorce is positively associated with default. The MOVE variable indicates that a move from the area is associated with default, and the variable for emotional problems (EMOPRO) following the earthquake also enters significantly. The two variables in this group that do not offer help in explaining default are the AGE of the borrower and the total number of years in Los Angeles before the earthquake. Even though TYRSINLA is a poorly constructed variable, its failure to perform any better than it does is perhaps a little surprising. For those who believe that the high mobility of Californians and their purported lack of attachment to place are potential explanations of default in the wake of a natural disaster, this variable offers no support.

Financial Variables: The second group of variables is the financial group. There were some interesting results here. BALATEQ carries a negative sign, and is significant. What is equally notable though, is that when it is deleted from the function, the explanatory power of the equation is not diminished (10-3). The negative sign on BALATEQ is unexpected. There is no reason to expect that a small loan balance should be associated with default. A related variable is the loan-to-value ratio. Note that when BALATEQ is eliminated, LTV becomes significant. LTV also carries a negative sign, but this is not the sign that we earlier indicated should be expected. A high LTV in previous studies of mortgage default is associated with default. Here, a low LTV is associated with default. It should be emphasized, however, that LTV does not play the same role in this analysis as it would in an ordinary default analysis. If there was no property damage, LTV would be something of a proxy for net equity. Since we have net equity as a separate variable, LTV is picking up a different kind of influence. It indicates that borrowers who took out high ratio loans were less likely to default (given net equity) than those who took out lower ratio loans. This could be rationalized if underwriting standards were more severe for high ratio loans. This explanation is perfectly reasonable, and we are comfortable with the negative sign for LTV.

The presence of secondary financing seems not to play a significant role in the default decision. A record of previous delinquency is associated with default, but its influence is not very strong. Financial problems are also positively associated with default, and the influence of this variable is fairly strong.

The two financial ratios, MOPRATIO and NWRATIO, have the expected positive signs. Recall that high mortgage payments relative to income are expected to be associated with mortgage default. As for NWRATIO, a high value is attributable to a high property value relative to net worth, and this would give the borrower less to fall back on in the case of property damage. Unfortunately, these two variables are only marginally significant.

Property and Property Ownership Variables: The last group of variables is that describing the property and property ownership. The specific lender did have a significant connection with default. Two of the three lenders were combined as one response, and this variable (ASSOC) picks up the influence of the remaining lender vis-a-vis the other two. The fact that default should be lender connected (other things equal) makes sense. Different lenders pursue different strategies and simply behave differently post-disaster [9]. It should follow that different postures have different ultimate effects on something as important as mortgage default.

It was expected that NETEQ would carry a negative sign--that the lower (or more negative) net equity, the greater the likelihood of default. Not only does NETEQ carry the expected sign, but the variable is clearly the most closely associated with default of the set of variables shown in Table V-10. It is important to point out that the variable is entered in a continuous form. This is important because it is not just that net equity is positive or negative that triggers default. It is that it is sufficiently positive or negative, given other influences on default, to determine whether or not default will occur.

HOUSVAL is an interesting variable, because it has a very large F statistic, and because of its positive sign. Just why it should be strong and positive is not clear to us. We indicated earlier that one possibility would be that owners of houses that had experienced an increase in value could be unaware of the increase in value, and hence would undervalue their properties and tend to default. In a run that is not shown, a variable was entered to capture only appreciation. This appreciation variable failed to carry a significant positive sign.

The last property ownership variable is ORIGDATE, the number of months between loan origination and the earthquake. This variable was disappointing. We expected a negative sign and the expectation was not realized. Length of time as a borrower evidently is not related to default behavior. This is another interesting dismissal of a commonly held belief of borrower loyalty. Casual conversation with lenders would lead one to believe that old borrowers are loyal borrowers--that having had a loan outstanding for a long period of time would make one prone to stick with the property and the loan. The results of Table V-10 imply that it is other factors associated with being in a property for a long time that are the important ones (such as having established a large net equity position).

Foreclosures vs. DILs

This completes the discussion of the basic discriminant runs for default. We noted earlier, though, that there is reason to believe that defaults arising from DILs might be different from those associated with foreclosure. With that in mind we ran separate discriminant functions for foreclosures and DILs. The results are shown in Tables V-11 and V-12.

Foreclosures differ from deeds in lieu in that the former requires a costly lender action and in that it leaves a blot on the borrower's credit record. It should follow that a foreclosing lender would have a good reason to foreclose, and a foreclosed borrower would be less concerned with the effect on his credit record. Evidence that supports these comments can be found in the first two groups of variables--those relating to the borrower. The third group primarily concerns the property, and there it is interesting that little distinguishes the two types of default.

In the first group of variables, the socio-demographic variables, note that the marital variable is only significant for foreclosures. Divorce is significant for both categories of default, but far more so for foreclosures than for DILs. In the second group, those relating to financial matters, the existence of secondary financing is a bit more important for foreclosures, but prior delinquency is really more important for foreclosures and plays no role at all in DILs. Lenders were evidently unwilling to go along with those borrowers who had been delinquent in the past. Financial problems also were much more strongly associated with foreclosure than with DIL, even though positively associated with both types of default. But MOPRATIO was significant for DILs and

TABLE V-11

DISCRIMINANT ANALYSIS--DILs vs. NOT ACQUIRED

Variable	Run (11-1) SCDFC	Run (11-1) F	Run (11-2) SCDFC	Run (11-2) F
ASSOC	0.27	9.24	0.29	9.04
MARITAL	-0.09	1.09		0.74
BALATEQ	-0.82	17.76		
SECFIN	0.10	1.16		
PRIORDEL		0.04		0.47
DIVORCE	0.12	2.00	0.11	1.47
FINPRO	0.12	1.45	0.24	5.56
MOVE	0.44	24.92		
EMOPRO	0.16	2.78	0.20	4.01
MOPRATIO	0.16	3.33	0.15	2.66
HOUSVAL	1.38	43.55	0.63	36.23
NWRATIO	0.17	3.87	0.16	3.21
NETEQ	-1.29	175.47	-1.22	172.76
ORIGDATE		0.16	0.11	1.28
LTV		0.55	-0.38	11.55
AGE		0.06		0.36
TYRSINLA		0.08		0.22
SUMMARY STATISTICS				
Canonical Correlation		0.742		0.709
Wilks Lambda		0.449		0.496
% of Grouped Cases Correctly Classified		86.79		85.00

NOTE:

SCDFC is Standardized Canonical Discriminant Function Coefficient.

F is the F statistic to remove or enter the variable.

TABLE V-12

DISCRIMINANT ANALYSIS--FORECLOSURE vs. NOT ACQUIRED

Variable	Run (12-1) SCDFC	Run (12-1) F	Run (12-2) SCDFC	Run (12-2) F
ASSOC	0.18	3.72	0.17	3.02
MARITAL	-0.15	3.21	-0.17	3.43
BALATEQ	-0.65	9.63		
SECFIN	0.12	1.88		
PRIORDEL	0.22	5.72	0.31	11.13
DIVORCE	0.40	21.95	0.38	18.48
FINPRO	0.35	14.47	0.49	30.75
MOVE	0.44	24.08		
EMOPRO	0.19	4.64	0.13	2.17
MOPRATIO		0.59		0.00
HOUSVAL	1.30	29.48	0.67	43.82
NWRATIO		0.12		0.02
NETEQ	-1.19	97.43	-1.09	101.86
ORIGDATE		0.03		0.98
LTV		0.09	-0.28	5.81
AGE		0.54		0.03
TYRSINLA		0.47		0.75
SUMMARY STATISTICS				
Canonical Correlation		0.749		0.713
Wilks Lambda		0.438		0.492
% of Grouped Cases Correctly Classified		90.08		88.55

NOTE:

SCDFC is Standardized Canonical Discriminant Function Coefficient.

F is the F statistic to remove or enter the variable.

not foreclosures, and the same appears to be true for the ratio of origination house value to net worth. Lastly in this group, the LTV ratio was more important in the DIL set than in the foreclosure set (but of the same sign, and still significant in the foreclosures).

The property/property ownership group of variables had the least pronounced different effects between the two kinds of default. The identity of the association was more important for DILs than foreclosures. The other variables in this group had similar effects on the two kinds of default.

Discriminant analysis is a good first step towards understanding the default process. The analysis allows us to identify important variables, discard some variables, and it clearly indicates that foreclosures should be distinguished from DILs. Variables other than those discussed in these pages were also tried in discriminant runs, and discarded. Some were insignificant and some were so highly correlated with one another that they eliminated other variables from being significant. The next stage of the analysis is to run PROBIT regressions on the same data.

The Probit Model

Our problem is to describe or quantify the relationship between a set of variables X and a decision. In this particular problem the decision is special in that it can only take on two "values": default or no default.[12] In explaining these two qualitative responses, one can talk about the probability of one or the other action. This response or election will depend on the variables X.

Putting the decision in terms of probability of one decision or another makes the problem quantitative rather than qualitative.

We know who did in fact choose one course or the other, so for those choices the quantification of the choice is 0 (did not elect to do something) or 1 (elected). One can now estimate the influence of the variables in X over the choice. One could use ordinary least squares to estimate this influence, but that would open up the possibility that a prediction from a given set of variables would be outside the 0,1 range of decision. Alternative methods of estimation have been developed to deal with this problem of confining the prediction. The two most frequently used methods are logit and probit analyses. The two methods differ in their assumption concerning the probability density function of the probability of the decision, and hence the error term in the estimating equation. Logit assumes a logistic cumulative density function while probit assumes a standard normal distribution. For most purposes the choice of logit or probit is simply one of availability of computer programs. "Given the availability of modern computer packages, which contain easily used matrix functions and density and cumulative density functions of normal random variables, there is little difference in the computational effort of the two methods. Furthermore, since the logistic cumulative density function can closely approximate that of a normal random variable, there is usually little difference in the empirical results produced by the two models.[13]"

The presentation of results of a probit equation is similar to the results of an ordinary least squares regression equation. The main difference that will be noticed is the absence of R^2 and the presence of the log of the likelihood function.

An estimate of R^2 can be calculated from a probit equation, but the particular program used in this study (Time Series Processor, Version 3.5B) did not provide that as program output. The log of the likelihood function is a very important component of maximum likelihood estimation (MLE). The actual estimation of probit is done using MLE, and in MLE the procedure is to maximize the log of the likelihood function.[14] Comparing different likelihood functions, when the number of observations is constant, is a way of ranking different equations by goodness of fit. In the equations displayed in Tables V-13 through V-16, this is not always possible, however, as different sets of variables occasionally require different numbers of observations. Still, the logs of the likelihood functions shown are helpful indexes of the overall fit of the equations.

Discussion of Probit Analysis Results

The results of the probit regression runs are displayed in Tables V-13 through V-16. Table V-13 exhibits runs for all defaults against all properties not acquired. This is the same data set used in the discriminant runs shown in Table V-10. We will focus our attention on the differences between the discriminant and probit runs, as well as on the differences between the types of default.

It should be noted that ASSOC and MOVE are not included in the regression runs. Each of these variables prevented the probit equations from converging. In the case of the MOVE variable this was due to the variable being exclusively associated with default. In the case of ASSOC it was because certain other variables were observed only in the loan records of one of the lenders. Because of this, ASSOC is perfectly correlated with the other variables. As in the discriminant runs, the inclusion of BALATEQ created problems of multicollinearity, and its elimination allows a better assessment of the influence of other variables. No equations are shown with BALATEQ included.

Significant Variables: The variables of major significance in the probit runs are again NETEQ followed by HOUSVAL. The deletion of HOUSVAL from the equation seriously reduces the overall fit. The sign of HOUSVAL continues to be positive. Two variables that help explain default somewhat more effectively in the probit runs than in the discriminant analyses are SECFIN and PRIORDEL. On the other hand, LTV, which had a relatively high F statistic in Runs (10-2) and

TABLE V-13

PROBIT ANALYSIS--ALL DEFAULTS vs. NOT ACQUIRED

Variable	Run (13-1) Coeffi-cient	Run (13-1) T Stat	Run (13-2) Coeffi-cient	Run (13-2) T Stat	Run (13-3) Coeffi-cient	Run (13-3) T Stat	Run (13-4) Coeffi-cient	Run (13-4) T Stat
Constant	-1.65	-0.81	0.78	0.80	-1.66	-1.52	-1.87	-1.64
SECFIN	0.49	1.90	0.82	3.54	0.46	1.88	0.44	1.78
PRIORDEL	0.55	1.66	0.26	0.91	0.58	1.85	0.58	1.85
DIVORCE	1.12	2.18	1.10	2.26	1.15	2.33	1.12	2.28
FINPRO	1.38	3.42	1.25	3.26	1.39	3.51	1.36	3.43
EMOPRO	1.06	1.94	0.87	1.70	1.10	2.09	1.12	2.12
MARITAL	-0.69	-1.45	-0.74	-1.83	-0.74	-1.63	-0.73	-1.58
ORIGDATE	-0.18-2	-0.29	-0.82-2	-1.62				
HOUSVAL	0.69-4	3.84			0.72-4	4.28	0.74-4	4.29
NETEQ	-0.24-3	-7.50	-0.20-3	-7.93	-0.24-3	-8.37	-0.24-3	-8.16
MOPRATIO	1.04	0.38	2.21	0.90				
LTV	0.28	0.16						
AGE	-0.73-2	-0.50						
TYRSINLA	-0.77-2	-0.38						
NWRATIO							0.51-4	0.91
Log of likelihood function		-93.90		-103.59		-94.40		-93.81

NOTE:

When a coefficient is followed by a minus number (such as -2) this is to indicate a negative exponent. For example, -0.83-2 should be read as -0.0083.

TABLE V-14

PROBIT ANALYSIS--FORECLOSURES vs. NOT ACQUIRED

Variable	Run (14-1) Coefficient	Run (14-1) T Stat	Run (14-2) Coefficient	Run (14-2) T Stat	Run (14-3) Coefficient	Run (14-3) T Stat
Constant	-4.13	-1.50	0.81	0.68	-2.39	-1.69
SECFIN	0.61	1.74	0.94	3.14	0.61	1.90
PRIORDEL	1.02	2.39	0.56	1.72	1.05	2.69
DIVORCE	1.56	2.70	1.44	2.82	1.47	2.77
FINPRO	1.78	3.75	1.47	3.53	1.68	3.82
EMOPRO	1.38	1.96	0.99	1.59	1.42	2.14
MARITAL	-1.19	-1.90	-1.02	-2.10	-0.97	-1.75
ORIGDATE	-0.38-2	-0.45	-0.87-2	-1.28		
HOUSVAL	0.90-4	3.41			0.82-4	3.59
NETEQ	-0.22-3	-5.06	-0.17-3	-5.32	-0.23-3	-5.79
MOPRATIO	-2.46	-0.67	1.01	0.33		
LTV	2.32	0.93				
AGE	0.11-1	0.52				
TYRSINLA	-0.61-2	-0.23				
Log of likelihood function		-50.52		-58.63		-51.39

NOTE:
When a coefficient is followed by a minus number (such as -2) this is to indicate a negative exponent. (For example, -0.83-2 should be read as -0.0083.

TABLE V-15

PROBIT ANALYSIS--DILs vs. NOT ACQUIRED

	Run (15-1)		Run (15-2)		Run (15-3)		Run (15-4)	
Variable	Coeffi-cient	T Stat	Coeffi-cient	T Stat	Coeffi-cient	T Stat	Coeffi-cient	T Stat
Constant	-1.21	-0.51	-0.49	-0.41	-2.07	-1.60	-2.33	-1.73
SECFIN	0.35	1.12	0.71	2.56	0.32	1.07	0.29	0.96
PRIORDEL	0.44-1	0.10	-0.98-1	-0.25	0.15	0.34	0.73-1	0.17
DIVORCE	0.80	1.08	0.51	0.69	0.86	1.19	0.87	1.22
FINPRO	1.17	1.96	0.95	1.69	1.04	1.83	1.07	1.87
EMOPRO	0.82	1.25	0.82	1.30	1.00	1.59	0.99	1.58
MARITAL	-0.23	-0.40	-0.23	-0.47	-0.45	-0.79	-0.47	-0.82
ORIGDATE	0.37-2	0.49	-0.88-2	-1.42				
HOUSVAL	0.59-4	2.72			0.63-4	3.10	0.67-4	3.15
NETEQ	-0.25-3	-6.94	-0.22-3	-7.22	-0.24-3	-7.46	-0.24-3	-7.24
MOPRATIO	3.56	1.09	3.24	1.11				
LTV	-0.86	-0.42						
AGE	-0.21-1	-1.21						
TYRSINLA	-0.57-2	-0.23						
NWRATIO							0.79-4	1.20
Log of likelihood function		-68.46		-74.05		-70.21		-69.26

NOTE:
When a coefficient is followed by a minus number (such as -2) this is to indicate a negative exponent. For example, -0.83-2 should be read as -0.0083.

TABLE V-16

PROBIT ANALYSIS--DILs vs. FORECLOSURES

(DIL=1, FORECLOSURE=0)

	Run (16-1)		Run (16-2)		Run (16-3)	
Variable	Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat
Constant	1.18	0.86	2.77	1.43	3.58	1.91
SECFIN	-0.63	-2.27	-0.82	-2.84	-0.84	-2.88
PRIORDEL	-0.50	-1.60	-0.39	-1.20	-0.38	-1.17
DIVORCE	-0.99	-2.12	-1.00	-2.12	-1.02	-2.19
FINPRO	-0.36	-0.91	-0.38	-0.98	-0.47	-1.23
EMOPRO	0.82-1	0.16	0.44-1	0.09	0.21-1	0.04
MARITAL	-0.15	-0.30	0.26-1	0.06	0.56-1	0.12
ORIGDATE			-0.29-2	-0.34		
HOUSVAL	-0.48-5	-0.24				
NETEQ	-0.77-5	-0.43				
MOPRATIO			-0.56	-0.19	0.24	0.08
LTV			-2.29	-1.12	-0.28	-1.33
AGE			0.11-2	0.06	0.30-2	-0.62
TYRSINLA			0.12-1	0.45	-0.85-1	-1.52
					0.93-5	0.34
Log of likelihood function		-68.15		-67.26		-65.53

(10-3), was of little or no importance in the probit runs. Another variable that performed better in the discriminant than in the probit was the NWRATIO. When included in the probit analysis it carried a t statistic less than one.

Of the four equations shown in Table V-13, Equation (13-3) is the best overall description of the influences on mortgage default in the aftermath of the 1971 San Fernando earthquake. The t statistics for each of the variables exceeds or is very close to the normal acceptance levels for the coefficient being significantly different from zero. By contrast, we can see from the other equations that a number of variables are poor contributors to the explanation of default: MOPRATIO, LTV, AGE, TYRSINLA, and ORIGDATE.

Foreclosures vs. DILs: Tables V-14 and V-15 analyze foreclosures and DILs separately, relating each to those properties that recorded damage, but that did not result in mortgage default. The variables just listed, those that did not explain default in the equations of Table V-13, were also of no help in explaining foreclosure or the taking of a deed in lieu of foreclosure. But as was seen in the discriminant analysis, the variables that influence foreclosure are not the same as those that influence DIL. Relative to other variables in the equations, financial problems appear to be more important in the probit runs for both foreclosures and DILs than in the discriminant analyses. Emotional problems are also relatively more important in the regression runs (and especially in the foreclosure runs) than in the discriminant runs. The LTV ratio was rather important in discriminant function (11-2) which explained DIL behavior, and the variable carried a negative sign. The comparison of the performance of LTV in equation (11-2) is extreme. In (15-1) the t statistic of the LTV coefficient is less than one half. The ratio of the appraised value of the property at loan origination of the borrower's net worth (NWRATIO) was somewhat helpful in explaining DILs in the discriminant runs, but in (15-4) it has a t statistic of 1.20.

Recall that in the discriminant runs there were fewer variables that were helpful in explaining DILs than foreclosures. This is also true in the probit equations. After the inclusion of the effect of net equity and HOUSVAL, there is little to be gained from the inclusion of the other variables in the DIL equations. Only FINPRO offers any help. It seems clear, now, that not only is default via a deed in lieu attributable to different factors than via a foreclosure, but DILs seem to be exclusively related to property/damage factors. Since DILs were substantially more common in the aftermath of this earthquake than foreclosures, this has important implications for policy as well as analysis.

A last set of probit regressions was run, to try and distinguish the variables affecting the two types of default. In these runs, DILs were coded as 1 and foreclosures as 0. Accordingly, a variable that is associated with foreclosure but not with DIL would carry a negative sign. The results of these runs are shown in Table V-16. Perhaps the most interesting feature of Table V-16 is the lack of effect of net equity or HOUSVAL in distinguishing the type of default. As we have seen in virtually every equation, these two variables are quite important in the determination of default, per se, but when it comes to the determination of the lender/borrower decision of foreclosure vs. DIL, they play no role. The most important variable separating the two actions is the presence of secondary financing. The existence of secondary financing (and a junior lienor) is a contributory factor to foreclosure. The second variable that is significantly associated with foreclosure is divorce. Both financial and emotional problems have been associated with foreclosure in the discriminant and probit runs, but they are not statistically significant in the equations of Table V-10. One variable that may be a surprise is the LTV ratio. Recall that this variable was at times seen to be related to DIL, but in Table V-16 it appears to point to foreclosure with its negative sign. This is because when the variable was associated with DILs it carried a negative sign. Hence, it is still playing the same role in (16-2) and (16-3), albeit not at a significant level.

The last variable in Table V-16 worthy of mention is that representing the existence of prior delinquency. This variable does not quite achieve the level of statistical significance one is generally comfortable with, but the coefficient is fairly stable over the three runs and the t statistic is highest in (16-1), which is a satisfactory version of the equation. PRIORDEL is associated with foreclosure rather than DIL. This is consistent with the role of this variable in other tables.

Footnotes

1. This assumes that the debt is a nonrecourse debt. This means that if the lender forecloses, the borrower's other assets will not be available to satisfy the difference between the loan balance at default and the value of the property. In California, any loan used to purchase a one-to-four family residence is by law a nonrecourse loan. This is not the case with nonpurchase money loans. To the best of our knowledge, all of the first loans on the properties in the sample were purchase money loans.

2. The general practice in California is to secure real property loans by deeds of trust rather than mortgages, and references hereinafter to foreclosure and foreclosure procedures shall be to California deed of trust practice.

3. In California, a foreclosure may be accomplished by means of a court action or by means of a private sale. For procedural reasons, the private sale is the preferred method. As far as we know, the private sale was used in all of the foreclosures in the sample.

4. California Mortgage and Deed of Trust Practice, p. 287.

5. Ibid.

6. This comment is based on observations of loan file information, but it is a subject we will return to in the empirical analysis.

7. It is also possible in theory, that the net equity really was large. If this was the case, though, overbidding should have taken place. There are no cases on the sample of which we are aware, of lenders being overbid at foreclosure sales.

8. Nie, N. H. et al., Statistical Package for The Social Sciences, Second Edition, McGraw-Hill Book Company, 1975.

9. Van de Geer, J. P., Introduction to Multivariate Analysis for The Social Sciences, W. H. Freeman and Company, 1971, p. 243.

10. This still requires information on the variable itself in order to interpret a relationship. For example, the variable for marital status at loan origination is coded as 1=single, 2=married. A positive sign on the marital variable would indicate that being married at loan origination is associated with loan default.

11. Op. Cit. SPSS, p. 442.

12. In the world as we know and experience it, this decision is really multifaceted rather than yes or no. The default decision could be yes or no, but it also could be "maybe," or "wait a few weeks and see." Time is of the essence, and the decision could swing back and forth over time. But our perspective is removed from this temporal process of decision making. We look back after the lapse of time and ask, did the homeowner default, or not? Looked at in this manner, the default decision is a binary choice.

13. Judge, G. G., W. E. Griffiths, R. C. Hill and T-C Lee, The Theory and Practice of Econometrics. John Wiley and Sons, New York, 1980, p. 607.

14. An easy to read explanation of MLE may be found in J. Kmenta, Elements of Econometrics. The Macmillan Company, 1971, pp. 174-182.

GLOSSARY OF VARIABLES

ACTION	A binary variable representing default or property not acquired. Property not acquired represents all observations other than default. Default can be divided into two responses: FORECLOSURE or Deed in Lieu (DIL). The values attached to the different ACTION responses are dependent on the format of the equation into which they are entered.
AGE	Age of the principal mortgagor. [Mean value in Table 13 discriminant runs: 36.8.]
APPRAMOU	Appraised value of the property at loan origination. This variable is used to update property value at the time of the earthquake. (See HOUSVAL.) [Mean value of all observations: $34,190.]
ASSOC	The coded identity of the lender. There were three savings and loan associations that provided data. In the discriminant runs two of the associations were combined so that ASSOC becomes a binary variable.
BALATEQ	Loan balance on first deed of trust at time of earthquake. [Mean value in Table 13 discriminant runs: $27,408.]
DIVORCE	A binary variable coded 1 in the case of a divorce at any time following loan origination. [Mean value in Table 13 discriminant runs: 0.04.]
EMOPRO	A binary variable coded 1 in cases where an emotional problem connected with the earthquake was mentioned in loan records. [Mean value in Table 13 discriminant runs: 0.03.]
FINPRO	A binary variable coded 1 in cases where a financial problem of the borrower was recorded in the loan records. Such problems could have been observed just prior to the earthquake, and in some cases included a filing for bankruptcy. [Mean value in Table 13 discriminant runs: 0.08.]
HOUSVAL	Property value at the time of the earthquake. The value is estimated by adjusting APPRAMOU for estimated appreciation from loan origination for 1971. [Mean value in Table 13 discriminant runs: $37,617.]
LTV	Ratio of original loan amount to APPRAMOU. [Mean value in Table 13 discriminant runs: 0.83.]
MARITAL	Marital status of principal borrower at loan origination. Coded as 1 for unmarried borrowers, 2 for married borrowers. [Mean value in Table 13 discriminant runs: 1.95.]
MOPRATIO	Ratio of monthly mortgage payment to monthly income of borrowers. [Mean value in Table 13 discriminant runs: 0.15.]

MOVE — A binary variable coded 1 in those cases where a move away from the property had taken place just prior to the earthquake (without a property sale) or where a move took place just after the earthquake. [Mean value in Table 13 discriminant runs: 0.04.]

NETEQ — Net equity at the time of the earthquake: HOUSVAL - BALATEQ - estimated damage. [Mean value in Table 13 discriminant runs: $2,333.]

NWRATIO — Ratio of APPRAMOU to estimated net worth of the borrower. [Mean value in Table 13 discrminant runs: 2.36.]

ORIGDATE — Number of months elapsed from loan origination to the time of the earthquake. [Mean value in Table 13 discriminant runs: 37.5.]

PRIORDEL — A binary variable coded 1 when a history of prior delinquency on mortgage payments was observed in loan records. [Mean value in Table 13 discriminant runs: 0.17.]

SALEPRI — The transaction price of residential property sales in the regressions used to create a hedonic price index for single family homes in the San Fernando Valley. [Mean value: $25,754.00.]

SECFIN — A binary variable coded 1 when secondary financing is known to have existed. The secondary financing could be either a purchase money loan or not. [Mean value in Table 13 discriminant runs: 0.36.]

CHAPTER VI

MITIGATING FACTORS AND STRATEGIES FOR REDUCING MORTGAGE DEFAULT RISKS ASSOCIATED WITH NATURAL DISASTERS

Several mitigating factors and strategies exist which can lessen mortgage default risks associated with natural disasters. These factors include outside financing following the disaster, such as federal disaster assistance and insurance. Others arise from the general nature of the mortgage default risk. Financial institutions and intermediaries that understand these factors can use them to develop a set of strategies to reduce their mortgage default risks. This section will examine various mitigating factors and discuss strategies which might be employed by lenders and secondary market intermediaries to lessen the mortgage default risk.

FEDERAL DISASTER ASSISTANCE PROGRAMS

Since the passage of the Federal Disaster Act of 1950, the federal government has been involved in providing various forms of relief following natural disasters. Homeowners have been able to obtain disaster assistance loans from the Small Business Administration since 1953. Following the Alaskan earthquake of 1964, the SBA loan program was made considerably more generous than it had been to date.[1] By 1970, the legislation controlling disaster assistance lending had altered the concept so that disaster loans were actually part grant as well as part loan.

The principal form that the "grant" component took was a forgiveness element of the loan. As a result of the Disaster Relief Act of 1970, a homeowner who had suffered damage in a Presidentially declared natural disaster could obtain a loan on which up to $2,500 would be forgiven. In order to maximize the forgiveness component, a homeowner would have to borrow $3,000 (and, accordingly, pay back $500). In addition to the forgiveness feature of the loans, the interest rate charged on the loans was below market, and repayment of principal could be delayed for as long as three years. Finally, if damage to a residence was extensive (over fifty percent) a homeowner could receive an SBA loan to refinance a first mortgage. Because the interest rate on the SBA loan would be below the original mortgage interest rate this would ease the borrower's financial plight.

Following the 1971 San Fernando earthquake, homeowners were not shy about taking out disaster loans. A survey done by the Los Angeles Times

> . . . revealed that homeowners were given funds to repair damage not caused by the earthquake; did their own work even though their loans were based on a contractor doing it; and frequently received more money than they needed for repairs. It is no coincidence that 16 percent of the applicants requested and received a loan for exactly $3,000, which enabled them to obtain the maximum amount of forgiveness.[2]

The SBA made 73,780 home disaster loans, 97.5 percent of which were for amounts less than $5,000.[3]

There would seem to be little question that the availability of SBA loans would affect the propensity to default. The forgiveness amount or grant portion of the loan would in effect increase the net equity to the owner of the damaged property which presumably would decrease the propensity to default. While the loan itself would not change the net equity, the fact that it would be offered at a subsidized rate would lessen the mortgagor's financial burden in repairing the property.

The most likely hypothesis to be drawn from the above would be that federal disaster assistance programs tended to reduce the number of defaults following the 1971 San Fernando earthquake. Unfortunately we were not able to test the hypothesis because information on SBA loan applications was not contained in the lender's loan files. While there were occasional references in the files to applications for SBA loans, such references were sporadic and contained incomplete data. Since these disaster loans were junior mortgages, there was no reason for the senior mortgagee to carry information about them in loan records. We observed no record of a first mortgage having been paid off as a result of an SBA re-financing loan.

While federal disaster assistance programs may tend to reduce mortgage defaults, they are not a factor over which the lender and mortgagor have much control. Disaster assistance programs operate at the will of Congress. Their form has been altered significantly in the past and may be changed in the future. For instance, the grant or forgiveness provision of SBA loans is not available today except where financial need can be demonstrated. Interest rates on SBA loans are no longer set at levels considerably below market.

It is noteworthy that while there have been some increases in the generosity of terms governing SBA loans in the wake of disasters over the last few years, by and large the terms have remained stringent relative to those that prevailed in the early 1970s. It would seem today's programs are not as attractive to the borrower as they were when the 1971 San Fernando earthquake occurred. It logically follows that federal disaster assistance programs could be expected to play a less important role today, in reducing the number of defaults following a natural disaster.

INSURANCE

Three different types of insurance may serve to reduce mortgage default risks: Property insurance on the dwelling, mortgage guaranty insurance, and mortgage impairment insurance. In the following section, these coverages will be discussed from the standpoint of their impact on mortgage default risks.

Property Insurance on the Dwelling

Property insurance on the dwelling can be a major mitigating factor in decreasing mortgage default losses. If adequate coverage is in effect, the natural disaster triggers a loss payment (equal to the property damage) to the mortgagor and lender as co-payees. This loss payment can be used to restore the property to its original value, which in turn restores the net equity value to its pre-disaster level. If repair or replacement is not elected, the lender can use the insurance payment as an offset against the outstanding mortgage balance.

The virtual universality of windstorm insurance on property is probably the main reason the authors have not observed a significant number of defaults following a tornado. Conversely, the virtual lack of earthquake insurance on residential property is undoubtedly a key factor in the explanation of the large number of defaults following the 1971 San Fernando earthquake. In examining the loan files, the authors did not find evidence of a single earthquake insurance policy on the properties studied.

Earthquake insurance presents somewhat of an anomaly. While earthquake insurance has been readily available in the private market for years, individuals have rarely purchased it.[4] Such a situation might be expected in regions with little or no earthquake hazard. Yet even in high hazard areas, earthquake insurance is seldom purchased. In the 1964 Alaska earthquake, less than five percent of the property damage was covered by insurance. Of the $553,000,000 in property damages caused by the 1971 San Fernando earthquake, only $31,600,000 was covered by private insurance.[5] Since this amount included automobile insurance and commercial insurance claims, the amount of funds available for residential dwellings was considerably less. The point to be made is that earthquake insurance held by mortgagors in 1971 (and even now) is minimal, and cannot be considered a mitigating factor for mortgage default risks associated with earthquakes.

Lenders could insist that mortgagors purchase earthquake insurance. Coverage for the other main disaster perils, tornado, hurricane, flood (when property is in a flood plain and has been recently financed) are generally now required by all lenders. While earthquake insurance would undoubtedly decrease the mortgage default risk, a requirement that it be purchased as a condition of a mortgage may have adverse competitive effects.

In fact, both home mortgage lenders and real estate appraisers tend to ignore earthquake hazards in their lending and appraisal decisions. To the extent that lenders recognize earthquake hazards as a risk they respond by not lending in hazard prone areas. Rarely, if ever, is the purchase of earthquake insurance encouraged or required of the home buyer.[6]

Mortgage Guaranty Insurance

Mortgage guaranty insurance protects the lender from losses due to default by the mortgagor. Typically, insurance is required by lending institutions when a loan is sought for more than 80 percent of the property value. When an investor purchases a mortgage, the benefits of this coverage follow the mortgage.

Intuitively, one may feel that mortgage guaranty insurance would substantially diminish default losses due to earthquakes and other natural disasters. This is incorrect. An exclusion in virtually all mortgage guaranty policies effectively renders the insurance inoperative in the event of damage by a natural disaster. A provision in the mortgage guaranty insurance policy states that if there has been physical loss or damage to the mortgaged property, it must be restored to its original condition (reasonable wear and tear accepted) in order for the mortgage guaranty claim to be honored.

A typical example would be as follows: A dwelling without earthquake insurance is damaged by an earthquake. The circumstances force the mortgagor into default. Since the property was not returned to its original condition, the mortgage guaranty insurance company is not obligated to pay. The result is that the holder of the mortgage absorbs the loss produced by the defaulted mortgage.

If earthquake insurance had existed in the above example, most likely it would have been used to restore the property to its original condition. While this would now satisfy the claim provisions in the mortgage guaranty policy, the mortgagor probably would not be forced to default - hence no claim would be made to the mortgage guaranty insurance company.

This situation may be aggravated by the fact that those property owners who were required to purchase mortgage guaranty insurance may be the most susceptible to default in the event of a major earthquake. Mortgage guaranty insurance was required of these mortgagors because of their low equity position in the property. Given the presence of mortgage guaranty insurance, it is reasonable for mortgage holders to feel protected against potential defaults caused by economic conditions for both high and low equity mortgages. Although a mortgagor with a low equity position may have a higher probability of default, the mortgagee has the benefits of mortgage guaranty insurance to cover losses. But for losses caused by uninsured natural disasters like earthquakes, these benefits are excluded. While this insurance is beneficial for certain situations, it is essentially inoperative with respect to default losses caused by an earthquake.

Mortgage Impairment Insurance

Mortgage impairment policies are nonstandard policies that have been developed for lenders to protect against certain mortgage default losses. The basic coverage is for losses in those situations where a mortgagor was supposed to have a certain insurance coverage, such as fire insurance, on the property. Due to a mistake in procedures, fire insurance was not in effect when a fire occurred. If the mortgagor subsequently defaults and produces a loss for the lender, the insurance company pays.

Mortgage impairment policies can be written to cover a default loss even when property insurance was not required as a condition of the mortgage. The lack of an earthquake insurance requirement is a case in point. In the case of a default loss caused by an earthquake, the insurance company would also pay this loss.

A coverage related to mortgage impairment insurance is mortgage special hazard insurance. This coverage is used when mortgages are packaged and used to back securities or bonds which are sold to investors. It essentially covers the investor's interest when an uninsured disaster causes default losses on the mortgages backing the securities or bonds. Mortgage special hazard insurance facilitates the packaging and selling of mortgages by a lender, and has the effect of passing the lenders' default risks onto the investors and ultimately to the insurance company.

The lenders examined in this study did not have mortgage impairment policies which covered earthquake related losses. Lenders typically have a type of mortgage impairment insurance, called mortgage errors and omissions, for default losses where required property insurance (fire, windstorm) was not in effect. While an extensive market analysis was beyond the scope of this study, the authors' impression is that most lenders, particularly small to medium size local institutions, typically do not have mortgage impairment coverage that extends to non-required insurance like earthquake insurance.

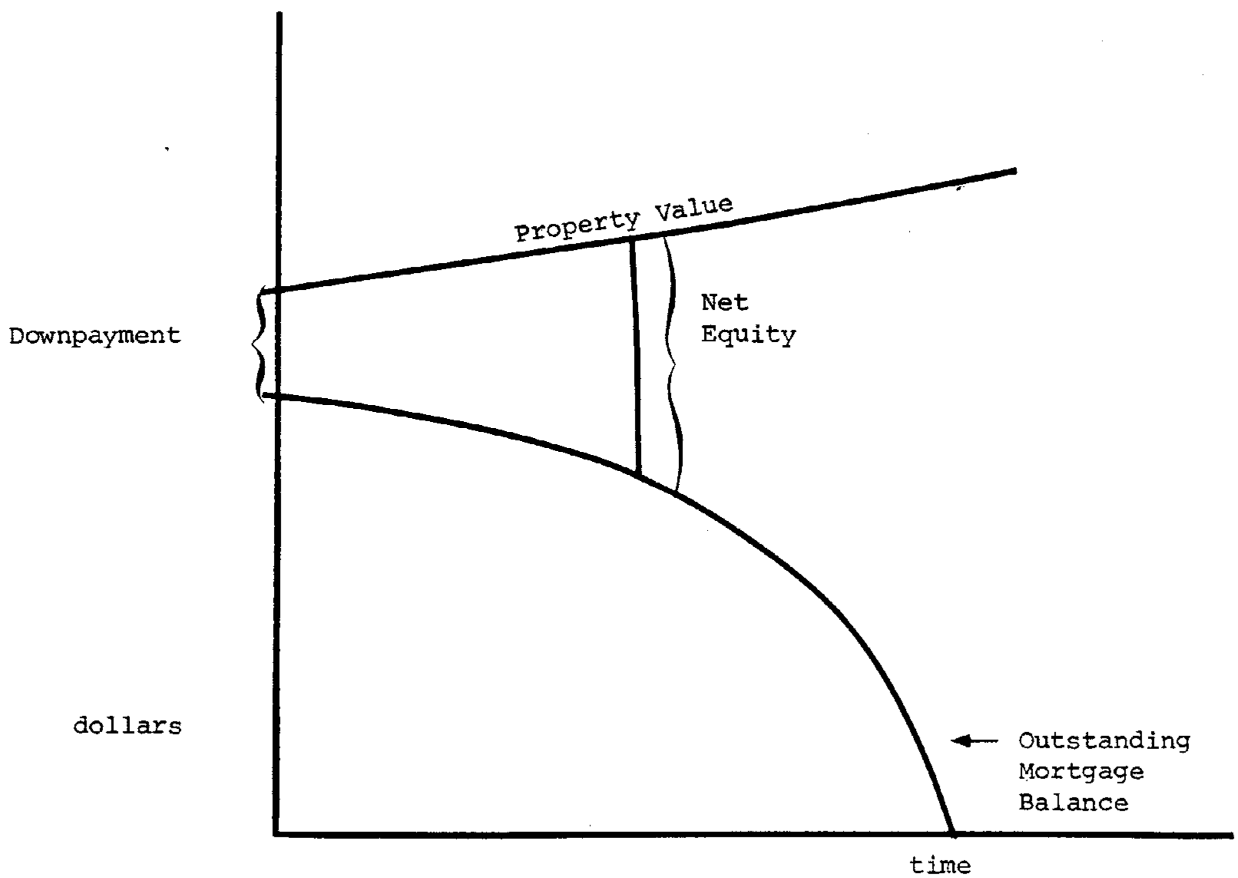
A mortgage impairment policy certainly would produce a strong mitigating force in reducing mortgage default losses associated with earthquakes. Apparently, high cost, unavailability, and possibly a lack of awareness, have caused many lenders to not use this policy to mitigate losses.

MORTGAGE DEFAULT RISK DECREASES OVER TIME

The nature of the mortgage default risk normally causes it to decrease over time. Figure VI-1 shows a traditional mortgage situation. The initial mortgage amount is less than the property value, the difference being the downpayment.

FIGURE VI-1

Net Equity Over Time



The net equity of course is equal to the downpayment at the origination date. If property values remain constant or increase and no additional financing is obtained, the net equity will increase overtime as is depicted in Figure VI-1.

Net equity decreases when property values fall and/or mortgage balances increase (additional financing). When the property value falls below the mortgage balance, net equity becomes negative and a high probability of default exists, as depicted in Figure VI-2. This situation frequently existed in the Depression and helps to explain the large number of defaults in that period.

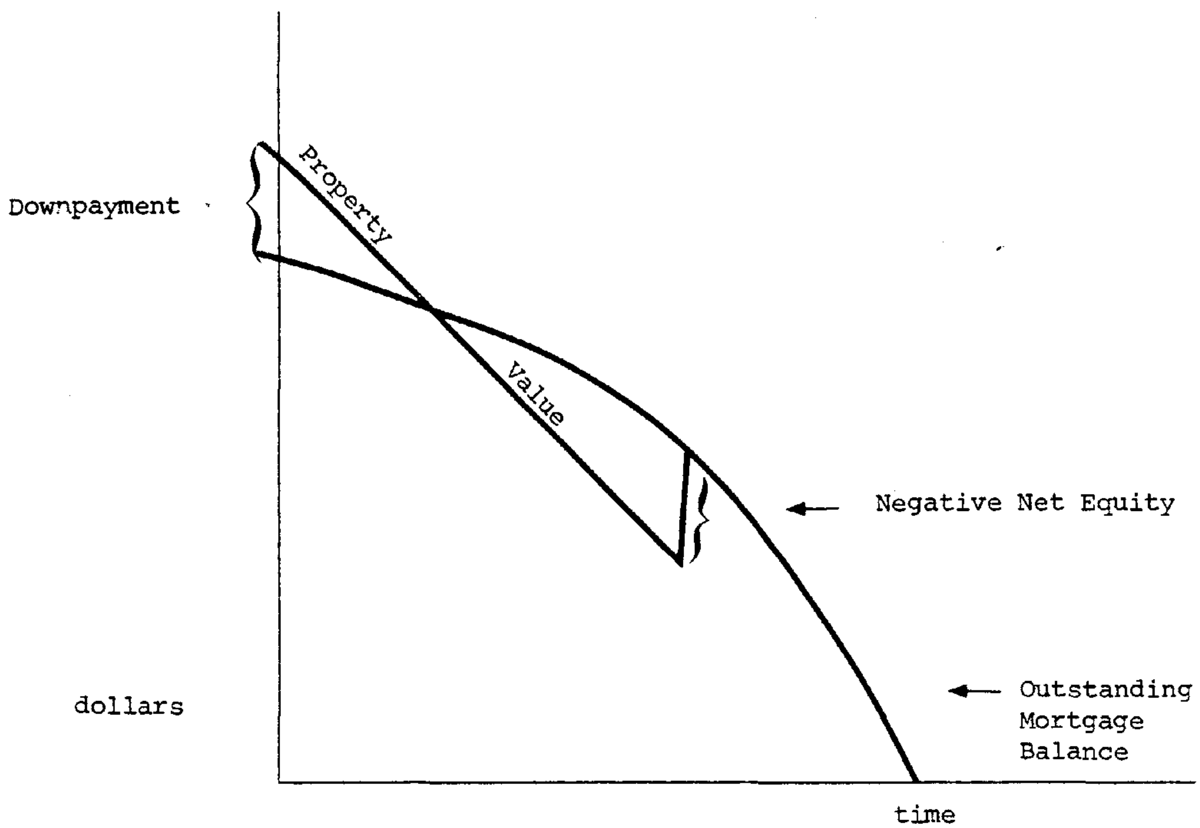
Until very recently, the experience of individual loans could be described by Figure VI-1. Property values have typically risen over the life of the mortgage. The typical mortgage has been a fixed rate loan with the attendant decline in principal balance over time. Net equity would increase over time and the mortgage default risk would diminish.

Most residential mortgages have actual lives considerably shorter than their contractual term to maturity. The actual term of a residential mortgage usually is between seven and ten years. This means that during the life of the loan little principal will be paid off. The improvement in net equity associated with the passing of time will generally and largely be the result of property value increase rather than principal reduction.

In this study we found that the length of time a mortgage had been outstanding was not a statistically significant explanation of default. This runs counter to the normal experience of loan maturity or age being inversely related to default as discussed above. One would suspect that the lack of importance of the loan maturity factor is due to the greater importance of net equity itself. Apart from the matter of what causes default, this observation on the role of maturity is important because lenders and secondary market intermediaries may not be able to rely on the general notion of mortgage default risks decreasing over time in the specific case of those associated with natural disasters.

FIGURE VI-2

Development of Negative Net Equity



Independent of the effects of natural disasters, a recent development in the mortgage market should have an impact on the relation between mortgage default risks and the time the mortgage has been in effect. This development is adjustable rate mortgages (ARMs). The decreasing risk over time is partly the consequence of a fixed rate mortgage. While the outstanding balance of a fixed rate mortgage will decrease overtime, an ARM can have a loan balance increase or decrease according to movements in interest rates. This is especially true in early years of the loan life. Thus even if property values increase or hold constant, increases in the outstanding balance of ARMs can decrease net equities.

Recent adverse experience of private mortgage guaranty insurance companies has been tied to ARMs. If ARMs continue to represent a significant part of the residential mortgage originations, as is now the case, mortgage default risks can be expected to increase.

Another related development is the increased popularity in home equity loans. If a loan is taken with the home equity as collateral, and the proceeds are invested in improvements in the house, the net equity should remain approximately the same. But if the loan proceeds are used for other purposes, the net equity will be decreased by the amount of the loan. To the extent that mortgagors are following this second pattern, mortgage default risks are increased.

SALVAGE VALUES

Even if the entire dwelling were destroyed by an earthquake, a considerable salvage value would exist in the form of the land values. It is estimated that land values, as a percentage of the total property value (dwelling plus land), are in the range of 25 - 35%. California is thought to be at the high end of that range. Thus even if the entire dwelling was destroyed, a substantial salvage value could still exist from the land. It would seem that site value would act as a mitigating factor in most natural disasters.

The present study confirmed this observation. In examining the earthquake damage estimates in the loan files, there appeared to be only one or two cases in which substantial land damage (fissures, cracks, shifting) had occurred.

MORTGAGE UNDERWRITING

The individual mortgage lender is not helpless in mitigating mortgage default risks. First, lenders can protect against large loss by being careful that their mortgages do not become over concentrated geographically. Any natural disaster has geographical limitations. If mortgage properties are spread geographically, a lender or investor can ensure that only a fraction of its portfolio will be subjected to the damage and the possibility of a disaster related default.

This strategy of course is much easier for a larger lender with a statewide or even multi-state lending practice. For smaller lenders, or those in states that do not permit branch offices, a spreading strategy is more difficult. The tendency of the lenders in the present study to over concentrate in certain areas that were hit by the earthquake undoubtedly contributed to their default losses.

The lender could insist on a higher downpayment in high risk areas. A higher downpayment increases the probability that the damage will not create a negative net equity situation. Obviously such an action would have to be balanced against potentially adverse competitive effects.

Note that two of the key factors in underwriting a mortgage, namely earning power and the ability to pay off the mortgage, do not necessarily mitigate mortgage default risks associated with natural disasters. As shown in the statistical analysis, mortgagors with higher incomes and net worths did not tend to have fewer defaults. When it comes to the default decision, it appears that mortgagors are guided by their net equity situation, irrespective of their financial capability to repair the damaged property.

Footnotes

1. Information on the SBA loan program is to be found in H. Kunreuther, Recovery From Natural Disasters: Insurance or Federal Aid? American Enterprise Institute for Public Policy Research, 1973.

2. Ibid., p. 21.

3. Ibid., p. 20.

4. For a discussion of reasons why individuals do not buy earthquake insurance see Kaplan, Smith and Associates, Geographic Mortgage Risk: Implications for the Federal Home Loan Mortgage Corporation, a report prepared for the Federal Home Loan Mortgage Corporation. (Washington, D.C.: Kaplan, Smith and Associates, 1978), p. 105.

5. Ibid., p. 107.

6. Palm, Rosa I., Home Mortgage Lenders, Real Property Appraisers and Earthquake Hazards, Monograph Number 38, December 1983.

7. Webb, Bruce G., "Borrower Risk Under Alternative Risk Mortgage Instruments," Journal of Finance, Volume 37, No. 1, 1982.

CHAPTER VII

MORTGAGE DEFAULTS IN CALIFORNIA'S NEXT GREAT EARTHQUAKE

A benefit of research analyzing residential mortgage defaults following the San Fernando earthquake of 1971 is the opportunity to estimate the number of defaults that may occur in the next great California earthquake. This section of the report attempts to reduce the amount of subjectivity in these estimates by identifying several components which can improve the predictive process. While a precise predictive model cannot be built, the unique data set assembled from this study will permit a reasonable estimate of the number of residential mortgage defaults following California's next great earthquake.

Major earthquakes vary substantially in both frequency and severity. Based on past history the next great earthquake in the United States is likely to occur in California within the next two-three decades and is expected to be of approximately the same magnitude as the San Francisco earthquake of 1906. While the severity (as measured by the Richter Scale) of an earthquake in the greater Los Angeles area theoretically cannot be as great as in the San Francisco area, more property value is exposed in the Los Angeles area. Therefore, whether the earthquake occurs in the San Francisco area or the Los Angeles area, the net effect is expected to be similar. Various authorities have attempted to estimate the total property damage that is likely to occur in these areas. Most findings suggest that an estimate of $30 billion (1980 dollars) in property damage proposed by a J. H. Wiggins study, is representative regardless of which of these two areas the earthquake strikes.[1]

In either case, a considerable degree of uncertainty exists in these estimates. Consequently, the authors decided to use three total property damage figures in thier calculations. These three figures are \$20 billion, \$30 billion and \$40 billion. The estimate of \$30 billion appears to be the most likely amount based upon the studies mentioned previously.

Along with the assumptions on total property damages, one must have data from the 1971 earthquake in order to predict the degree of future mortgage defaults. The key variables relating to the San Fernando earthquake which will be used to make the estimates are shown below:

1) the number of defaults,

2) the total damage to all buildings,

3) the total dollar damage to single family dwellings,

4) the number of single family dwellings damaged.

The total number of defaults examined in this study was 134. These defaults originated from the mortgage portfolios of three lenders in the San Fernando Valley, the nearest residential area to the earthquake's epicenter. All other mortgage lenders in the area were contacted but none reported any significant adverse experiences with defaults following the 1971 earthquake. While there were undoubtedly a few more defaults, the authors believe that 134 defaults examined in this study represent a substantial portion of all defaults associated with the 1971 earthquake. The authors feel that it is unlikely that the maximum number of defaults due to the earthquake exceeded 250. Since uncertainty as to the exact number of defaults in the 1971 earthquake exists, the authors have included future default estimates based on 150, 200 and 250 San Fernando defaults.

The total dollar damage of the 1971 earthquake has been estimated by the Insurance Information Institute as approximately \$553,000,000.[2] This estimate is comparable to that obtained from other sources.[3] Approximately $114,400,000 of the damage (21% of the total property damage) was incurred by single family dwellings.[4] A study by the J. H. Wiggins Company estimated the typical ratio of single family dwelling damage to total property damage is approximately 0.33:1 (33%). The predictions in this section will use 21% as a low figure and 33% as a high figure. If the reader feels that a number between these two point estimates is more accurate, interpolation can be done by using any other estimate within this interval.

Given this background information, we can turn to the estimation of residential mortgage defaults associated with the next great earthquake. For these estimates we consider three baseline total damage figures: $20 billion, $30 billion and $40 billion. These total damage figures are used in combination with the average dwelling loss of the San Fernando earthquake to estimate the number of single family dwellings that will be damaged in the next great earthquake. We will use McClures figures of $114,400,000 in property damage dollars resulting from damage to approximately 20,000 single family dwellings in the San Fernando earthquake.[5] This results in an average dwelling loss of $5,720.[6]

The information on the average dwelling loss can be used in conjunction with the range of defaults in the San Fernando earthquake (150 to 250) and the dwelling factors (single family dwelling to total property damage ratios) of 21% and 33% to arrive at estimates of defaults in the next great earthquake.

Graphs VII-1, VII-2, and VII-3 and Table VII-1 show that the estimated number of defaults in the next great earthquake will range from approximately 5,500 to 28,800 depending upon the assumptions being used. If only the most likely estimate of $30 billion in total property damage is considered, the range is approximately 8,000 to 21,000 defaults. Across all total property damage assumptions, the lower dwelling factors result in a lower estimated number of

FIGURE VII-1

Defaults Associated With
$20 Billion Earthquake

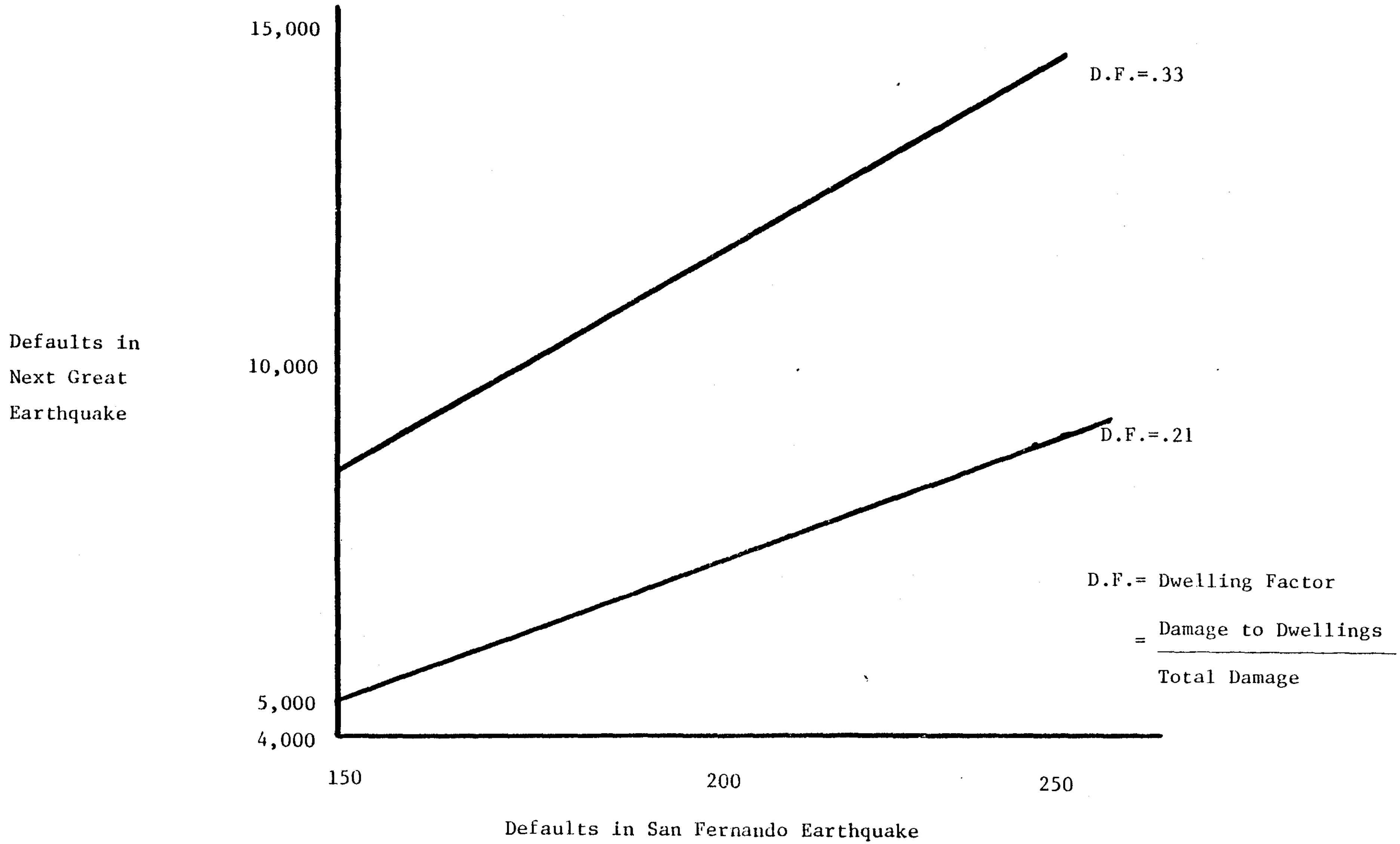


FIGURE VII-2

Defaults Associated With
$30 Billion Earthquake

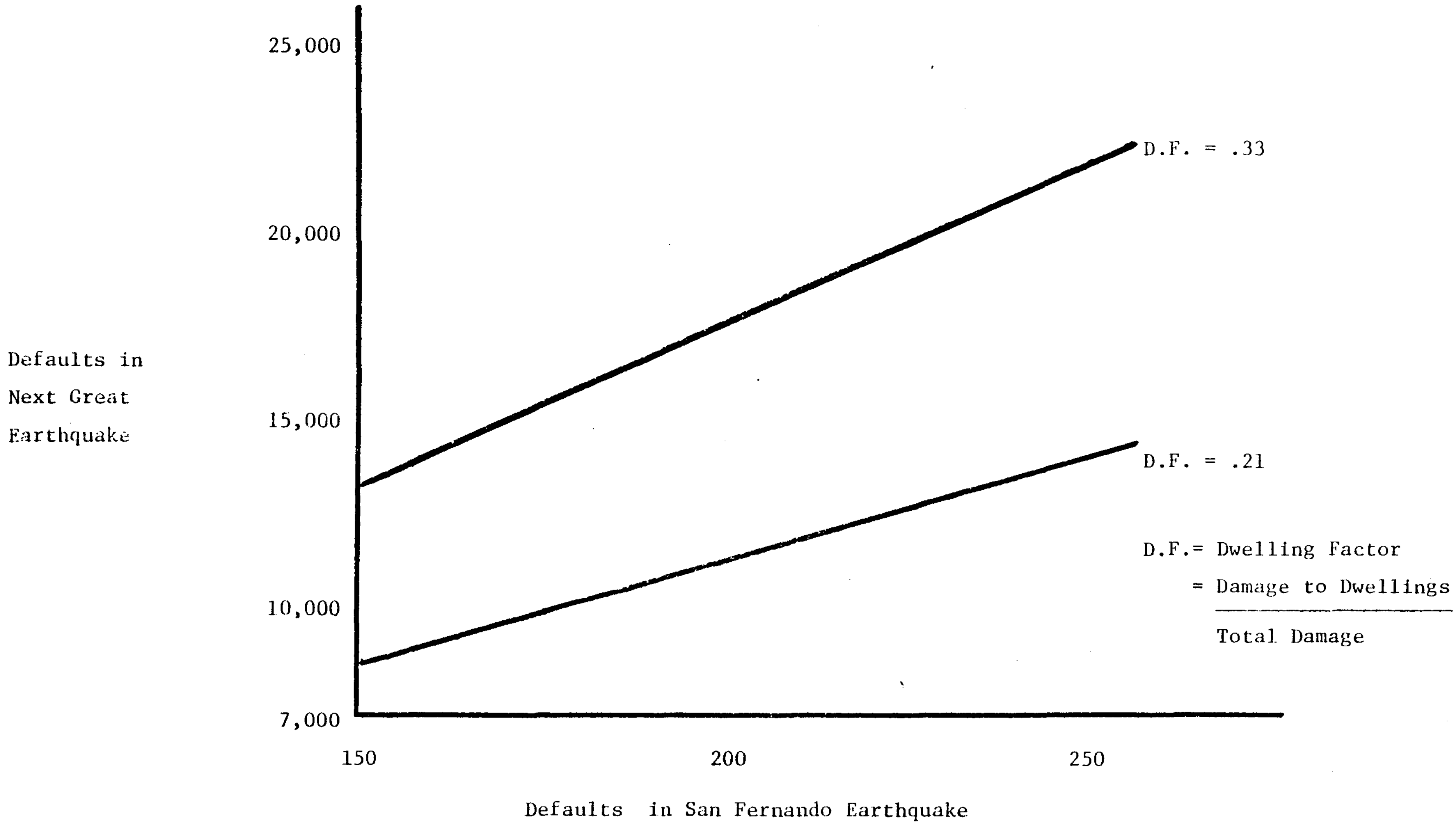


FIGURE VII-3

Defaults Associated With
$40 Billion Earthquake

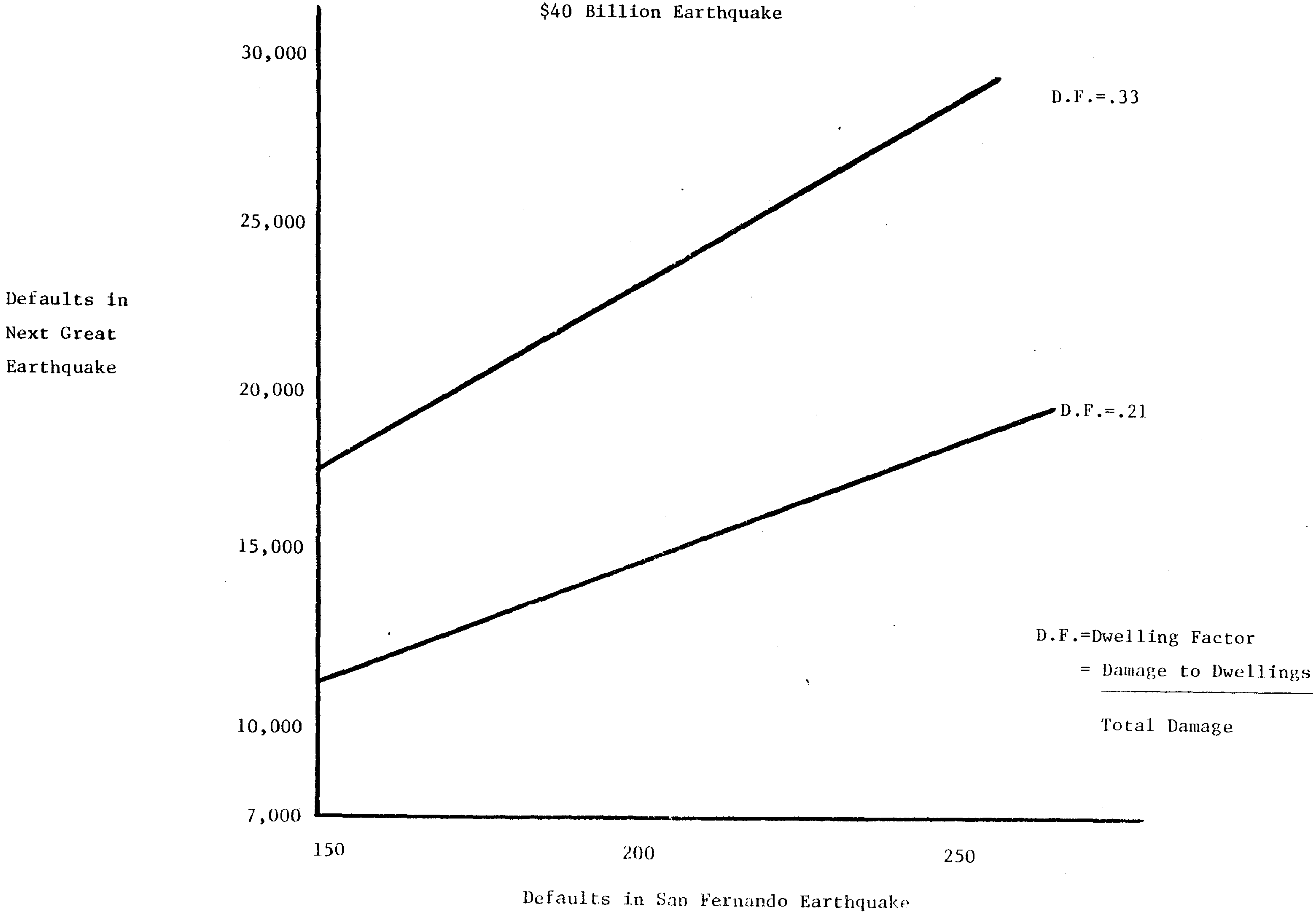


TABLE VII-1

ESTIMATED DEFAULTS IN THE NEXT GREAT CALIFORNIA EARTHQUAKE*

Percentage of Defaults						
	.75 (150/20,000)		1.0 (200/20,000)		1.25 (250/20,000)	
Dwelling Factor	.21	.33	.21	.33	.21	.33
Total Property Damage						
$20 Billion	5,507	8,654	7,343	11,655	9,178	14,423
$30 Billion	8,260	12,981	11,014	17,483	13,767	21,635
$40 Billion	11,013	17,308	14,685	23,311	18,357	28,846

* Figures derived by use of the following formula

$$\text{Estimated Number of Defaults} = \frac{\text{(Estimated Total Property Damage)(Dwelling Factor)}}{\text{Average Dwelling Loss}} \times \text{Estimated percentage of Defaults}$$

Average dwelling loss is assumed to be $5,720.

defaults. One should also note that higher the estimated number of defaults resulting from the given 20,000 single family dwellings damaged in the 1971 earthquake, the greater is the predicted propensity to default in the next great earthquake.

It should be noted that the effect of net equity is incorporated implicitly within the predictions. It can be assumed that a large percentage of those mortgagors who default will be faced with a negative net equity on their property. The authors considered estimating the number of properties with negative net equities and then using this estimate to arrive at the estimated number of defaults. It was felt that this procedure would result in an overrefinement of an estimation process that was dealing with rather crude input data. In either method the estimated number of defaults would be approximately the same. In addition the estimation process was producing ranges of numbers rather than a specific point estimate.

Greater refinement would be more appropriate in estimating the number of defaults to be incurred by specific lenders. A specific lender could input a model with data on the number of its mortgages outstanding and the net equities of the properties corresponding to these mortgages. Various damage scenarios could be run to arrive at postdisaster net equity distributions which could be used to arrive at estimates of the number of defaults.

One must be very careful in using any historical experience as the basis for predictions of the effects of future catastrophic situations. The estimates of future defaults derived in this study implicitly assumes that such factors as average dwelling loss, propensity to default, the proportion of dwellings damaged, building patterns, and the loss severity distributions will not be substantially different in the next great earthquake.

There is little question that any future event will differ from the past, but to the extent that one can understand how the future will differ, the past can be a good guide. Accordingly, we feel that these estimates are the best to date of future defaults from the next great California earthquake.

Footnotes

1. Wiggins, J. H. Estimated Losses and Premiums by State (1980 values) page 1. "On Earthquake Insurance Losses for Single Family Wood Frame Dwellings," A presentation made by Karl Steinbrugge before the National Committee on Property Insurance in Los Angeles on May 25, 1973.

2. Insurance Information Institute, Insurance Facts 1981-82 Edition, page 51.

3. See for example U.S. Department of Commerce, Environmental Science Services Administration, Coast and Geodetic Survey, Studies in Seismicity and Earthquake Damage Statistics, 1969, A Report Prepared for Department of Housing and Urban Development, Office of Economic and Market Analysis, 1969, Table 2, page 2; and California Division of Mines and Geology, San Fernando, California, Earthquake of 9 February, 1971, Bulletin 196, page 326.

4. McClure, Frank E. Performance of Single Family Dwellings in the San Fernando Earthquake of 9 February, 1971. U.S. Government Printing Office, page 5.

5. Ibid, page 5.

6. The mean loss of $8,112 to properties studied in our sample is higher than the $5,720 figure due to the proximity of our sample of damaged properties to the earthquake's epicenter.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The 1971 San Fernando earthquake presented a unique opportunity to study mortgage default risks associated with natural disasters. Indeed it is the only natural disaster to date which resulted in a significant number of recorded defaults. In this final chapter, the authors will summarize their efforts and offer a number of concluding comments.

THE PARTIAL EQUILIBRIUM EFFECTS OF AN EARTHQUAKE ON MORTGAGE DEFAULT

The impact of the San Fernando earthquake can be divided into partial and general equilibrium effects. The partial equilibrium effect is the effect of the event on variables associated with the individual property and the individual property owner. The general equilibrium effect is the effect on the overall community and climate in the community, which in turn may have an additional effect on property values and other aspects of community life.

A major earthquake directly affects properties, the value of properties, and the lives of individuals. All of these can have mortgage default consequences. In our analysis of the 1971 San Fernando earthquake we found that property damage was potentially an extremely important explanatory variable for the default decision. The damage variable is, however, not important in and of itself, but rather works its influence through its effect on the property owner's net equity. That is, a large amount of damage to a property can be sustained without leading to a high likelihood of default if the property owner has substantial equity in the property. The same volume of damage with different owner equities would lead to different default probabilities. Damage must be viewed in the context of other variables if one is to predict residential mortgage default.

It should be emphasized that the damage that is relevant to default is perceived property damage to the dwelling itself (not damage to contents). If a homeowner mistakenly believes damage has occurred, this false perception is just as important as real damage. The structural factor is important because the damage must be related to the property for net equity to change. Substantial damage to contents will not affect the potential selling price of the home, and hence the probability of default.

Post-disaster net equity is determined by pre-disaster property value, property damage and the existence of debt against a property. Accordingly, those things that determine the mortgage balance and property value will have default consequences. If mortgages against properties are relatively recently originated, if they have high loan to value ratios, or if they are accompanied by junior liens, default probabilities will be higher. The newer alternatives to fixed-rate mortgages may have an impact on default if they have a substantial period or amount of negative amortization. Another set of factors that can affect net equity through their effect on the amount of debt against a property is the existence of disaster loans, and the financial terms of such loans. It is possible that loans terms of disaster loans could affect net equity. We believe that to some degree this was true with SBA loans to homeowners in the San Fernando earthquake.

A second factor affecting net equity is property value. If an area has undergone substantial property appreciation between the time loans were originated and the time of the disaster, this by itself will discourage default. If, however, a property owner responded to increases in property values by borrowing against the additional equity, and did not invest these funds in the property, the increase in property value would not provide a cushion against possible default.

In our empirical work, mortgage variables such as the loan to value ratio at loan origination exhibited little or no independent effect on default. The effect of such a variable works through net equity, not as a supplemental factor in addition to net equity.

We also investigated whether certain personal financial characteristics of homeowners were related to default. Our hypothesis was that on rational economic grounds there is little reason for a homeowner's balance sheet position to affect default. This was supported by the data. Similarly, the income reported by the homeowners at loan origination (as a ratio to monthly mortgage payments) had no independent influence on default.

One variable that did play a significant role in the explanation of mortgage default was our estimate of the property value at the time of the earthquake. This variable was positively related to default--higher valued properties were more likely to experience default than others. We attempted to explain the influence of this variable by breaking it down into appreciation and origination value, but this did not lead to an understanding of the relationship. Why property value should be independently important is not clear to us.

The discussion in the preceding paragraphs is on a set of variables associated with the property and property ownership. A second set of variables we examined relates to the homeowners. We were interested in whether default can be connected to socio-economic variables. Specifically, variables were included that were designed to pick up the influence of emotional and financial problems relating to the earthquake, prior delinquency experience with the mortgage lender, marital status, and others. One might phrase the question as follows: "Is it <u>only</u> property value and loan balance that determine whether default is likely to occur?" The answer is a strong no.

In our investigation of the influence of socio-economic variables on mortgage default we discovered that it was necessary to divide the defaults in our data set into defaults that came about as a result of foreclosure and as a result of the turning over of a deed-in-lieu of foreclosure (DIL). Different variables influenced the two different defaults. Prior delinquency, the existence of secondary financing, divorce subsequent to loan origination, and marital status at origination all were significantly associated with foreclosure but not with DIL. To some extent these variables could have been picking up a difference in lender behavior (particularly the secondary financing and prior delinquency variables) but they also would seem to represent differences in borrower behavior.

There were some socio-economic variables that were significant in their influence on both types of default. Emotional problems (associated with the earthquake) and financial problems fall into this category. A decision to move made prior to the earthquake also seems important to both defaults, but statistical problems with the variable precluded our using it in the regression analysis. The importance of the socio-economic variables reveals that there are factors beyond the simple measurement of net equity that are playing a role in the default decision.

Standing back from the individual variables, a few important conclusions on mortgage default are evident. First, it is unquestionably true that the major influence on default is net equity following the disaster. But related to this is the conclusion that net equity can be influenced by mortgage lenders, by government agencies, and by others. Hence, the incidence or volume of mortgage default can be influenced. Additionally, it is clear that non-property related variables influence default, and especially default that culminates in foreclosure. Here again, some of this default could probably be offset by government and non-government policy action, but lenders (in particular) may not wish to do this in all cases. In some cases the disaster may be the final straw for both the lender and the borrower. There will also be some borrowers for whom default is the only way out. It is even possible that they will default with positive net equity. We observed a sufficient number of cases of default with positive net equity to convince us that it was not simply a problem with our damage estimates.

In sum, it is possible to explain mortgage default or to develop a relationship that estimates the likelihood of mortgage default with a set of economic and non-economic variables. The default process appears to be economically rational and at the same time influenced by other variables that might not fit into everyone's description of economic rationality.

THE GENERAL EQUILIBRIUM EFFECTS OF AN EARTHQUAKE ON MORTGAGE DEFAULT

The partial equilibrium effects are the effects of individual variables on mortgage default. There are additional effects that can come into play that are somewhat like echoes reverberating from the disaster. We refer to these as general equilibrium effects.

The first general equilibrium effect would be that of externalities on site values. A disaster can result in more or less damage than can be measured by its destruction. If a house falls down there is a specific amount of damage incurred, as could be measured by replacement cost. But if all houses on a city block fall, or if all are severely damaged on several blocks, the damage may exceed or fall short of the sum of the replacement costs of the individual properties. This is because there could be an external effect on site value. Suppose all of the residence that were destroyed were in a blighted neighborhood or a slum. The effect of the major destruction might be to raise property values--the neighborhood now could be substantially or totally rebuilt. Similarly, damage might result in a reduction in site values. This would be the case if there was reason to believe the type of disaster might be repeated or if there was permanent damage to the neighborhood. The reduction in site value might also take place if there was a reduction in amenity value, such as the elimination of a lake, pond, cliffs, or other visual attraction.

A closely related general equilibrium effect would be damage to social capital of a community. If an island community loses its bridge to the mainland this would be important additional damage. The same would hold true for damage to sewers, roads, utilities, and retail shopping areas. In many cases the social capital will eventually be replaced, but for some area residents it might be too long in coming. In other cases, the service might never be restored.

A third type of effect is on the employment prospects in the community. A disaster that is large in the context of the community could sufficiently eliminate employment prospects as to encourage a reduction in area population. This would reduce the demand for housing and, hence, for land.

Lastly, a disaster can disrupt the nature of the community itself, such as by forcing the departure of a large number of families of one ethnic group. This might well diminish the attractiveness of the community to others of the community group. A related effect would be on the attitude of residents in an area, and particularly on their attitude towards financial institutions from whom they have their mortgage loans. It is possible that attitudes that would be formed in isolation, if one was the only mortgagor to experience residential damage, would be altered if many others also experienced damage. This would be even more likely if the lender or lenders took action(s) that were viewed favorably or unfavorably by the community of homeowners.

All of these general equilibrium effects share a common element--by eliminating something of value (or changing something of value) they alter the perceived property value. It was concluded with respect to partial equilibrium effects that net equity is an important determinant of default. If the perceived property values fall because of factors other than direct damage to a property, there is every reason to believe that increased mortgage default would be a response. Again, a number of residential properties were observed to go into mortgage default even though our measure of net equity indicated positive net equity.

In the case of interaction between lenders and borrowers there is an added factor. It is possible for lender actions to alter the costs or benefits of defaulting.

In our empirical analysis of default it is impossible to sort out the different effects on property value, and hence on net equity and default. We can recognize the possibilities of overall community changes in property values but in the case of the San Fernando earthquake the damaged communities were not large enough to reflect this kind of change in property value. However, we did observe differing default relationships across different lenders, and this would confirm that lender attitude and behavior can have a mitigating or aggrevating effect on default.

DEFAULTS RESULTING FROM EARTHQUAKES VS OTHER NATURAL DISASTERS

As we have noted throughout this study, a significant number of residential mortgage defaults has only been observed following the 1971 San Fernando earthquake. The authors feel that the key factor in the California case was the total lack of earthquake insurance on private dwellings. The virtual universality of windstorm insurance undoubtedly is the main reason that defaults have not been associated with tornadoes and hurricanes which caused large amounts of wind damage. When present, insurance can be used to either repair the property or reduce the mortgage balance. In either case net equity is approximately returned to its pre-disaster level.

The case of defaults and floods is not so easy to explain. Flood insurance only started to be available to homeowners in 1968 with the establishment of the National Flood Insurance Program. Even after incorporation of this program, much flood damage has not been insured (see our study of Jackson, Mississippi flood [9]). Still we found no evidence of any community incurring a significant number of defaults following a major flood.

The most plausible explanation is that floods often cause more contents than structural damage. Contents damage of course does not influence the default decision. Most floods involve slowly rising water levels. Damage is rarely total as in the case of an earthquake shifting a house off its foundation. Much of the structural damage is interior, such as walls, carpets, cabinets, etc. Such damage, where not insured, can often be repaired slowly and with the homeowners' own labors to minimize costs.

In the flood damaged communities we closely studied, Wilkes-Barre, and Johnstown, Pennsylvania, and Jackson, Mississippi, we sensed a strong sense of community loyalty. A staying power seemed to exist among the damaged mortgagors to stay and fix up their homes. The 1971 San Fernando earthquake hit many newly developed, sprawling neighborhoods. Many of the damaged areas were not old enough to have any sense of community loyalty.

Over time, most property in identified floodplains will be covered by flood insurance due to the requirements of the National Flood Insurance Program. As more exposed property is insured, mortgage default risks associated with floods should decrease. As long as earthquake insurance is not required by lenders and not purchased by homeowners, it can be reasonably expected that disaster related default risks will only be associated with earthquakes. All other major natural disaster damage will be largely insured. Landslide and volcano damage while uninsured, generally do not cause significant property damage relative to other natural disasters.

MORTGAGE DEFAULT RISKS ASSOCIATED WITH FUTURE EARTHQUAKES

It can be expected that earthquake related mortgage default losses will continue to be significant in the future. In Chapter VII, we estimated the number of defaults resulting from the next great California earthquake will be in the range of 10,000 - 20,000. Lesser quakes of the magnitude of the 1971 San Fernando earthquake will result in hundreds of defaults.

The most significant mitigating strategy, a universal earthquake insurance requirement, seems highly unlikely to be implemented. For competitive reasons, lenders will most likely not require earthquake insurance as a condition of a mortgage. Due to the perceived high cost and large deductibles of earthquake insurance, as well as the general attitude of "it can't happen to me," it seems unlikely homeowners will begin purchasing coverage in any significant amounts. Finally, the insurance industry seems mildly apprehensive about having significant amounts of earthquake insurance in force. If earthquake insurance were suddenly universally mandated or demanded, the insurance industry may be hesitant to allocate adequate capacity to cover the increased risks.

Mortgage default risks in general can be expected to increase in the future. It seems unlikely that property values will climb in the future at their pace over the decades of the 1960s and 1970s. As property values increase more slower, or even remain level, net equities will be smaller. Variable rate and adjustable mortgages will result in fluctuating mortgage balances, as opposed to steadily declining balances of traditional fixed rate mortgages. Such fluctuations will often result in lower, even conceivably negative, net equities.

To the extent that the movements in property values and mortgage balances result in lower (possibly negative) net equities, mortgage defaults risks in general increase. The specific case of default-risks associated with earthquakes also increases because properties with lower net equities are more susceptible to post-disaster negative net equities. These increasing risks suggest that the lessons learned in the present study will be both useful and relevant in the future.

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