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1. INTRODUCTION

In the past seven years, the housing finance system has experienced its worst period of delinquencies, foreclosures, and institutional insolvencies since the Great Depression of the 1930s. The anatomy of this financial disaster, which in the end will cost the American public $50 to $100 billion, is now being written. The purpose of this paper is to explore the role played by the mortgage market. In particular, we will explore how asymmetric information in the residential mortgage market, including expanded use of the secondary market and mortgage insurance, may have exacerbated economic trends causing delinquency and foreclosure rates to rise.

The potential impact of asymmetric information between borrowers and lenders is one of the more important implications of information theory. Asymmetric information affects loan markets because lenders cannot accurately identify the default risk of each separate borrower. In particular, adverse selection occurs when the average risk of loans turns out to be higher than expected, while moral hazard occurs when individual borrowers turn out to be riskier than expected. In either case, asymmetric information causes default risk to rise.

Lenders of course will try to reduce or eliminate the effects of asymmetric information. For one thing, they will invest in additional information (borrower screening) to identify high-risk borrowers. But it is a feature of

asymmetric information that the benefits of screening are limited, because high-risk borrowers will try to conceal their true nature.

For another thing, lenders can charge higher interest rates as compensation for higher risk. Higher interest rates, however, reduce the demand of low-risk borrowers more than the demand of high-risk borrowers, which actually makes the problem of adverse selection worse. [1] Credit rationing can then result as a "market failure" in which the market operates less efficiently than it would in the absence of asymmetric information. [2] Information theory thus indicates that asymmetric information may depress loan market activity, with the amount of the effect depending on the total amount of default risk, the diversity of borrowers, and other characteristics of the loan market and the loan instrument.

In this paper, we will examine how adverse selection and moral hazard may be currently operating in the market for residential mortgages. The residential mortgage market is a particularly interesting case for two reasons. First, as shown in Figure 1, the delinquency rate on mortgages rose dramatically between 1980 and 1986, and it is useful to understand why this happened. Second, the mortgage market has undergone substantial changes in recent years, and it is

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[1] High-risk borrowers are less sensitive to high rates because the level of the rate is irrelevant when default occurs.

[2] See Akerlof [1970], Jaffee and Russell [1976], and Jaffee and Stiglitz [1988].

possible that these changes created adverse selection and moral hazard, leading, in turn, to rising delinquency rates.

We will look specifically at two main explanations for rising mortgage delinquency and default rates. One explanation--referred to as the economic environment--is that mortgage market behavior has remained unchanged, but negative shocks in economic conditions have caused ex post delinquency rates to be higher than expected. For example, an unexpected decline in the rate of increase of housing prices would fall within this class.

The second explanation--asymmetric information--is that lenders have responded to changing mortgage market conditions by making loans with higher ex ante risk. For example, managers of failing savings and loan associations may originate high risk-high expected return loans in attempts to save their institutions. The economic environment and asymmetric information may also interact.

In the following, we will first examine the effects of asymmetric information in the mortgage market and how recent mortgage market changes may have increased these effects. We will then turn to the empirical evidence regarding the source of rising delinquency rates in the mortgage market.

II. ASYMMETRIC INFORMATION AND THE MORTGAGE MARKET

The default risk of home mortgage lending is potentially high and variable. For most residential mortgage borrowers, their mortgage debt far exceeds their net worth, and usually even exceeds the gross value of all their assets other than the home. Also, mortgage payments often represent a substantial percentage (usually greater than 25%) of disposable income. Default is thus a distinct possibility for most mortgage borrowers, and the amount of default risk may vary substantially across individual borrowers.

To minimize the effects of asymmetric information, mortgage lenders use screening devices to identify the actual level of risk for each loan, primarily loan-to-value and payment ratios. We will now look at how these work.

Loan-To-Value Ratios

Given the potentially high level of default risk, mortgage instruments have been designed to provide a degree of protection for lenders. By definition, a mortgage is a loan that is secured by real estate. The value of the real estate generally exceeds the amount borrowed, with the excess value representing the equity provided by the borrower. Of course, property values may fall and substantial transactions costs may be incurred in selling properties, so a lender may suffer a loss even when a loan initially appears to be well collateralized.

Nevertheless, the loan-to-value ratio--the amount of the loan divided by the value of the real estate--should be a useful indicator of default risk, with higher ratios indicating riskier loans. A lender can use loan-to-value ratios to classify loans and to charge borrowers the appropriate interest rates. Adverse selection is avoided to the extent that loan-to-value ratios correctly identify the risk level of each loan. Moral hazard is avoided to the extent that a borrower cannot change the loan-to-value ratio after the loan has been made.

However, two problems can arise in using loan-to-value ratios to identify default risk. First, if there is unexpected house price inflation, loan-to-value ratios will change after loans are made. Second, default risk will be understated if the loan-to-value ratio is based on an inflated property value--another form in which moral hazard can occur. To avoid this, lenders will invest resources to obtain accurate appraised values for properties. Lenders, of course, may also choose to understate loan-to-value ratios on loans that are to be sold.

Payment Ratios

Payment ratios--defined as the ratio of mortgage payments (and other homeowner costs) to disposable income--may also serve a screening function for default risk. Mortgage borrowers with higher payment ratios are more likely to

become short of funds and delinquent on loan payments. However, delinquency does not necessarily imply default. [3] In particular, a delinquent borrower with positive equity in the property may be better off selling the property than defaulting on the loan.

Nevertheless, in the presence of transactions costs for home sales, payment ratios are likely to be an independent indicator of default risk. This is illustrated by the following case in which default occurs as the result of a payment delinquency, even though the borrower's equity is positive. Let the transactions costs be represented as θ percent of the sales price P, making $(1 - \theta)P$ the net amount received if the home is sold. If M is the amount of the outstanding mortgage, then one possible situation is that:

$$P > M, \text{ but } (1 - \theta)P < M.$$

In this case, the borrower would ordinarily not default, since the property value P exceeds the mortgage debt M (the equity is positive). However, if there is a payment problem, the borrower is better off defaulting than selling the property, since the proceeds from the sale after transactions costs, $(1-\theta)P$, will not cover the mortgage debt, M.

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[3] See Campbell and Dietrich [1983], Vandell [1987], and Waller [1988] for discussions of the relationship between delinquency created by a shortage of funds and default.

III. CHANGES IN THE RESIDENTIAL MORTGAGE MARKET

The U.S. mortgage market has changed dramatically within the last 15 years, shifting from a system with modest default risk and small effects of asymmetric information to a system with the opposite characteristics. In this section, we describe the main features of the two systems.

The Mortgage Market: 1930s to 1970s

Legislation passed during the Great Depression created a mortgage instrument on which default risk tended to be low and uniform. Relatively low loan-to-value ratios were used, and the mortgages were self-amortizing and fixed-rate instruments. Asymmetric information had a limited role because the level of default risk was relatively low and there was little variation across borrowers.

The structure of the mortgage market also limited the effects of adverse selection and moral hazard. For one thing, thrift institutions had a dominant role in the market, and they generally held all of the mortgages they originated. So there was a limited amount of secondary market trading which could serve as a channel for the selling of riskier mortgages based on asymmetric information. For another thing, mortgage lending by the thrift institutions was regulated to limit default risk.

Recent Changes in the Mortgage Market

The mortgage market started to change during the 1970s as inflation rates and interest rates trended upward. Some of the main factors were:

1. Secondary market mortgage trading expanded as the result of periodic rounds of disintermediation and the establishment of the FNMA and FHLMC mortgage-backed-security programs.

2. Alternative mortgage instruments, such as adjustable-rate mortgages, were developed to allow thrift institutions to hedge the interest rate risk on fixed-rate mortgages and to allow more borrowers to meet the qualification standards.

3. Inadequately capitalized deposit insurance agencies allowed failing thrift institutions to continue to operate.

4. The supply of private mortgage insurance expanded greatly, in large part due to the above factors.

We will now look at how each of these may have created moral hazard and adverse selection in the mortgage market.

Secondary Market Trading of Mortgages

Secondary market trading of mortgage provides an important channel for asymmetric information: lenders may be able to originate high-risk mortgages (at high interest rates) and then to sell them at a high price by concealing

the amount of default risk. Consequently, the relationship between the seller and the buyer of a mortgage parallels the relationship between the borrower and the initial lender. Specifically, secondary market buyers of mortgages will recognize the potential for adverse selection and moral hazard--that sellers will try to sell high-risk mortgages and to understate the default risk--thus raising the possibility that the secondary market will fail to operate efficiently on this account.

As a result, most secondary market transactions use mortgage insurance provided by government agencies (the FHA and VA programs) or private mortgage insurance companies (PMIs). It is evident that the secondary market will operate more efficiently when the risk of default is covered through insurance. However, this raises another question: how does mortgage insurance deal with asymmetric information?

The mortgage insurance companies and the FHA and VA agencies rely on underwriting standards for individual loans to respond to the problems created by asymmetric information. They also enforce reputation standards for lenders: if the loans made by an institution default at a higher rate than the average, then that institution may loose its access to the insurance. In practice, the FHA and VA agencies have enforced stricter lending standards than the private companies, and as we will see in a moment, the agencies have had lower loss rates.

Alternative Mortgage Instruments

The form of the mortgage instrument can also influence the effects of asymmetric information. An interesting case is the self-amortizing mortgage, which has been the standard instrument in the United States since the 1930s. Compared to instruments that allow lump-sum repayment of principal, self-amortizing mortgages should have a lower incidence of default risk, and therefore fewer effects of asymmetric information.

Perhaps more importantly, U.S. mortgage markets now provide borrowers with a choice between fixed-rate (FR) and variable-rate (VR) instruments. VR mortgages increase the problems of asymmetric information, since higher interest rates may unexpectedly raise the payment amount, thus raising the risk of delinquency and default.

However, institutions still have reasons to offer VR mortgages:

- VR mortgages have shorter durations, which may balance the institution's short-term deposits and thus reduce it exposure to rising interest rates.

- Borrowers with higher default risk may identify themselves by self-selecting VR mortgages, which helps reduce adverse selection overall. [4]

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[4] High-risk borrowers may hope that falling interest rates will protect them from default. If interest rates actually rise, the loss due to default is borne by the lender.

- There is a moral hazard with FR mortgages, since more of these mortgages are prepaid after interest rates fall. [5] In addition, FR mortgages will be chosen by borrowers who are flexible in timing their prepayments.

Thrift Institution Capital and Federal Deposit Insurance

Thrift institutions are the dominant lenders in U.S. mortgage markets, which creates a possible connection between mortgage risk and federal deposit insurance. The main link is that deposit insurance provides failing institutions with an incentive to make high-risk mortgage loans (at suitably high interest rates). If the loans turn out well, then the institutions may survive. While if the loans and institutions fail, then the deposit insurance fund has to cover the additional losses.

This does not mean that all thrift institutions act on this moral hazard. In particular, the likelihood of bankruptcy may be very remote for sound institutions with ample capital. The managers of these institutions would therefore anticipate paying for any loan losses out of the institution's capital, and moral hazard would not be a factor in their lending decisions. So the moral hazard of making high-risk loans is mainly a problem with weak institutions.

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[5] However, lenders can be compensated for this risk by charging points (which serve as an option premium) or prepayment penalties (where state laws allow them).

IV. EMPIRICAL EVIDENCE REGARDING DELINQUENCY RATES AND ASYMMETRIC INFORMATION

Figure 1 shows the pattern since 1970 for annual delinquency rates on all outstanding mortgage loans in the United States. From 1971 to 1979, the delinquency rates were relatively stable. They then rose rapidly, reaching a peak of just over 1% in 1985. After 1985, they declined slightly. (We use delinquency rates, instead of foreclosure rates, because the delinquency data are much more accurate. In particular, if and when a loan is foreclosed depends on state law and on whether the loan is insured.)

One explanation for the rise in delinquency rates is that the nationwide figures are dominated by the high rates in Texas and other southwestern states that occurred as a result of falling oil prices and a collapse in the real estate market. However, Figure 2 shows that the same general pattern of delinquency rates occurred in all four main regions of the United States, and the level of delinquency rates is highest in the South (which includes Texas and other southwestern states) only after 1986. Figure 2 thus reinforces the challenge of determining the extent to which the pattern of delinquency rates is the result of the economic environment or asymmetric information.

Evidence for Delinquency Rates by Type of Mortgage

Figure 3 shows the national pattern of delinquency rates since 1970 for four sub-categories of mortgages: conventional, privately insured (PMI), FHA insured, and VA insured. Relative to the delinquency rates on conventional mortgages, the rates on the three classes of insured mortgages are at least twice as high and they are rising. Most dramatically, the delinquency rates on privately insured mortgages are now over three times as high as government-insured mortgages and over six times as high as conventional mortgages.

The high delinquency rates for insured mortgages relative to conventional mortgages is prima facie evidence of adverse selection and moral hazard activity: high-risk mortgages are the ones being insured by federal agencies and private companies. Moreover, since a large percentage of insured mortgages are sold in secondary market transactions, the combination of mortgage insurance and secondary market transactions represents a key channel in which asymmetric information may have an effect.

It is noteworthy note that the loss rates of private mortgage companies rose sharply (including the bankruptcy of one major company) during the period of rising delinquency rates, while the loss rates of federal insurance agencies remained relatively stable. This suggests that the shift to higher-risk mortgages may not have been anticipated by the

private companies, while the federal agencies may have been protected by their stricter standards.

Regression Evidence

We will next look at regression tests that examine the extent to which the pattern of delinquency rates is based on the economic environment and asymmetric information. We will use two sets of annual data, one based on aggregate data for the United States and the second based on cross-section data for individual states. The following describes the variables and interprets the results shown in Table 1 for the aggregate data and in Table 2 for the state data. All data are measured in percent, and the Data Appendix provides complete definitions of the variables.

There is a shortage of observations at the aggregate level, since the main period of interest is from 1970 to 1988 and various data limitations create additional constraints. To be parsimonious with the limited degrees of freedom, we will first separately examine the sets of variables that correspond to the alternative explanations. The last section of this part discusses further tests that we plan to carry out if the appropriate data are made available.

Economic Environment

Equation 1 in Table 1 contains three variables that represent the ex post effects of the economic environment in which lenders were operating during the 1970s and 1980s:

unemployment rate [U]. A higher unemployment rate indicates a weaker economic environment, and thus should be associated with higher delinquency rates.

house price relative [APP] (average house price divided by average house price lagged two years). Higher house prices increase the owner's equity, and thus should be associated with lower delinquency rates.

nominal income relative [INC] (national income divided by national income lagged one year). Higher income growth indicates an improving economic environment, and thus should be associated with lower delinquency rates.

The signs of the estimated coefficients shown in equation (1) are as expected, but even the largest t-statistic is only 1.08. Also, the R^2 is only .37 and the Durbin-Watson statistic is only .35, indicating a poor fitting relationship and possibly omitted variables. The tentative conclusion from these results is that factors other than the economic environment must play an important role in explaining the observed pattern of residential mortgage delinquency rates.

The results of estimating a comparable state cross-section equation are shown in equation (1) of Table 2. The state delinquency rates are measured as of the second quarter of 1988, the unemployment rate is the 1987 annual average, the house price relative covers the period from 1985 to 1987, and the income relative covers the period from 1986 to 1987. The state cross-section results are similar to the aggregate time-series results, with the exception that higher income relatives are a significant factor (t-statistic = 3.8) in lowering delinquency rates.

Contract Terms

Equation 2 in Table 1 contains two variables that represent the contract terms that lenders set at the time a mortgage is originated:

loan-to value ratio [LVR]. A higher loan-to-value ratio indicates that borrowers have less equity invested in their homes, which should be associated with higher delinquency rates.

payment ratio [PMT] (annual mortgage payment to annual income). A higher payment ratio indicates that borrowers are covering their payments with less income, which should also be associated with higher delinquency rates.

The signs of the estimated coefficients in equation (2) are as expected and both are statistically significant. The

goodness of fit is also somewhat better than for equation (1). The tentative conclusion is that there does appear to be a significant relationship between loan contract terms and mortgage delinquency rates. This relationship could reflect either the economic environment or asymmetric information. On the one hand, lenders who expect an improving economic environment might be willing to bear the risk of higher loan-to-value and payment ratios. On the other hand, lenders might make riskier mortgages because they expect to sell them at a price that does not discount all of the risk.

The results of estimating a comparable equation on a state cross-section basis are shown in equation (2) of Table 2. The state cross-section and aggregate time-series results are similar, but the explanatory power of the cross-section regression is very low and the payment ratio has the wrong sign and is not significant.

Adverse Selection and Moral Hazard

Equation 3 in Table 1 shows three variables that represent channels for the influence of asymmetric information on delinquency rates:

secondary market ratio [SEC] (the ratio of mortgage loans sold in the secondary market to total loans outstanding). A higher secondary market ratio improves the opportunities for lenders to sell high-risk mortgages. Accordingly, the variable should be associated with higher delinquency ratios.

saving and loan (S&L) capitalization rates [SL] (S&L capital to total deposits). Higher S&L capitalization rates reduce moral hazard in S&L mortgage originations, which should be associated with lower delinquency rates.

AR mortgages as a percentage of total mortgages [AR]. If AR mortgages have greater levels of default risk, the variable should be associated with higher delinquency rates.

The signs of the estimated coefficients in equation (3) are as expected, but only the secondary market variable SEC is statistically significant. [6] The goodness of fit, with an R^2 of .87, is substantially higher than for equations (1) and (2). The tentative conclusion is that the tested variables, especially the secondary market ratio, represent an important channel for the effect of asymmetrical information on mortgage delinquency rates. A comparable state cross-section equation could not be estimated because the necessary state data have not yet been made available to us.

Combinations of the Variables

Although the logical next step would to be combine the three sets of variables in a single equation, the limited amount of annual data makes this not practical. To illustrate the nature of the results, however, we show in

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[6] The regression is estimated starting in 1975 because reliable data for the variable SEC are not available earlier.

equation (4) of Table 1 an equation that combines one variable from each of the groups: U, LVR, and SEC. The equation indicates that each of the three factors--economic environment, contract terms, and the secondary market--has a role in determining delinquency rates, and together they explain a substantial part of the variation (R^2 = .88). Moreover, the secondary market ratio, which we interpret as a channel for the effects of asymmetric information, is highly significant (t-statistic = 6.3). Other combinations of variables from the three groups yielded similar results.

Agenda for Future Empirical Research

The regression results presented here are preliminary, pending access to more complete data. The following is a list of further tests we hope to carry out shortly.

- Expected changes in the economic environment are distinguishable from changes that are a surprise. Expected changes should influence the contract terms, but not the delinquency rates, while surprises should have the opposite effects.

- Variables representing the contract terms, such as the oan-to-value and payment ratios, could be treated as the dependent variables in an analysis that looked at the ex ante decisions made by mortgage lenders. These results could then be integrated with an analysis of the delinquency rates that occur ex post as a result of the actual economic environment.

- Tests could be carried out to determine how the economic environment, contract terms, and asymmetric information interact in determining delinquency rates. For example, asymmetric information might mainly affect delinquency rates when the economic environment is unexpectedly depressed, in which case the rise in delinquency rates could be greater than would be predicted on the basis of either factor alone.

- Tests of the secondary market ratio and other channels for the effects of asymmetric information should be carried out on a state cross-section basis. A data base might also be assembled for pooled time-series, cross-section, regressions.

- Further insight into the effects of asymmetric information could be provided by analyzing the delinquency rates of sub-categories of mortgages, such as those insured by the private mortgage companies or federal agencies.

V. CONCLUSIONS

Information theory indicates that asymmetric information can have an important influence on loan market activity. This influence, moreover, may be an increasing function of the underlying level of risk, the diversity of borrowers, and the opportunities for transferring risk that are available in the market. It is thus plausible that recent changes in the residential mortgage market have provided a channel through

which asymmetric information creates higher mortgage delinquency ratios.

Our preliminary empirical tests provide a set of results that are consistent with the hypothesis that asymmetric information has been a significant factor creating higher mortgage delinquency rates. The mortgage market, however, has a complex structure in which both asymmetric information and the expected economic environment may influence lending decisions, while lending decisions and the economic environment jointly determine the actual delinquency rates. We hope to assemble in the near future a more complete data base to carry out further tests of this complex structure.

DATA APPENDIX

Delinquency rates: The Mortgage Bankers Association's publication, National Delinquency Survey, provided data on delinquencies and foreclosures on a national and state by state basis for conventional, VA, and FHA insured loans. Moody's Annual Report of the Private Mortgage Industry provided data on losses sustained on PMI insured loans.

Mortgage contract terms: Loan-to-value ratios [LVR] are the average ratios for existing home mortgages from the Federal Home Loan Bank Board. The mortgage payment ratio [PMT] is computed for current existing home mortgages as follows:

$$\frac{\text{(average loan size)(average mortgage rate)}}{\text{average household income}}.$$

Economic variables: The unemployment rate [U] is from the Bureau of Labor Statistics, house price relatives [APP] are based on the existing home prices of the National Association of Realtors, and income relatives [INC] are based on per capita personal income from the Department of Commerce.

Asymmetric information variables: The secondary market ratio [SEC] equals total mortgage-backed security issues (tabulated by FNMA, FHLMC, GNMA, and Solomon Brothers) divided by total mortgage originations (from the Department of Housing and Urban Development). Savings and loan capitalization ratios and adjustable rate mortgage ratios are FHLBB data.

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Table 1

Annual Aggregate Regression Estimates

(absolute value of t-statistics in parentheses)

Dependent Variable

[DR] Delinquency rate, all outstanding loans

Independent Variables

[U] Unemployment rate
[APP] House price relative
[INC] Income relative
[LVR] Loan-to-value ratio
[PMT] Payment ratio
[SEC] Secondary market ratio
[SL] Savings and loan capitalization ratio
[AR] Adjustable rate mortgage ratio

Equation 1 (Economic Environment)

$$DR = \underset{(1.6)}{4.3} + \underset{(1.1)}{.04\ U} - \underset{(.71)}{.60\ APP} - \underset{(1.0)}{2.93\ INC}$$

$R^2 = .37$ D.W. = .37 Sample: 1970 to 1988

Equation 2 (Contract Terms)

$$DR = \underset{(2.1)}{-4.5} + \underset{(2.9)}{.06\ LVR} + \underset{(2.2)}{.02\ PMT}$$

$R^2 = .41$ D.W. = .47 Sample: 1970 to 1988

Equation 3 (Asymmetric Information)

$$DR = \underset{(2.1)}{.74} + \underset{(2.2)}{.01\ SEC} - \underset{(.88)}{.06\ SL} + \underset{(1.13)}{.28\ AR}$$

$R^2 = .87$ D.W. = 1.04 Sample: 1975 to 1988

Equation 4 (Combined Variables)

$$DR = \underset{(1.5)}{-2.7} + \underset{(1.52)}{.04\ LVR} + \underset{(2.20)}{.05\ U} + \underset{(6.25)}{.01\ SEC}$$

$R^2 = .82$ D.W. = 1.11 Sample: 1975 to 1988

Table 2

State Regression Estimates

(absolute value of t-statistics in parentheses)

Equation 1 (Economic Environment)

$$DR = \underset{(3.8)}{30.5} + \underset{(.74)}{.05\ U} - \underset{(.21)}{.15\ APP} - \underset{(3.8)}{28.1\ INC}$$

$R^2 = .46$ Sample: 51 states, 1988-2.

Equation 2 (Contract Terms)

$$DR = \underset{(2.3)}{-4.1} + \underset{(2.9)}{.07\ LVR} - \underset{(.72)}{.002\ PMT}$$

$R^2 = .15$ Sample: 51 states, 1988-2.

Figure 1

NATIONAL DELINQUENCY RATIOS, ALL LOANS

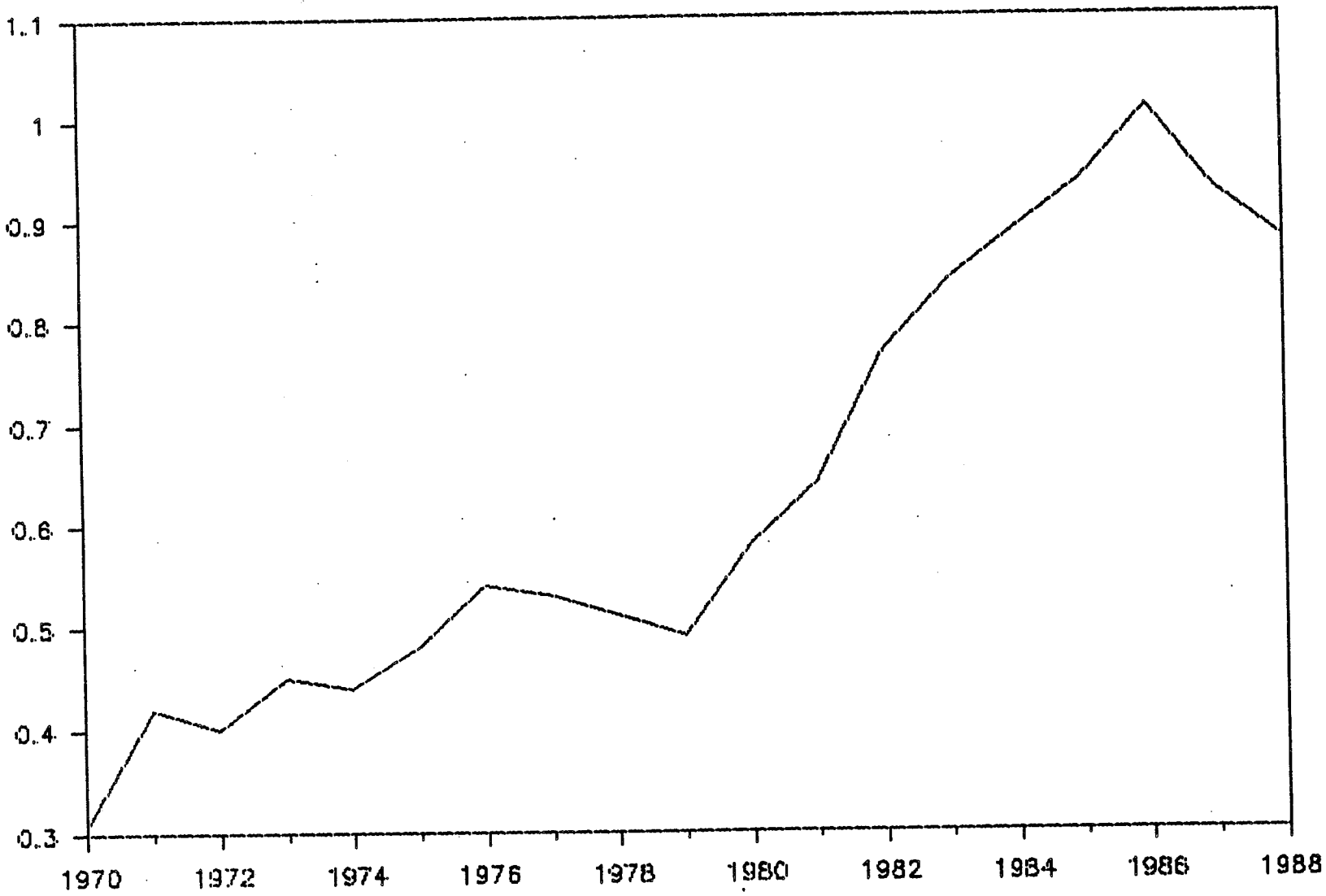

Figure 2

Regional Deliquency Ratios, All Loans

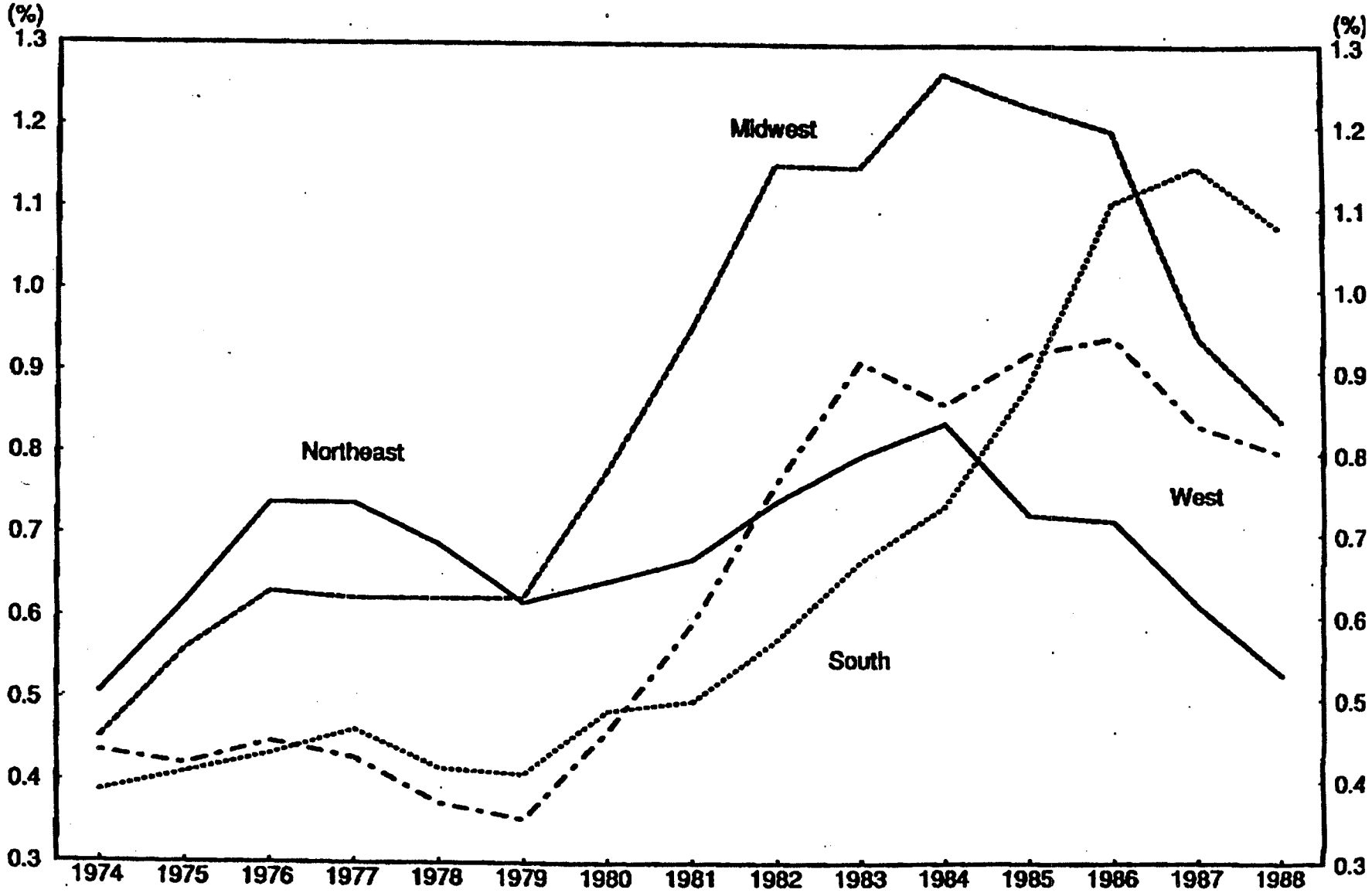

Figure 3

Deliquency Ratios by Type of Loan