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Differences in the Cost of Mortgage Credit Implications for Discrimination*

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Abstract

This paper estimates the mortgage interest rate differences paid by Asian, Hispanic, and African–American borrowers to a national home mortgage lender in the years 1988–1989. Controlling for differences in market rates, rate lock protection, and borrower risk factors, conventional loan interest rates are almost perfectly race-neutral. The single deviation from race-neutrality is that when interest rates fall during the borrower's rate-lock period, only African–American borrowers are unable to capture a share of this decline. Government (FHA and VA) credit models show small premia paid by African–American borrowers of about $1.80 per month on average. In government lending, Hispanic borrowers alone are unable to capture rate declines occurring during the borrower's rate-lock period.

Key Words:

1. Introduction

Most research on racial discrimination in home finance accepts, as a simplifying assumption, that interest rates in home mortgage markets do not differ across borrowers. Examples from the redlining literature include Avery and Buynak (1981), Shlay (1988), Bradbury et al. (1989), Gabriel and Rosenthal (1991), Hula (1991), Holmes and Horvitz (1994), Berkovec et al. (1994), and Rossi and Phillips-Patrick (1995). Examples in the debate over differential denial rates in underwriting include Canner and Smith (1991, 1992), Kohn et al. (1992), Munnel et al. (1992), Liebowitz (1993), Glennon and Stengel (1994), Horne (1994), and Ferguson and Peters (1995). While not always explicit, the basis for this view of a single interest rate is the credit rationing model of Stiglitz and Weiss (1981) and Williamson (1986, 1987). However, in this paper, we will present evidence of significant price differences between individual borrowers, even for a single lender, and even holding product and time constant. The failure to observe this price dispersion in the past is probably due to a deficit of good data, particularly of mortgage terms and timing. For instance, Benston and Horsky (1992) know only the year of the loan, though annual market changes are often over one hundred basis points.

This paper accesses the mortgage origination processing system of a major national

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mortgage lender in the 1988–89 period to empirically measure mortgage interest rate differences paid by Asians, Hispanics, and African–Americans. The calculated interest rate differences control for differences in market rates, rate lock protection, and borrower risk factors. In calculating a net interest rate, we test several different tradeoffs between interest rates and discount points.

Under these strict controls, we find that conventional loan interest rates, while varying markedly between individuals, are largely race-neutral. Government credit models, however, show statistically significant, but economically insignificant, difference in interest rate premia paid by African–Americans. These premia differences are approximately three basis points or $1.80 per month on an average loan. Additionally, African–American borrowers obtaining conventional mortgages and Hispanic borrowers obtaining government mortgages are not able to capture rate declines occurring during the borrower's rate-lock period.

Nothaft and Perry (1996) use neighborhood-level data to examine this issue; the effect of neighborhood racial composition on mortgage interest rates. They find that, while neighborhood characteristics affect rates, neighborhood racial composition has only a small and mixed effect on interest rates.

While not focusing on racial differences, Avery, Beeson, and Sniderman (1996, 1992) provide more general studies of the determination of mortgage lending rates across lenders and markets and the effects of interest rates on lending activity. They find that mortgage rates vary across lenders as a function of borrower risk and lender quality measured by processing time and lending activity.

2. Data

The present study examines 5,679 conventional loans made in 41 states and 5,921 government (FHA and VA) loans made in 35 states. See table 3 for state frequency distributions. All loans were originated by a single lender, City Federal Savings Bank (CFSB) of New Jersey, in the period from 12/22/87 to 11/28/89. A great deal of loan-level data is available regarding borrower demographic and financial characteristics, as well as loan terms and conditions, and was captured by an underwriting data management system.

Tables 1 and 2 provide summary statistics for both sets of loans. All variables are defined in the appendix. Average loan amounts and most other measures of financial value are higher for conventional borrowers; mean loan to value is much higher for government borrowers. Hispanics and particularly African–Americans are represented in greater percentages in the government sector.

In the conventional data set, 109 loans (2.5%) were made to African–Americans, 134 (3.1%) to Hispanics, and 157 (3.6%) to Asians. Mean values are much more alike than different between the groups. It is to be remembered that these are all successful mortgage applicants. Perhaps the group most significantly deviating from the population averages is Asians, who on average have the most bank assets, seek the largest mortgages, have the lowest loan to value ratios, show the least income relative to their prospective mortgage payment, and attain the greatest educational levels. Assuming home and personal

Table 1. Summary statistics—conventional loans.

Variable		African–American	Asian	Hispanic	White	All Races
LTV	Mean	80.79	75.00	79.66	76.59	76.73
	Std Dev	12.80	12.97	12.32	13.71	13.65
LOAN AMOUNT	Mean	91.63	108.79	86.22	95.58	95.63
	Std Dev	38.09	37.02	39.18	38.00	38.00
EDUCATION	Mean	15.04	15.95	14.31	15.30	15.30
	Std Dev	2.66	3.18	2.77	2.68	2.71
DEBTRATE	Mean	25.80	12.51	16.82	17.93	17.90
	Std Dev	23.16	16.80	19.95	19.84	19.84
INCRATE	Mean	18.32	20.22	19.01	18.67	0.21
	Std Dev	5.92	6.58	7.53	6.44	0.41
LBANK	Mean	9.12	9.70	9.00	9.33	9.33
	Std Dev	1.87	2.70	2.46	2.34	2.35
INTEREST	Mean	10.21	10.22	10.24	10.22	10.22
RATE	Std Dev	0.43	0.43	0.43	0.43	0.43
POINTS	Mean	2.20	2.14	2.12	2.07	2.08
	Std Dev	1.02	1.00	1.06	1.04	1.03
LOAN YIELD	Mean	10.55	10.54	10.56	10.53	10.53
	Std Dev	0.38	0.40	0.39	0.39	0.39
NEGCHNG	Mean	0.11	0.12	0.10	0.12	0.11
	Std Dev	0.17	0.17	0.17	0.18	0.18
POSCHNG	Mean	0.14	0.10	0.14	0.14	0.14
	Std Dev	0.18	0.15	0.18	0.18	0.18
BPOS	Mean	0.14				
	Std Dev	0.18				
BNEG	Mean	0.11				
	Std Dev	0.17				
HPOS	Mean			0.14		
	Std Dev			0.18		
HNEG	Mean			0.10		
	Std Dev			0.17		
INCRATE28	Mean	0.20	0.30	0.28	0.20	0.21
LTVUND80	Mean	0.52	0.77	0.64	0.67	0.67
REFINANCE	Mean	0.16	0.08	0.16	0.15	0.15
NOOCCUPY	Mean	0.03	0.04	0.01	0.02	0.02
FIRSTBUY	Mean	0.31	0.34	0.24	0.27	0.27
DETACHED	Mean	0.90	0.86	0.82	0.90	0.90
Number of Observations		109	157	134	3991	4391

education to be forms of capital, all these facts are consistent with a view of Asian mortgage borrowers as having higher savings rates, on average.[1] In the government set, 341 loans (8.2%) were made to African–Americans, 191 (4.7%) to Hispanics, and 129 (3.2%) to Asians. Again there is general homogeneity of average values, with the Asian distinctions being repeated.

The majority of borrowers at this lender accepted a sixty day commitment period and

Table 2. Summary statistics—government loans.

Variable		African–American	Asian	Hispanic	White	All Races
LTV	Mean	97.16	94.50	96.17	96.07	96.11
	Std Dev	5.09	7.33	5.90	6.32	6.26
LOAN AMOUNT	Mean	69.66	85.04	70.25	69.53	70.05
	Std Dev	24.54	28.08	23.92	23.24	23.70
EDUCATION	Mean	13.96	14.56	13.46	14.22	14.17
	Std Dev	2.31	2.72	2.29	2.44	2.44
DEBTRATE	Mean	27.13	19.86	19.95	25.63	25.28
	Std Dev	24.53	23.19	23.15	25.50	25.29
INCRATE	Mean	20.01	23.65	21.41	19.55	19.81
	Std Dev	7.09	8.18	6.82	6.67	6.81
LBANK	Mean	7.57	7.47	6.93	7.66	7.61
	Std Dev	2.62	3.55	3.30	2.82	2.86
INTEREST	Mean	10.20	10.11	10.16	10.17	10.17
RATE	Std Dev	0.43	0.43	0.46	0.45	0.45
POINTS	Mean	2.55	2.37	2.45	2.55	2.54
	Std Dev	1.02	1.02	1.06	1.10	1.09
LOAN YIELD	Mean	10.84	10.70	10.78	10.81	10.81
	Std Dev	0.43	0.44	0.47	0.44	0.44
NEGCHNG	Mean	0.15	0.15	0.14	0.14	0.14
	Std Dev	0.21	0.22	0.20	0.21	0.21
POSCHNG	Mean	0.13	0.14	0.11	0.14	0.14
	Std Dev	0.19	0.20	0.17	0.19	0.19
BPOS	Mean	0.13				
	Std Dev	0.19				
BNEG	Mean	0.15				
	Std Dev	0.21				
HPOS	Mean			0.11		
	Std Dev			0.17		
HNEG	Mean			0.14		
	Std Dev			0.20		
LTVUND95	Mean	0.12	0.30	0.16	0.18	0.18
INCRATE33	Mean	0.11	0.25	0.14	0.09	0.10
REFINANCE	Mean	0.04	0.03	0.03	0.03	0.03
NOOCCUPY	Mean	0.01	0.03	0.02	0.01	0.01
FIRSTBUY	Mean	0.63	0.61	0.61	0.51	0.53
DETACHED	Mean	0.88	0.72	19.95	0.93	0.92
Number of observations		341	129	191	3511	4172

closed within that period. Only these loans are used in this paper to hold time, risk aversion, and rate protection constant. The interest rate point combination was negotiated with a loan officer, who received a daily (and sometimes more frequent) rate sheet, which provided suggested rate/point combinations for different products, lock periods, and to a limited extent, risk characteristics. As virtually all fixed rate loans were sold into the secondary market, which did not at that time price risk characteristics of qualifying loans,

Table 3. State distribution of loans.

State	Conventional Frequency	Percent	Government Frequency	Percent
AK	4	0.1	0	0.0
AL	4	0.1	24	0.4
AZ	15	0.3	11	0.2
CA	374	6.6	499	8.4
CO	100	1.8	327	5.5
CT	2	0.0	0	0.0
DC	44	0.8	13	0.2
DE	3	0.1	0	0.0
FL	523	9.2	195	3.3
GA	76	1.3	88	1.5
HI	43	0.8	78	1.3
ID	4	0.1	51	0.9
IL	202	3.6	90	1.5
IN	39	0.7	30	0.5
KS	9	0.2	10	0.2
KY	93	1.6	175	3.0
LA	5	0.1	0	0.0
MA	107	1.9	23	0.4
MD	473	8.3	507	8.6
MI	138	2.4	27	0.5
MN	38	0.7	42	0.7
MO	229	4.0	117	2.0
MS	0	0.0	19	0.3
MT	1	0.0	0	0.0
NC	25	0.4	75	1.3
NH	7	0.1	5	0.1
NJ	889	15.7	24	0.4
NM	64	1.1	130	2.2
NV	95	1.7	213	3.6
NY	43	0.8	0	0.0
OH	269	4.7	317	5.4
OK	42	0.7	56	0.9
OR	153	2.7	312	5.3
PA	257	4.5	234	4.0
SC	131	2.3	205	3.5
TN	40	0.7	331	5.6
TX	268	4.7	402	6.8
UT	28	0.5	29	0.5
VA	379	6.7	494	8.3
WA	418	7.4	678	11.5
WV	44	0.8	90	1.5
WY	1	0.0	0	0.0

explicit risk pricing at the borrower level was very limited. For some products and down payment levels, an additional fraction of a point was requested for non-occupancy and refinance mortgages. As the loan officer's compensation depended, in part, on the number

of loans closed and the rate/point combination negotiated, earning more for higher rates, he was encouraged to achieve the highest possible yield consistent with eliciting applications from qualified borrowers. All loans are thirty-year, fixed-payment-rate, fixed-accrual-rate, amortizing mortgages for single-family one-to-four unit properties. All conventional loans were agency-conforming in the year of origination.

LOAN YIELD is the calculated rate of return for funds lent to a given borrower. This net interest rate is based on the interest rate on the closed loan as well as all points paid, either at application or origination. Many alternative specifications were examined relating the interest rate and the points paid.[2] Generally, results varied little across these specifications and the two simplest are reported here. These are a point-rate tradeoff of 0.15 interest rate percent per point and a tradeoff of 0.25 interest rate percent per point.

3. Importance of Rate Commitment

Rate guarantees are given a high level of attention in order to distinguish market movement from borrower-specific pricing differentiation. It is not rare for long market rates to move 20 basis points during the loan processing period, and more in high volatility periods. Figure 1 shows distributions of conventional and government LOAN YIELD change over the loan processing periods for the borrowers analyzed in this paper.

A complication, however, is that rate locks are not absolute. As the regressions will show, there is about a 10% slippage toward the rate in effect on the close date. In general, the lender must honor the commitment rate, assuming the loan closes, for the full sixty

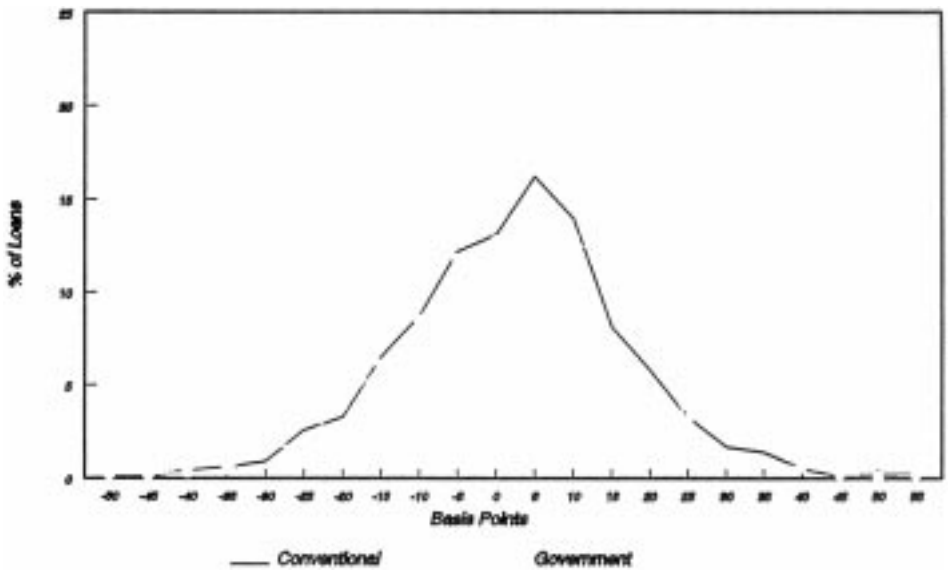

Figure 1. Market change over the commitment period

days. However, any material change to the loan provides the lender an opportunity to violate the lock and impose a new market rate. Examples of such changes are a change in loan product, a new point/rate combination, and a lower down payment. While the borrower is generally bound by the lock during the commitment period, he may gain a limited amount of bargaining power to demand a new rate when market rates fall, by threatening either to withdraw or to delay the closing date beyond the sixty days.

For this reason, the change in market rate between lock and close date can partially determine LOAN YIELD. When rates fall, borrowers who have the means to switch or delay financing will make efforts to capture some of the value of the market drop. Similarly, when rates rise, the lender may find excuses to modify the lock or fail to close the loan in the lock period. Because the incentives and market power of loan supplier and demander may be different in rising and falling markets, two variables are modelled:

$$NEGCHNG = \min(MARKET\ YIELD_C - MARKET\ YIELD_L, 0) \tag{1}$$

$$POSCHNG = \max(MARKET\ YIELD_C - MARKET\ YIELD_L, 0) \tag{2}$$

where the market yield is the average yield of all other mortgages closing on that day in the data set.

In addition to measuring for price differentials for African–Americans and Hispanics, we want to understand if bargaining power under locks is different by race. For this reason, four interaction variables are also created: BPOS, BNEG, HPOS, and HNEG which are interactions of POSCHNG and NEGCHNG with African–American and Hispanic, respectively.

4. Empirical Specification

Applying notation similar to Rachlis and Yezer (1993), one can specify a two equation system of credit risk and interest rates.

$$X_i = \gamma_X + M_i\beta_X + R_i\alpha_X + \varepsilon_{Xi} \tag{3}$$

$$R_i = \gamma_R + M_i\beta_R + X_i\alpha_R + \varepsilon_{Ri} \tag{4}$$

where X_i is a one-dimensional measure of credit risk, R_i is the interest rate, M_i is the race of the borrower, and γ_X, β_X, α_X, γ_R, β_R, and α_R are parameters to be estimated. Credit risk is assumed to be a function of interest rates because the latter alter payment levels and hence the probability that the borrower will not have cash flows sufficient to make timely payment.

Because variables that are related to credit risk are also related to the interest rate, identification is not possible and a version of the interest rate equation alone is estimated.[3]

$$R_i = \gamma_R + M_i\beta_R + X_i\alpha_R + \varepsilon_{Ri}. \tag{5}$$

This equation, with the addition of transaction day indicator variables to purge the effect of daily interest rate fluctuations and daily borrower composition changes from the parameter estimates, is our estimation equation.

5. Empirical Results

Ordinary Least Squares is employed to model the determination of LOAN YIELD, measured in percentage points. These results are presented in table 4. Separate models are estimated for conventional (columns A and B) and government loans (columns C and D). Each of these models are estimated for point-rate tradeoffs of 0.15 (columns A and C) and 0.25 (columns B and D) interest rate percent per point. All variables come directly from the data or are calculated directly from the data.[4] With both the conventional and

Table 4. Loan yield equations.[1]

	Conventional Loans		Government Loans	
Variable	A Point/Rate Trade-Off: 1/0.15	B Point/Rate Trade-Off: 1/0.25	C Point/Rate Trade-Off: 1/0.15	D Point/Rate Trade-Off: 1/0.25
Intercept	10.1092*	10.2536*	10.2513*	10.5290*
	(0.0817)	(0.0838)	(0.0789)	(0.0797)
AFRIAMER	− 0.0123	− 0.0008	0.0361*	0.0393*
	(0.0264)	(0.0272)	(0.0136)	(0.0140)
HISPANIC	0.0217	0.0370	0.0206	0.0162
	(0.0214)	(0.0215)	(0.0172)	(0.0179)
ASIAN	− 0.0102	0.0012	0.0087	0.0112
	(0.0124)	(0.0127)	(0.0134)	(0.0135)
NEGCHNG (basis points)	− 0.1629*	− 0.1650*	− 0.2813*	− 0.2580*
	(0.0228)	(0.0232)	(0.0231)	(0.0213)
POSCHNG (basis points)	0.0018	0.0161	0.0165	− 0.0129
	(0.0220)	(0.0218)	(0.0249)	(0.0234)
BPOS	0.0402	0.0709	− 0.0624	− 0.0294
	(0.0968)	(0.0929)	(0.0520)	(0.0491)
BNEG	0.2069*	0.1696	− 0.0033	0.0079
	(0.1043)	(0.1061)	(0.0459)	(0.0439)
HPOS	0.0070	− 0.0257	− 0.0463	− 0.0659
	(0.0792)	(0.0771)	(0.0735)	(0.0690)
HNEG	0.0142	0.0399	0.2059*	0.1788*
	(0.0865)	(0.0858)	(0.0631)	(0.0606)
LTV (%)	0.0006*	− 0.0003	− 0.0004	− 0.0003
	(0.0003)	(0.0003)	(0.0006)	(0.0006)
LTVUND80/95[2]	0.0163*	0.0263*	− 0.0076	− 0.0075
	(0.0073)	(0.0075)	(0.0089)	(0.0090)

Table 4. (*continued*)

	Conventional Loans		Government Loans	
Variable	A Point/Rate Trade-Off: 1/0.15	B Point/Rate Trade-Off: 1/0.25	C Point/Rate Trade-Off: 1/0.15	D Point/Rate Trade-Off: 1/0.25
LOANAMT (1,000s)	− 0.0004*	− 0.0005*	− 0.0024*	− 0.0027*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
NOOCCUPY	0.0817*	0.1235*	0.1017*	0.1238*
	(0.0155)	(0.0158)	(0.0186)	(0.0188)
REFINANCE	0.0295*	0.0001	0.0530	0.0144
	(0.0075)	(0.0076)	(0.0134)	(0.0135)
EDUCATION	− 0.0005	− 0.0010	− 0.0021*	− 0.0029*
	(0.0009)	(0.0009)	(0.0010)	(0.0010)
DETACHED	0.0248*	0.0424	− 0.0429*	− 0.0450*
	(0.0079)	(0.0081)	(0.0090)	(0.0091)
DEBTRATE	0.0004*	0.0003	0.0001	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
INCRATE	0.0014*	0.0013	0.0009	0.0007
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
INCRATE28/33[3]	− 0.0062	− 0.0141	0.0070	0.0046
	(0.0080)	(0.0082)	(0.0099)	(0.0100)
LBANK (1,000s)	0.0007	− 0.0003	− 0.0003	− 0.0012
	(0.0011)	(0.0011)	(0.0009)	(0.0009)
FIRSTBUY	0.0156*	0.0152	0.0020	− 0.0051
	(0.0058)	(0.0059)	(0.0048)	(0.0049)
State indicated variables	YES	YES	YES	YES
Origination date Indicated variables	YES	YES	YES	YES
Number of observations	5679	5679	5921	5921
R-squared	0.8327	0.8263	0.8638	0.8692
Adj R-squared	0.8173	0.8104	0.8516	0.8574

Notes:
[1] Standard errors are in parentheses.
[2] For conventional loans, the variable LTVUND80 is used. For government loans, the variable LTVUND95 is used.
[3] For conventional loans, the variable INCRATE28 is used. For government loans, the variable INCRATE33 is used.
*Significant at the 0.05 level.

government models, the point-rate tradeoffs of 0.15 lead to results with the highest level of statistical significance.

Included in these equations are credit-risk variables, transaction-cost variables, race indicator variables and transaction day indicator variables.[5] Credit risk variables, such as LTV, and income ratios, are known to affect both the probability of loan default and the approval/denial decision, but may or may not be priced in yields.[6] Loan size is the

principal transaction cost variable, because profits are proportional to loan size while origination costs are basically fixed. Yields may therefore fall for large loans. Discrimination variables include racial/ethnic group. Transaction day indicator variables control for daily variation in market rates. Appendix A presents a complete dictionary of all variables used in the paper. All of the equations are quite successful in explaining a large share of the variation in mortgage rates across borrowers.

For conventional lending with a point-rate tradeoffs of 0.15 (table 4, column A), LTV, LTVUND80, LOANAMT, NOOCCUPY, REFINANCE, DETACHED, DEBTRATE, INCRATE, and FIRSTBUY are significantly related to the LOAN YIELD and have signs that are consistent with lending costs increasing with credit risk.

Borrower race does not significantly affect the level of LOAN YIELD. However, when interest rates fall during the borrower's rate-lock period, only African–American borrowers are not able to capture this decline.

For government lending with a point-rate tradeoffs of 0.15 (table 4, column C), LOANAMT, NOOCCUPY, EDUCATION, and DETACHED are significantly related to the LOAN YIELD and have signs that are consistent with lending costs increasing with credit risk.

In government lending, borrower race does significantly affect the level of LOAN YIELD; African–American borrowers pay 3.6 basis points more. This, however, translates to an economically small differential of approximately $1.80 per month. Additionally, when interest rates fall during the borrower's rate-lock period, Hispanic borrowers are not able to capture this decline.

An explanation consistent with the results that African–American conventional loan borrowers and Hispanic government borrowers are not able to capture rate declines during the rate-lock period is that these borrowers do not face price discrimination from the lender at the point of rate setting (lock-in), but are less able than other borrowers either to find alternate financing when market rates fall, break their lock through a credible threat of finding alternate financing, or delay their closing beyond the lock period. This is consistent with Rosenblatt (1997), which documents lower loan application withdrawal rates for African–Americans at the same lender. This result could occur if fewer African–American conventional borrowers or Hispanic government borrowers are able to obtain alternative financing in order to capture the market drop, whether from constraints on information, real or perceived discrimination, or different search strategies or costs.

While it is interesting to speculate on the precise mechanics for the statistically significant price differentials experienced by African–American borrowers, the monetary value of the differential is small.

6. Discussion and Conclusions

This paper estimates the mortgage interest rate differences paid by Asian, Hispanic, and African–American borrowers to a national home mortgage lender in the years 1988–1989. The calculated interest rate differences control for differences in market rates, rate lock protection, and borrower risk factors. Conventional loan interest rates are almost perfectly

race-neutral. The only deviation from race-neutrality for this lender is that when interest rates fall during the borrower's rate-lock period, only African–American borrowers fail to capture this decline. Government (FHA and VA) credit models show small premia paid by African–American borrowers of about $1.80 per month on average. Hispanic government borrowers in this data set are not able to capture rate declines occurring during the borrower's rate-lock period.

Appendix A

The empirical model employs the differences between the variables for a loan and the population means on the commitment date.

Mortgage and Yield:	
LOAN AMOUNT	Amount borrowed in thousands
POINTS (%)	Sum of origination fees and discounts, both set in practice as a percentage of loan amount
INTEREST RATE	Fixed thirty year interest rate after any discount
LOAN YIELD (%)	Closing yield of borrower calculated from interest rates and points
NEGCHNG	Lessor of $(MARKET\ YIELD_C - MARKET\ YIELD_L, 0)$ in basis
POSCHNG	Greater of $(MARKET\ YIELD_C - MARKET\ YIELD_L, 0)$ in basis points
BPOS	POSCHNG if the borrower is African–American in basis points, else 0
BNEG	NEGCHNG if the borrower is African–American in basis points, else 0
HPOS	POSCHNG if the borrower is Hispanic in basis points, else 0
HNEG	NEGCHNG if the borrower is Hispanic in basis points, else 0
Race:	
AFRIAMER	1 if African–American; else 0
ASIAN	1 if Asian; else 0
HISPANIC	1 if Hispanic; else 0
Risk:	
LTV (%)	Loan amount divided by sale price, where sale price is the lower of appraisal or purchase price
LTVUND95	Indicator variable, $=1$ if LTV under 95; else 0
LTVUND80	Indicator variable, $=1$ if LTV under 95; else 0
LINCOME	Natural log of annual household income; income in thousands
INCRATE	Principal and interest divided by monthly income
INCRATE28	INCRATE >0.23 (Taxes and insurance are estimated at 5% of income, giving front end ratio of 28%)
INCRATE33	INCRATE >0.28 (Taxes and insurance are estimated at 5% of income, giving front end ratio of 33%)
DEBTRATE	Non-real estate debt divided by annual income
LBANK	Natural log of bank assets in thousands
REFINANCE	1 if a refinance, 0 for purchase
NOOCCUPY	0 if owner occupancy expected, 1 otherwise
FIRSTBUY	First time home buyer
EDUCATION	Years of school of first borrower on note
DETACHED	Detached structure

Notes

1. Rosenblatt (1994) documents the low rate of credit problems among Asian mortgage applicants to the same lender.
2. For an appendix discussing the alternatives explored, contact the authors.
3. This leads to biased estimates of β_R. The magnitude of the bias in the estimates of β_R is

$$Bias = \hat{\beta}_R - \beta_R = \text{cov}(X_i, M_i)[-\text{cov}(X_t, \varepsilon_{Rt})]. \tag{6}$$

   The first term is positive if minorities are, on average, of higher credit risk implying that β_X is positive. Because both α_X and α_R are positive, the sign of the second term is ambiguous.

$$cov(X_i, \varepsilon_{Ri}) = \frac{\alpha_X}{1 - \alpha_X \alpha_R}\ . \tag{7}$$

   The term α_X is positive if an increase in the interest rate increases credit risk. The term α_R is positive if an increase in credit risk increases the interest rate. Since both α_X and α_R are positive, the sign of the denominator, and the direction of the bias, is indeterminate. Because the sign of the identification bias is indeterminate, it is not possible to either prove or disprove discrimination. A positive parameter estimate for β_R could mean either discrimination or no discrimination and a biased estimate. A parameter estimate for β_R that is not significantly different from zero could mean either no discrimination or discrimination and a biased parameter estimate.

   The magnitude of α_X, however, is likely to be small. This is primarily because increases in interest rate premia, which are small compared to the omitted market component, only have small effects on payment levels. A second reason is that, given a higher contract rate, the expected duration of the mortgage is shorter so the mortgage will be at risk of default for a shorter period of time.
4. In alternative models not shown, instruments were created for LTV and for LOAN AMOUNT, on the theory that these would be a function of price. However, PREMIUM is a very small component of price, market yield being dominant, and not likely to determine loan demand to a high degree. Also, the simultaneous equation biases of our approach are too great to be erased by such devices. Finally, the instruments did not have a qualitative effect. For simplicity, therefore, the approach was dropped.
5. The only variables related to personal credit history available in these data are prior bankruptcies and prior judgments. Since these are so uncommon, they had no effect in any of the models and are not presented.
6. High loan-to-value is priced through mortgage insurance.

References

Avery, Robert B. and Thomas M. Buynak. (1981). ''Mortgage Redlining: Some New Evidence,'' *Economic Review*. Federal Reserve Bank of Cleveland, 15–31.

Avery, Robert B., Patricia E. Beeson, and Mark S. Sniderman. (1994). ''Cross-Lender Variation in Home Mortgage Lending,'' *Economic Review*. Federal Reserve Bank of Cleveland, 15–29.

Avery, Robert B. and Thomas M. Buynak. (1996). ''Posted Rates and Mortgage Lending Activity,'' *Journal of Real Estate Finance and Economics* 11–26.

Arrow, Kenneth J. (1972a). ''Models of Job Discrimination,'' in A. Pascal, ed.: *Racial Discrimination in Economic Life*.

Arrow, Kenneth J. (1972a). ''Some Mathematical Models of Race Discrimination in the Labor Market,'' in A. Pascal, ed.: *Racial Discrimination in Economic Life*.

Becker, Gary S. (1971). *The Economics of Discrimination*. The University of Chicago Press. IL. 2nd edn.

Benston, George J. and Daniel Horsky. (1992). ''The Relationship Between the Demand and Supply of Home

Financing and Neighborhood Characteristics: An Empirical Study of Mortgage Redlining,'' *Journal of Financial Services Research* 5, 235–260.

Berkovec, James A., Glenn B. Canner, Stuart A. Gabriel, and Timothy Hannon. (1994). ''Race and Residential Mortgage Market Defaults: Evidence from the FHA-Insured Single-Family Loan Market,'' *Manuscript Presented at the ASSA-AREUEA Meetings.*

Bradbury, Katherine L., Karl E. Case and Constance R. Dunham. (1989). ''Geographical Patterns of Mortgage Lending in Boston, 1982–1987,'' *New England Economic Review.* Federal Reserve Bank in Boston, 3–30.

Canner, Glenn B. and Dolores S. Smith. (1991). ''Home Mortgage Disclosure Act: Expanded Data on Residential Lending,'' *Federal Reserve Bulletin* 77(11), 859–881.

Canner, Glenn B. and Dolores S. Smith. (1992). ''Expanded HMDA Data on Residential Lending: One Year Later,'' *Federal Reserve Bulletin* 78(11), 801–824.

Carr, James H. and Isaac F. Megbolugbe. (1993). ''The Federal Reserve Bank of Boston Study on Mortgage Lending Revisited,'' *Journal of Housing Research* 4(2), 277–313.

Ferguson, Michael F. and Stephen R. Peters. (1995). ''What Constitutes Evidence of Discrimination in Lending?,'' *Journal of Finance* 50(2), 739–748.

Gabriel, Stuart A. and Stuart S. Rosenthal. (1991). ''Credit Rationing, Race, and the Mortgage Market,'' *Journal of Urban Economics* 29(3), 371–379.

Glennon, Dennis and Mitchell Stengel. (1994). ''An Evaluation of the Federal Reserve Bank of Boston's Study of Racial Discrimination in Mortgage Lending,'' *Office of the Comptroller of the Currency, Economic and Policy Analysis,* Working Paper 94–2.

Holmes, Andrew and Paul M. Horvitz. (1994). ''Mortgage Redlining: Race, Risk, and Demand,'' *Journal of Finance* 44(1), 81–99.

Horne, David K. (1994). ''Evaluating the Role of Race in Mortgage Lending,'' *FDIC Banking Review* 7(1), 1–14.

Hula, Richard C. (1991). ''Neighborhood Development and Local Credit Markets,'' *Urban Affairs Quarterly* 27(2), 249–267.

Kohn, Ernest, Cyril E. Foster, Bernard Kaye, and Nancy J. Terris. (1992). *Are Mortgage Lending Policies Discriminatory?—A Study of 10 Savings Bank*. New York Banking Department, Working Paper.

Liebowitz, Stanley J. (1993). ''A Study that Deserves No Credit,'' *Wall Street Journal* A14.

Munnell, Alicia H., Lynn E. Browne, James McEneaney, and Geoffrey M. B. Tootell. (1992). *Mortgage Lending in Boston: Interpreting HMDA Data*. Federal Reserve Bank of Boston, Working Paper 92–7.

Nothaft, Frank E. and Vanessa G. Perry. (1996). *Redlining: Do Mortgage Rates Vary by Neighborhood?*. Federal Home Loan Mortgage Corporation, Working Paper.

Rachlis, Mitchell B. and Anthony M. Yezer. (1993). ''Serious Flaws in Statistical Tests for Discrimination in Mortgage Markets,'' *Journal of Housing Research* 4(2), 315–336.

Rosenblatt, Eric and James H. VanderHoff. (1992). ''The Closing Rate on Residential Mortgage Commitments: An Econometric Analysis,'' *Journal of Real Estate Finance and Economics* 5(2), 85–98.

Rosenblatt, Eric. (1997). ''A Reconsideration of Discrimination in Mortgage Underwriting with Data from a National Mortgage Bank,'' *Journal of Financial Services Research* 11, 109–131.

Rossi, Clifford, and Fred Phillips-Patrick. (1995). *Redlining in Washington, D.C.? A Cautionary Tale*. Office of Thrift Supervision, Working Paper.

Schill, Michael H. and Susan M. Wachter. (1993). ''A Tale of Two Cities: Racial and Ethnic Geographic Disparities in Home Mortgage Lending in Boston and Philadelphia,'' *Journal of Housing Research* 4(2), 277–313.

Shear, William B. and Anthony M. Yezer. (1985). ''Discrimination in Urban Housing Finance: An Empirical Study across Cities,'' *Land Economics* 61(3), 292–302.

Shlay, Anne B. (1988). ''Not in That Neighborhood: The Effects of Population and Housing on the Distribution of Mortgage Finance within the Chicago SMSA,'' *Social Science Research* 17.

Stiglitz, Joseph E. and Andrew Weiss. (1981). ''Credit Rationing in Markets with Imperfect Information,'' *American Economic Review* 71, 393–410.

Williamson, Stephen D. (1986). ''Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing,'' *Journal of Monetary Economics* 159–179.

Williamson, Stephen D. (1987). ''Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing,'' *Quarterly Journal of Economics* 135–145.