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Mortgage Redlining: Race, Risk, and Demand

ANDREW HOLMES and PAUL HORVITZ*

ABSTRACT

Charges that geographical redlining is widely practiced by mortgage lenders and is associated with racial discrimination have received much attention. However, empirical research in this area has yet to document a convincing answer to the question of whether redlining even exists. Much of the previous research in this area has suffered from failure to account for variations in risk, and/or failure to adequately control for geographical differences in demand. This study addresses these problems in an effort to determine whether the disparity in the flow of mortgage credit can be explained by differences in risk and demand.

THE U.S. MORTGAGE MARKET is operationally efficient with long-term mortgage loans made to highly leveraged borrowers at very thin spreads above the lender's cost of funds. There has long been controversy, however, with respect to considerations of equity. Legislation on this issue began with the Fair Housing Act of 1968, followed by the Equal Credit Opportunity Act of 1974, and the Home Mortgage Disclosure Act of 1975 (HMDA). It is now over 15 years since passage of the Community Reinvestment Act of 1977 (CRA). This legislation was designed to assure that banks meet the credit needs of neighborhoods in their service areas. In recent years much attention in the administration of the CRA has been devoted to the issue of racial discrimination in mortgage lending. Questions still remain as to whether the decisions of mortgage lenders are influenced by the race of the loan applicant or on the racial composition of his neighborhood.

Redlining is the refusal of lenders to make mortgage loans in certain areas regardless of the creditworthiness of the individual loan applicant. Many studies claim to verify the existence of racially based mortgage redlining. The earliest studies were generally carried out by community groups and were rather crudely done. For a summary of such studies, see Benston (1981). Several studies appear in professional literature (for example, see Bradbury, Case, and Dunham (1989) and Hutchinson, Ostas, and Reed (1977)). From a public policy standpoint, these findings, if valid, would indicate a need for additional regulation to ensure social equality. Additionally, the existence of redlining in the absence of structural defects in the market would conflict

* Sam Houston State University and the College of Business Administration, University of Houston, respectively. We thank Clifford Fry, William Kretlow, Archer McWhorter, Bernell Stone, Michael Pinegar, Grant McQueen, and particularly, George Benston and René Stulz for helpful comments.

with the economic man assumption upon which much of economic analysis is based. That is, mortgage lenders are rational agents functioning in a competitive market. Rational agents would not reject profitable projects based on noneconomic criteria such as race.

Indirect evidence in support of the economic man assumption can be found in the literature on the performance of minority-owned banks. If redlining is racially induced, then minority-owned banks should be the beneficiaries of this prejudice since they would have little competition for the profitable projects in minority neighborhoods. This should lead to superior profitability at these institutions. However, this is not the case. Bates and Bradford (1980), Boorman and Kwast (1974), and Brimmer (1971) all document lower profitability at minority-owned banks. Additionally, Kwast (1981) finds evidence of higher loan losses and Meinster and Elyasiani (1988) show higher operating expenses at these institutions. While there are alternative explanations for the poor performance and higher risk observed at minority-owned institutions, the experience of these banks does not support the idea that mortgage lenders are rejecting good loan applications by minority borrowers who presumably could be served by these banks.

Most of the studies claiming to verify the existence of redlining suffer from at least two design flaws. First, the methods employed to control for differences in the demand for mortgage credit are inadequate. There is little doubt that the flow of mortgage credit is uneven. However, both the supply and the demand for mortgages must be examined in an analysis of redlining (see Benston (1981) for a discussion of demand side modeling). Second, there is no attempt to control for the risk differences of different geographic areas. Mortgage lending requires examination of the risk and return aspects of the loan. As such, risk differences must be accounted for when examining alleged redlining. Masulis (1982) uses an option-pricing framework to determine the effect that borrower characteristics, real estate valuation risk, and depreciation rates have on the market value of a mortgage, and thus on the decisions of the various parties involved. Those aspects of a mortgage which increase the uncertainty of its cash flows also decrease its market value. That is, loans that have greater default risk or greater depreciation risk have lower values. Therefore, lenders either attempt to offset this additional risk (e.g., by issuing shorter maturity loans or charging higher rates, etc.) or minimize the number of these riskier loans made. To the extent the current operating environment precludes altering the terms of mortgages with different risk characteristics (due to the CRA or community group pressure or the fear of being accused of discrimination), lenders rationally avoid these higher risk loans. If these higher risk loans are geographically clustered, this rational risk aversion on the part of the lender creates the appearance of redlining. The intent of this research is to examine whether racial composition affects the flow of mortgage credit after controlling for the relevant economic variables, including differences in risk and demand.

The initial allegation of redlining in the 1960s involved ethnic white neighborhoods in older cities. In recent years, more attention has been

devoted to alleged racial discrimination in mortgage lending, and the issue has been linked with the redlining controversy. However, these remain separable issues. The existence of geographical redlining could be independent of the discrimination issue.

Recent empirical research can be dichotomized into studies using survey data obtained through interviews in a few neighborhoods, and studies using data reported by lenders as required by the HMDA. The former use considerable data on individual housing and mortgage decisions to examine a small number of communities, while the latter have coverage of nearly all mortgages made, but only limited variables that can proxy for demand differences.[1] The studies employing survey data usually fail to find evidence supporting the claim of redlining, while those studies using HMDA data usually do. The recent work of Bradbury, Case, and Dunham (1989) attempts to deal with the need to control for differences in demand. However, that study has been criticized by, among others, Benston and Horsky (1992).

Those conducting personal surveys are able to inquire into the location decision of the resident, and to ask about difficulties in obtaining financing. Such studies are expensive, and necessarily involve small samples. Studies using HMDA data, on the other hand, do not adequately adjust for differences in demand across geographic areas. An effect attributed to race may simply reflect demand factors which are unaccounted for. Moreover, the failure of such studies to account for risk differences means that the issue is still open.

This article examines whether the flow of mortgages is affected by the racial composition of census tracts in Houston. This study differs from the existing literature in four important ways. First, Houston is a particularly interesting city to analyze because housing in Houston has experienced dramatic price swings and record numbers of residential foreclosures. Since variation is necessary for statistical power, this provides a unique opportunity to measure both price risk and default risk. Second, Houston has two large minority groups. Third, a much-improved data set is used. The recent release of the 1990 census and the expansion of data reported under the HMDA make a more current and rigorous study possible. Finally, improvements are made in modeling the demand side of the mortgage market.

The next two sections of the paper describe the data and our methodology. The following section discusses the results. Our conclusions are summarized in the final section of the paper.

I. Data

The data used in this project are more complete and up to date than data available for earlier studies. The mortgage data are from the HMDA, cover-

[1] Examples of the former include Benston, Horsky, and Weingartner (1978), Benston and Horsky (1979, 1992). Examples of the latter are Ostas, Reed, and Hutchinson (1979), Leahy (1985), and Bradbury, Case, and Dunham (1989).

age of which was extended in 1989 and 1990. In 1989, mortgage-banking subsidiaries of depository institutions became subject to HMDA reporting, and in 1990 independent mortgage bankers were covered. This latter change increased the number of loans reported by 15 percent. Even with this expanded coverage, the HMDA does not cover all mortgage loans made.[2]

Because of the improved coverage, the 1990 data should provide better estimates than the data for earlier years. However, mortgage lending exhibits substantial year-to-year variation. This suggests using several years of data to average out these differences. To allow for this year-to-year variation, as well as to allow for an analysis of the impact of excluding independent mortgage bankers prior to 1990, we have divided our sample into two periods —1988–1989 and 1990–1991. Previous studies that use reported data have not included the independent mortgage bankers. Dividing the sample in this manner allows us to assess the impact of this omission.

The demographic data are from the 1990 census. The default data come from the Harris County clerk's deed file. The small number of foreclosures during the 1960s and 1970s would not have provided a meaningful measure of risk in most metropolitan areas. However, the number of defaults in Houston during the sample period is large enough to allow calculation of default rates for each census tract. In 1990, 1,800 foreclosures were distributed among the 525 census tracts. Due to the cost of gathering default data, an implicit assumption underlying the analysis is that the distribution of defaults in 1990 is similar to the distribution over the entire sample period. The census and HMDA data are publicly available at federal depository libraries. The default data for Houston was obtained from Real-Comp, a private firm which collects data for the real estate industry.

II. Methodology

We use standard multiple regression methodology to explain differences in mortgage-lending activity by census tract in Houston. Census tracts are an appropriate unit of analysis because they are generally populous enough to allow for calculation of meaningful averages, while they are also small enough to represent reasonably uniform economic units. Larger units, such as zip code areas, lack such internal consistency.

One of the major problems in redlining research is the need to account for differences in demand. An obvious starting place is controlling for the scale of the tracts. Census tracts differ in population, geographic size, and housing stock. Several methods of dealing with this have been considered in the

[2] In particular, loans made by individuals are not subject to HMDA reporting. It is possible that such transactions are more apt to occur in areas of low home prices, and to involve borrowers who could not qualify for loans from institutional lenders. This would tend to bias the results of a study excluding such loans toward the finding of discrimination. Benston, Horsky, and Weingartner (1978) did not find that loans in central city Rochester often were on properties that did not meet code requirements, and hence the owner would not be able to provide an institutional lender with a certificate of occupancy.

literature. One approach is to use the number of households as the measure of size. The problem with this variable is that households includes renters who do not demand mortgages. Bradbury, Case, and Dunham (1989) use the number of mortgageable properties. This measure includes rental units and commercial properties, which may not turn over at the same rate as owner-occupied properties.

The gauge of mortgage activity used as the dependent variable in our regressions is the number of loans made, divided by the number of owner-occupied units in the census tract. The number of owner-occupied units is used to standardize for differences in the size of tracts and potential demand.[3] This form of the dependent variable is intended to control for the number of potential owner-occupant transactions. The task of controlling for differences in actual demand is then reduced to controlling for differences in the mobility (i.e., the propensity to move) of area residents. Mobility will be handled on the independent side of the equation and will be discussed more completely below. We fit separate equations for government-insured loans (Federal Housing Administration and Veterans Administration), and conventional loans.

The emphasis in our analysis is on conventional loans, because this is where allegations of redlining and discrimination have been focused. In fact, some of the early allegations of redlining claimed that lenders forced Federal Housing Administration loans on the redlined area. The implication of this is that government-insured loans are a somewhat inferior product from the point of view of borrowers. The differences between conventional and government insured loans are significant to some borrowers. Insured mortgages involve higher administrative costs to lender and borrower, and the borrower must pay the mortgage insurance premium. On the other hand, insured mortgages have a lower down payment requirement, which makes them more attractive for some borrowers. To test whether racial redlining takes the form of altering the distribution between conventional and government-insured mortgages, we fit an equation in which the dependent variable is the ratio of conventional loans to total loans.

The HMDA and the census provide data on a large number of variables that are potentially important to the mortgage-lending process. We use five categories of variables. First are property and loan characteristics, used to gauge the economic viability of the mortgage loan. The variables in this category are median home value, the percentage of homes in the tract that are vacant, and the ratio of average loan size to average home value.

The second category of variables relates to the economic condition of the residents of the census tracts. The paper considers four such factors: median

[3] In order to determine whether the results are sensitive to the form of the dependent variable, several different denominators are substituted for the number of owner-occupied units. These alternatives include total population, number of single-family homes, and number of households. None of the alternative specifications qualitatively affect the results, indicating that the model is quite robust to changes in the dependent variable.

household income; the percentage of heads of households in their prime home-buying years (age 25 to 34); percentage of adult residents with some college experience; and, as a measure of leverage, the percentage of owner occupants whose mortgage payment is greater than 30 percent of income. Additionally, the square of the income variable is included due to an observed nonlinear distribution of median income. All the above variables come from the 1990 census.

Third are variables indicative of the risk inherent in loans made in each census tract. Risk is a crucial element in the lending process, yet other studies employing reported data lack good measures of risk on a census tract basis. There are two related but separable sources of risk to mortgage lenders. One is the probability of default by a borrower. The second is the risk of price depreciation which affects the amount of loss, once a default and foreclosure takes place. The Houston market over the 1988 to 1991 period provides an unusual opportunity to measure these risks. Mortgage defaults became very common. Also, Houston house prices during the 1980s experienced large but geographically uneven price declines. Studies conducted in healthier markets, or during more benign times for the mortgage-lending business, cannot adequately consider risk.

Default risk is measured by the number of defaults on government-insured loans in 1990 as a percentage of the number of insured loans made over the sample period. This is intended to minimize a potential problem in interpreting the default risk variable that could result if minority loan applicants are subjected to more stringent credit requirements. If there were such racial discrimination in mortgage lending, we would expect defaults by minority borrowers to be lower than normal. Thus, the default rate could be a misleading indicator of risk for use in an analysis of redlining. To minimize this possibility, we use defaults on government-insured mortgage loans, on the assumption that discrimination is less likely on these loans (most of which will be sold in the secondary market, rather than held in portfolio). Risk is also measured by the depreciation of property values, specifically the percentage change in median home value.

Variables of the sort falling into these three categories represent economically justifiable and appropriate factors that a rational lender would consider. They are useful in analyzing the supply of mortgage credit. In order to more fully evaluate differences in demand, however, some measure of mobility, or the tendency of the population to seek mortgage loans, is needed. Adjusting for differences in the mobility of residents in each census tract is the key element in controlling for differences in demand.

Mobility is proxied by three variables. The first of these is the percentage of current owner occupants who have moved into the area between 1985 and 1990. This will gauge the propensity of area residents to move into or out of a neighborhood. An area into which a large percentage of the residents have recently moved would be experiencing high turnover and thus should have a high demand for mortgages. The second proxy is the percentage change in the number of owner-occupied units between 1980 and 1990. This will control for

any growth or shrinkage of the area. An area which has experienced a larger amount of development will have many new residents and thus many new mortgages. This variable will account for the effect of new construction on the flow of mortgages. Last, the percentage of single-family homes that are rental units will be included. The existence of rental property may affect the value of the dependent variable, particularly in areas with low home values. If an area is redlined, there may be more rental homes in that area due to the inability of local residents to obtain financing. If these rental units turn over more frequently than the average property, this would increase the number of mortgages granted, obscuring any effect from redlining. The purpose of this variable, then, is to control for the possibility that financing of landlord-owned rental units could mask the effect of redlining.

Finally, to determine whether redlining on a racial basis exists, we need to include variables reflecting racial characteristics of the census tracts. If racially based redlining exists, the coefficients of these variables will be significant. If the variables are not significant, we will conclude that such redlining does not exist in Houston. Since Houston has two large minority groups, two of the variables used are the percentage of the census tract population that is Black and the percentage Hispanic. In addition to the static view of racial composition, Hutchinson, Ostas, and Reed (1977) find evidence that changing racial composition impacts the flow of mortgages. That is, they find that areas with an increasing percentage of minority residents receive fewer loans. It is possible that changing demographics are related to changing economic factors. If these economic factors causing the racial changes are not considered, then these changes could create the appearance of redlining. However, if all relevant economic factors are included, the racial changes should not affect the flow of mortgages in a properly functioning market. To test for this phenomenon, the third variable in this category is the change in the percentage of residents classified as belonging to a minority group between 1980 and 1990. All variables employed are described in Tables I and II, which provide information on the distribution of the variables employed as well as correlation among the variables.

III. Results

Over the 1988 to 1991 period, the raw data show that census tracts in Houston in which Blacks constitute more than 80 percent of the population receive an average of 20 conventional mortgage loans, while tracts in which Blacks constitute less than 20 percent of the population receive an average of 121 conventional mortgage loans. The purpose of this study, of course, is the see whether this discrepancy can be explained on the basis of economic variables. The raw mortgage data are summarized in Table III.

A. Conventional Loans

Table IV shows the results of the different regressions for both periods. The model does a good job of explaining the variation in the flow of mortgage

Table I

Summary Statistics

CONV1 is the dependent variable (loans divided by owner occupants) for conventional loans for 1988 to 1989. INS1 is the dependent variable for insured loans in 1988 to 1989. CONV2 and INS2 are the dependent variables for 1990 to 1991. HISP is the percentage of residents that are Hispanic and BLACK is the percentage that are black. CHGMINOR is the change in the percentage of minorities between 1980 and 1990. VALUE is the median home value. LTV is the ratio of average loan to average value. INCOME is the median household income. AGE is the percentage of adult residents between the ages of 25 and 34. COLLEGE is the percentage of adult residents who have at least one year of formal education after high school. MORTRAT is the percentage of owner occupants whose mortgage-payment-to-gross-income ratio is greater than 30 percent. HVCHG is the change in median home values between 1980 and 1990. DEFAULTS is the natural log of the insured-defaults-to-mortgages-granted ratio. TURNOVER is the percentage of area residents who have moved in since 1985. NEWOWN is the percentage change in the number of owner occupants between 1980 and 1990. SFRENT is the percentage of single family homes that are rental units.

Variable	Mean	Minimum	Maximum
CONV1	0.025007	0	0.399160
INS1	0.013146	0	0.110197
CONV2	0.029459	0	0.210332
INS2	0.007805	0	0.068182
HISP	24.999124	0.287742	95.985130
BLK	23.172753	0.129132	99.482060
CHGMINOR	11.975137	−19.427600	55.945230
VALUE	82.285634	18.800000	1459.701000
VACANT	13.217154	2.057000	67.535400
LTV	0.882063	0	5.342298
INCOME	35.649595	4.999000	290.883000
AGE	19.090083	5.986400	45.355900
COLLEGE	43.542005	5.762800	97.803800
MORTRAT	16.266851	0	38.714500
HVCHANGE	34.494205	−40.000000	538.955800
DEFAULT	−4.652743	−9.210340	1.386319
TURNOVER	28.267667	0	76.926200
NEWOWN	8.461049	−76.144000	2132.569000
SFRENT	21.876277	0	79.166700

credit. The R^2 for the conventional loans was 43 percent in the first period and 59 percent in the second.

The major result of this research is that the data do not support allegations of redlining in the conventional loan market. In the 1990 to 1991 period, all of the coefficients on the noneconomic variables are insignificant. That is, racial characteristics or changes in racial characteristics do not affect the flow of conventional mortgage credit.

While each noneconomic variable is insignificant in the 1990 to 1991 period, it is possible that several insignificant variables could have a combined effect that is significant. An F-test comparing the full model with one omitting the three racial variables was performed. For the 1990 to 1991

period, the full model does not do a better job of explaining the variation in the dependent variable than the restricted model (F-statistic = 0.89). Therefore, the data provide no evidence of racially based redlining in this period, even when all the racial variables are considered together.

In the 1988 to 1989 period, the coefficients on BLACK and HISP are also insignificant. However, the coefficient on CHGMINOR is negative and significant. This has three possible interpretations. First, this could result from a bias against areas with increasing minority populations. Second, this could also be due to some inadequacy in the model that does not properly gauge changing economic factors in areas that have changing racial composition. However, since the model was the same in both periods these first two possible solutions seem doubtful. The third alternative is that this result is induced by a data problem in this period. Specifically, independent mortgage bankers are not included in the 1988 to 1989 period. It is possible that the omission of the mortgage bankers induces this result. If this is the case, it would explain why many earlier studies that used reported data found evidence to support allegations of redlining. In any case, the economic significance is very small.

Home value is significant and positive in both periods, indicating that areas with higher home values tend to receive more conventional mortgage loans. One reason this relationship is strong is that, because of large fixed costs, lenders are reluctant to make small mortgage loans. Census tracts with low-priced houses (not uncommon in Houston) may receive few mortgage loans from institutional lenders.

At this point, discussion of the interpretation of the coefficients may be useful. As an example, consider the coefficient on VALUE in the 1990 to 1991 period of 0.000148. Since values are stated in thousands, an increase in home values of $10,000 would increase the predicted value of the dependent variable by 0.00148. This can be interpreted as increasing mortgages as a percentage of owner occupants by 0.148 percent. Evaluated at the mean number of owner occupants of 1,072, this translates to an increase of about 1.6 conventional mortgages. So, all else constant, increasing the median home values by $10,000 would lead to a predicted increase of about 1.6 conventional mortgages in the average census tract.

The loan-to-value (LTV) ratio is also significant, but has a positive sign. We anticipated that the higher risk inherent in high LTV ratios would result in a negative sign. It appears, however, that high values of the ratio indicate lender confidence in the area, and willingness to make loans on such terms meets a large demand. The interpretation of this variable illustrates a problem in distinguishing ex ante and ex post effects. Undoubtedly, other things being equal, a high LTV ratio in an application will be a negative factor in a lender's mortgage decisions (ex ante). Given that the loan has been made (ex post), however, it can be interpreted as a favorable indicator of willingness to lend in a particular area.

Borrower characteristics also affect the flow of mortgage credit. Although AGE is insignificant in both periods, it does have the anticipated positive

Table II

Simple Correlations

CONV1 is the dependent variable (loans divided by owner occupants) for conventional loans for 1988 to 1989. INS1 is the dependent variable for insured loans in 1988 to 1989. CONV2 and INS2 are the dependent variables for 1990 to 1991. HISP is the percentage of residents that are Hispanic and BLACK is the percentage that are black. CHGMINOR is the change in percentage of minorities between 1980 and 1990. VALUE is the median home value. LTV is the ratio of average loan to average value. INCOME is the median household income. AGE is the percentage of adult residents between the ages of 25 and 34. COLLEGE is the percentage of adult residents who have at least one year of formal education after high school. MORTRAT is the percentage of owner occupants whose mortgage-payment-to-gross-income ratio is greater than 30 percent. HVCHG is the change in median home values between 1980 and 1990. DEFAULTS is the natural log of the insured-defaults-to-mortgages-granted ratio. TURNOVER is the percentage of area residents who have moved in since 1985. NEWOWN is the percentage change in the number of owner occupants between 1980 and 1990. SFRENT is the percentage of single family homes that are rental units. *p*-Values in parentheses.

	CONV1	INS1	CONV2	INS2	HISP	BLK	CHGMINOR	VALUE	VACANT
CONV1	1.00000								
	(0.0)								
INS1	−0.04364	1.00000							
	(0.3331)	(0.0)							
CONV2	0.71143	0.05179	1.00000						
	(0.0001)	(0.2506)	(0.0)						
INS2	0.15867	0.57023	0.26244	1.00000					
	(0.0004)	(0.0001)	(0.0001)	(0.0)					
HISP	−0.23664	−0.10465	−0.30191	−0.16740	1.00000				
	(0.0001)	(0.0200)	(0.0001)	(0.0002)	(0.0)				
BLK	−0.29486	−0.02320	−0.28093	−0.13160	−0.30410	1.00000			
	(0.0001)	(0.6070)	(0.0001)	(0.0034)	(0.0001)	(0.0)			
CHGMINOR	−0.12017	0.20091	−0.10021	0.18775	0.37146	−0.22333	1.00000		
	(0.0075)	(0.0001)	(0.0259)	(0.0001)	(0.0001)	(0.0001)	(0.0)		
VALUE	0.42113	−0.04760	0.46655	0.01782	−0.27690	−0.25859	−0.12358	1.00000	
	(0.0001)	(0.2911)	(0.0001)	(0.6928)	(0.0001)	(0.0001)	(0.0060)	(0.0)	
VACANT	−0.12924	−0.12002	−0.13794	−0.09552	0.22697	0.38515	0.10925	−0.21537	1.00000
	(0.0040)	(0.0076)	(0.0021)	(0.0338)	(0.0001)	(0.0001)	(0.0151)	(0.0001)	(0.0)
LTV	−0.07576	−0.12463	−0.10691	−0.03215	0.18460	0.04710	−0.10955	−0.25603	0.15701
	(0.0926)	(0.0055)	(0.0175)	(0.4759)	0.0001	(0.2961)	(0.0148)	(0.0001)	(0.0005)
INCOME	0.33376	0.19791	0.39039	0.20038	−0.32576	−0.32853	−0.09714	0.81509	−0.38900
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0309)	(0.0001)	(0.0001)

Table II—*Continued*

	CONV1	INS1	CONV2	INS2	HISP	BLK	CHGMINOR	VALUE	VACANT
AGE	0.34348	0.17244	0.35026	0.29137	0.09898	−0.29631	0.31481	0.00241	0.09525
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0278)	(0.0001)	(0.0001)	(0.9574)	(0.0343)
COLLEGE	0.62606	0.11523	0.65210	0.23365	−0.54626	−0.36758	−0.11321	0.59308	−0.38596
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0118)	(0.0001)	(0.0001)
MORTRAT	−0.22463	0.00148	−0.13302	−0.15789	−0.08548	0.56620	−0.21197	−0.04370	0.13068
	(0.0001)	(0.9738)	(0.0031)	(0.0004)	(0.0576)	(0.0001)	(0.0001)	(0.3324)	(0.0036)
HVCHANGE	0.23371	−0.00359	0.30976	−0.00025	−0.17721	−0.09474	−0.20417	0.74928	−0.12458
	(0.0001)	(0.9366)	(0.0001)	(0.9957)	(0.0001)	(0.0353)	(0.0001)	(0.0001)	(0.0056)
DEFAULT	−0.32426	0.27475	−0.31505	0.10721	0.10626	0.20500	0.13808	−0.22675	−0.00827
	(0.0001)	(0.0001)	(0.0001)	(0.0171)	(0.0182)	(0.0001)	(0.0021)	(0.0001)	(0.8545)
TURNOVER	0.43098	0.31744	0.53220	0.42364	−0.19631	−0.47782	0.13805	0.31429	−0.29859
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0021)	(0.0001)	(0.0001)
NEWOWN	0.01567	0.25900	0.16269	0.28424	−0.15254	−0.10349	−0.02666	0.09184	−0.17598
	(0.0188)	(0.0001)	(0.0003)	(0.0001)	(0.0007)	(0.0214)	(0.5544)	(0.0413)	(0.0001)
SFRENT	−0.00863	−0.08078	−0.08864	−0.00391	0.40657	0.14958	−0.00855	−0.31863	0.42866
	(0.8483)	(0.0728)	(0.0490)	(0.9310)	(0.0001)	(0.0009)	(0.8497)	(0.0001)	(0.0001)

	LTV	INCOME	AGE	COLLEGE	MORTRAT	HVCHANGE	DEFAULT	TURNOVER	NEWOWN	SFRENT
LTV	1.00000									
	(0.0)									
INCOME	−0.32265	1.00000								
	(0.0001)	(0.0)								
AGE	−0.06370	−0.02756	1.00000							
	(0.1575)	(0.5412)	(0.0)							
COLLEGE	−0.27464	0.60390	0.30846	1.00000						
	(0.0001)	(0.0001)	(0.0001)	(0.0)						
MORTRAT	−0.02508	−0.10659	−0.27100	−0.22717	1.00000					
	(0.5781)	(0.0178)	(0.0001)	(0.0001)	(0.0)					
HVCHANGE	−0.26350	0.80030	−0.02410	0.34928	0.08183	1.00000				
	(0.0001)	(0.0001)	(0.5930)	(0.0001)	(0.0692)	(0.0)				
DEFAULT	−0.09013	−0.05490	−0.14075	−0.26933	0.25162	−0.06302	1.00000			
	(0.0453)	(0.2232)	(0.0017)	(0.0001)	(0.0001)	(0.1619)	(0.0)			

Table III

Summary Statistics on Mortgages Granted Based on Minority Population in Houston from 1988 to 1991

This table provides information on the number of conventional mortgages granted and number of conventional mortgages granted divided by the number of owner occupants (i.e., the dependent variable) for the period 1988 through 1991 based on percentage minority population. Panel A gives mortgage information on census tracts with varying percentages of black residents and Panel B gives mortgage information for census tracts with varying percentages of Hispanic population.

Percentage of Population	Number of Conventional Mortgages Granted	Number of Conventionals Divided by Number of Owner Occupants
Panel A. Mortgages Granted Based on Percentage of Population which is Black		
80–100	19.89	0.0101
60–79.9	34.33	0.0208
40–59.9	50.00	0.0296
20–39.9	95.02	0.0249
0–19.9	121.23	0.0340
Panel B. Mortgages Granted Based on Percentage of Population which is Hispanic		
80–100	8.77	0.0076
60–79.9	18.58	0.0131
40–59.9	30.25	0.0172
20–39.9	47.43	0.0265
0–19.9	147.77	0.0363

sign. COLLEGE has a positive and highly significant relationship with conventional mortgages granted. Education may be correlated with factors such as job security and wealth, both of which increase an applicant's ability to obtain a mortgage.

INCOME has the anticipated positive sign but is not statistically significant. INCSQ is statistically significant and has a negative sign indicating the existence of a nonlinearity. This result is induced by a low demand for new mortgages by residents of very high-income areas.

Default risk also appears to affect the flow of conventional loans. Specifically, those areas with higher default rates tend to receive fewer conventional mortgage loans. We run regressions on conventional loans without including the risk variables. In these models, the race variables are significant and negative, i.e., they exhibit the presence of redlining. This is consistent with studies that do not include risk measures and conclude that racial redlining exists. These results demonstrate the importance of including such measures in studies of mortgage lending.

As expected, turnover of area residents has a positive effect on mortgage flows for both conventional and insured loans. Most new residents will need a mortgage loan to purchase a home. However, the change in the number of owner occupants (NEWOWN) is significant only for insured loans. The explanation for this lies in the fact that most Houston census tracts became more

Table IV

Conventional and Insured Loans as a Percentage of Owner Occupants

This table reports the results of the OLS equation we estimate to describe the flow of mortgage loans (t-statistic in parentheses). The dependent variable is the number of loans granted in a category for each period divided by the number of owner-occupied units. HISP is the percentage of residents that are Hispanic and BLACK is the percentage that are black. CHGMINOR is the change in percentage minority between 1980 and 1990. VALUE is the median home value. LTV is the ratio of average loan to average value. INCOME is the median household income. INCSQ is the square of median household income. AGE is the percentage of adult residents between the ages of 25 and 34. COLLEGE is the percentage of adult residents who have at least one year of formal education after high school. MORTRAT is the percentage of owner occupants whose mortgage-payment-to-gross-income-ratio is greater than 30 percent. HVCHG is the change in median home values between 1980 and 1990. DEFAULTS is the natural log of the insured-defaults-to-mortgages-granted ratio. TURNOVER is the percentage of area residents who have moved in since 1985. NEWOWN is the percentage change in the number of owner occupants between 1980 and 1990. SFRENT is the percentage of single family homes that are rental units.

Variable	Conventional 1988–1989	Conventional 1990–1991	Insured 1988–1989	Insured 1990–1991
HISP	0.025007	−0.0000327	−0.0000141	−0.0000818
	(1.478)	(−0.457)	(−0.347)	(−3.047)*
BLACK	0.000103	0.0000262	0.0000757	0.0000175
	(1.490)	(0.477)	(2.432)**	(0.772)
CHGMINOR	−0.000287	−0.0000839	0.000137	0.000133
	(−2.393)**	(−0.879)	(2.539)*	(3.378)*
VALUE	0.000162	0.000148	−0.0000452	−0.0000169
	(5.205)*	(5.962)*	(−3.227)*	(−1.659)
VACANT	0.0000836	0.000208	0.0000128	0.0000462
	(0.446)	(1.393)	(0.152)	(0.750)
LTV	0.004586	0.005162	0.0000308	0.002188
	(1.831)	(2.587)*	(0.273)	(2.656)*
INCOME	0.00286	0.000218	0.000411	0.000228
	(1.752)	(1.676)	(5.581)*	(4.252)*
INCSQ	−0.0000028	−0.0000305	6.2×10^{-8}	−0.0000024
	(−3.553)*	(−4.868)*	(−0.218)	(−0.945)
AGE	0.000478	0.00040	0.000451	0.000290
	(1.595)	(1.676)	(3.336)*	(2.944)*
COLLEGE	0.000689	0.00040	−0.0000506	−0.0000246
	(6.048)*	(4.412)*	(−0.984)	(−0.656)
MORTRAT	−0.000314	0.000330	0.000131	−0.000041
	(−1.518)	(2.001)**	(1.399)	(−0.596)
HVCHG	−0.000038	0.0000573	−0.0000884	−0.00051
	(−0.884)	(1.673)	(−4.559)*	(−3.587)*
DEFAULTS	−0.000723	−0.000788	0.000548	0.000241
	(−2.189)**	(−2.995)*	(3.678)*	(2.215)**
TURNOVER	0.000411	0.000687	0.000117	0.000125
	(3.241)*	(6.793)*	(2.036)**	(2.994)*
NEWOWN	−0.0000121	−0.0000095	0.0000092	0.0000085
	(−1.129)	(−1.110)	(1.903)	(2.397)**
SFRENT	0.000741	0.000383	0.0000251	0.000139
	(5.795)*	(3.754)*	(0.435)	(3.299)*
CONSTANT	−0.063609	−0.053675	−0.007562	−0.008271
	(−6.756)*	(−7.155)*	(−1.780)	(−2.671)*
R^2	0.5368	0.5890	0.3385	0.3352
Observations	494	494	494	494

* Significant for alpha ≤ 0.01 for a two-tailed test.
** Significant for alpha ≤ 0.05 for a two-tailed test.

renter occupied during the 1980s, and the number of owner occupants declined. As previously owner-occupied units became rental units, new mortgages were often required by the landlord. This would cause larger numbers of mortgages to be demanded at the bottom end of the NEWOWN distribution. These landlord-owned properties would generally require conventional mortgages, thus explaining the difference in sign of NEWOWN in the two equations. Given the structure of the dependent variable, these variables are intended to proxy for demand. We test the importance of these controls by omitting them from the regression to determine what the effect this would have on the racial variables. Once again, we found that if demand is not adequately controlled for, the racial variables do show up as negative and significant. Therefore, it is necessary to control for demand and risk when studying geographic discrimination.

B. Insured Loans

The model is less successful in explaining the flow of government-insured mortgages, with R^2 of 0.34 in both periods. This is to be expected: the model attempts to explain the variation in mortgage flows on the basis of rational economic considerations, but the availability of a government guarantee changes the risk considerations.

For insured loans, several racial variables are significant and positive—BLACK and CHGMINOR in the 1988 to 1989 period and CHGMINOR in the 1990 to 1991 period. As distinct from the concerns about redlining, however, the positive signs indicate a bias on the part of insured lenders toward lending in areas of high or growing minority populations. This could be the result of the CRA or other pressures on lenders to increase such lending.

One confusing result is the fact that the coefficient of HISP in the 1990 to 1991 period is negative and significant. It seems improbable that insured lenders would be biased in favor of one minority group and at the same time be biased against another minority group. It is possible that this is an anomaly of the data. The coefficient is not significant if 1990 and 1991 are examined separately or if 1988 to 1991 are examined as a whole. This is the only racial variable that is materially affected by these changes. Additionally, this phenomenon appears to be driven by the bottom of the HISP distribution in 1992. That is, if the decile of census tracts with the lowest percent Hispanic population are eliminated, the coefficient becomes insignificant (t-statistic = -0.9). There is no discernable difference between a tract which is 20 percent Hispanic and one which is 80 percent Hispanic. In any case, the economic significance of this result is very small. All else constant, a ten percentage point increase in the Hispanic population of a census tract would lead to a predicted decrease of only slightly less than one mortgage over the two-year sample period. That is, the ten percentage point increase would reduce the predicted number of mortgages from 8.37 to 7.4 if all variables were evaluated at their mean values.

The nature of the insured mortgage produces different results for other variables as well. The sign of VALUE is negative, indicating that in tracts

with high home values, fewer insured mortgage loans are made. This is an inevitable result of the fact that there are ceilings on the value of homes that can be financed with insured mortgages. Thus tracts with very high-priced homes will receive few insured mortgages.

Similarly, the risk variables have signs that seem counterintuitive, but simply reflect the fact that lenders face less risk in granting insured mortgage loans. Very high-risk loan applications will be rejected, but those loans that are granted in higher risk areas will tend to be government insured. Thus the sign on HVCHANGE is negative, and the sign on DEFAULTS is positive.

C. Conventional vs. Insured Loans

Because of the differences in the interpretation of several variables between conventional and insured mortgages, we estimate an equation using the same independent variables, but with conventional loans as a percentage of total loans as the dependent variable. This model attempts to explain the distribution of conventional vs. insured mortgages by census tract. The results are shown in Table V.

In both periods, the coefficients on the racial variables are insignificant when considered individually. An F-test comparing the full model with one omitting the racial variables shows that taken collectively, the racial variables have no impact in the 1990 to 1991 period. The fact that the null hypothesis can be rejected in the 1988 to 1989 period is more evidence of the bias caused by the omission of the mortgage bankers in this time period. It is also interesting to note that if the risk variables or the demand variables are omitted from the equations, we once again get results which would support the redlining allegation. This is further evidence of the necessity of accounting for all economic variables when examining mortgage redlining.

IV. Conclusions

This paper examines the existence of racially induced redlining in the mortgage market in Houston. Previous efforts to use HMDA data to study this issue are plagued by data and methodological problems. Chief among these has been the difficulty of adequately controlling for differences in demand and risk. We believe that we have improved the measures of these variables.

After controlling for the economic characteristics of the census tracts by using variables that would be rationally considered by nondiscriminatory lenders, we find no evidence that racial composition or changes in racial composition by census tracts affects the flow of mortgage credit. The data do not support claims of racially based mortgage redlining.

As we have noted, most studies using reported HMDA data find fewer mortgage loans made in neighborhoods with high minority populations. The differences are real, but the inability to control adequately for differences in demand and risk make it dangerous to draw conclusions from these studies as to the existence of redlining.

Table V

Conventional Loans As a Percentage of Total Loans

This table reports the results of the OLS equation we estimate to describe distribution of conventional loans vs. insured loans (t-statistics in parentheses). The dependent variable is conventional loans divided by total loans. HISP is the percentage of residents that are Hispanic and BLACK is the percentage that are black. CHGMINOR is the change in percentage minority between 1980 and 1990. VALUE is the median home value. LTV is the ratio of average loan to average value. INCOME is the median household income. INCSQ is the square of median household income. AGE is the percentage of adult residents between the ages of 25 and 34. COLLEGE is the percentage of adult residents who have at least one year of formal education after high school. MORTRAT is the percentage of owner occupants whose mortgage-payment-to-gross-income ratio is greater than 30 percent. HVCHG is the change in median home values between 1980 and 1990. DEFAULTS is the natural log of the insured-defaults-to-mortgages-granted ratio. TURNOVER is the percentage of area residents who have moved in since 1985. NEWOWN is the percentage of change in the number of owner occupants between 1980 and 1990. SFRENT is the percentage of single family homes that are rental units.

Variable	Coefficient (1988–1989)	Coefficient (1990–1991)
HISP	0.001396	0.000388
	(1.6873)	(0.5703)
BLACK	−0.00112	−0.00023
	(−1.7986)	(−0.04398)
CHGMINOR	−0.00111	−0.00116
	(−1.002)	(−1.2807)
VALUE	0.000757	0.000693
	(2.6465)*	(2.9491)*
VACANT	0.001894	−0.00207
	(1.0991)	(−1.4588)
LTV	0.082126	0.011782
	(3.5622)*	(0.6213)
INCOME	−0.0041	−0.00147
	(−2.7302)*	(−1.1906)
INCSQ	0.0000032	−0.0000072
	(−0.4367)	(−1.2017)
AGE	−0.00356	−0.00162
	(−1.289)	(−0.7155)
COLLEGE	0.00719	0.001939
	(6.8598)*	(2.2493)**
MORTRAT	−0.00342	0.003686
	(−2.0618)**	(2.3543)**
HVCHG	0.001309	0.000689
	(3.307)*	(2.116)**
DEFAULTS	−0.01236	−0.01105
	(−4.0666)*	(−4.4196)*
TURNOVER	0.003245	0.001147
	(2.777)*	(1.1933)
NEWOWN	−0.00022	−0.000073
	(−2.2972)**	(−0.8998)
SFRENT	0.000115	0.001698
	(0.0976)	(1.7542)
CONSTANT	0.135646	0.48923
	(0.613)	(2.688)*
R^2	0.4846	0.2237
N	494	494

* Significant for alpha $\leq$ 0.01 for a two-tailed test.
** Significant for alpha $\leq$ 0.05 for a two-tailed test.

The raw data on mortgage loans made in Houston also show fewer loans in census tracts of high minority population. This is accounted for by the correlation between the minority variables and the economic variables included in our analysis. That is, as shown in Table II, the percentage of the census tract population that is Black or Hispanic is positively correlated with VACANT and DEFAULT, and negatively correlated with INCOME, VALUE, and COLLEGE, though none of the simple correlations is extremely high. This raises the possibility that some personal or economic variable is serving as a proxy for race. For example, since fewer blacks than whites have attended college, the effect of a lender preference for neighborhoods with a high value for COLLEGE may have the effect of discriminating against neighborhoods with a high black population. If COLLEGE is omitted from the regressions, the coefficient on BLACK becomes negative, but is still statistically insignificant. COLLEGE is a reasonable variable to use as a general proxy for the desirability of a neighborhood. The data do not support the view that a positive coefficient for COLLEGE represents noneconomic discrimination. COLLEGE is negatively correlated with DEFAULT, and positively correlated with HVCHG. That is, loans in census tracts with a high percentage of the population having some college education are safer. Additionally, COLLEGE is a reasonable proxy for other prudent lending variables such as wealth and job stability for which we do not have direct data.

As a further examination of this issue, we run an equation with BLACK as the dependent variable and all the economic variables as independent variables and obtained an R^2 of 0.51. This indicates that the economic variables, either individually or as a group, are not serving as a proxy for the racial variables. In any case, a claim of racially based geographic discrimination in mortgage lending must be based on a consideration of race *after* taking account of variables that are rationally connected with the economics of the mortgage lending process. Our results indicate that, at least in Houston, the racial composition of a neighborhood does not have a significant effect on the number of mortgage loans made.

Mortgage credit allocation does respond to reasonable economic criteria. Risk characteristics affect the flow of insured mortgages differently than conventional mortgages. Generally, attributes that increase the risk of making loans in a certain area will tend to increase the number of insured loans granted and decrease the number of conventional loans granted. Although increasing risk leads to larger numbers of insured loans, the net effect of increasing risk is a decrease in the total number of mortgages granted.

It is interesting to compare our results with the recent interview-based study by Benston and Horsky (1992). Their interviews with several hundred home sellers and buyers (including potential buyers and sellers who were not successful) in allegedly redlined neighborhoods in Indianapolis, Cincinnati, and Nashville did not find evidence of redlining. This approach allowed them to measure demand directly, but the cost of such research limited the number of mortgage transactions covered. Our study covers a large number of mortgage loans and our measures of demand (derived from census data), while not

as direct as Benston and Horsky's, should represent better proxies than the variables used in other studies of HMDA data. It is interesting to note that neither our study nor the Benston and Horsky study find evidence of redlining, despite using quite different methodologies. Those who claim that irrational biases against particular neighborhoods, perhaps because of their racial composition, significantly influence the decisions of mortgage lenders must come up with a more convincing empirical basis than we have seen so far.

It is not possible to compare these results directly with studies of racial discrimination in the mortgage application acceptance-rejection decision, as in the recent Boston Federal Reserve study. First, if minority borrowers are rejected by one lender, they may still obtain loans by going to a second lender. Their disparate rejection rates will show up in studies of discrimination, but, if they end up getting a loan, their previous rejections will not affect our data. Second, we examine differences by census tracts with different racial composition. It is possible that a disproportionate percentage of the loans in census tracts with high minority populations are going to white residents.[4] To repeat, our study concerns only the question of whether the mortgage-lending process discriminates against *areas* with high or increasing minority populations. For Houston in 1988 to 1991, the data demonstrate that it does not.

Public policy questions can be reexamined in light of these findings. Given that regulation was in place during the sample period, we cannot conclude that existing regulation is unnecessary. However, it appears that either the existing regulation is adequate to alleviate the problem or that the regulation as it exists could be dismantled in whole or in part.

Rational economic agents accept all good projects without regard for noneconomic factors such as race. The existence of redlining would be contrary to this basic tenet. The results we obtain are consistent with the idea that the mortgage markets are allocationally efficient.

[4] The 1991 HMDA data do include information on the race of borrowers, but we have not yet been able to obtain information on a census tract basis on a basis comparable with the mortgage loan data. When these data become available, it will be possible to check this point directly.

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