

# The Influence of Race in Residential Mortgage Closings

---

Authors                      John P. McMurray and Thomas A. Thomson

---

## Abstract

This study examines how applicants identified as Asian, Black or Hispanic differ in mortgage closing outcomes compared to the remaining applicants. First, the findings show that minority applicants are somewhat less likely to close a loan for purchase, but equally likely to close a loan for refinance. A more important question this study addresses is whether minority borrowers have less efficient closing outcomes. The findings show no statistical difference between minority and non-minority applicants. This indicates that originators do not demonstrate a “taste for discrimination” by basing their loan approval for minorities on whether the loan can be profitably sold.

---

## Introduction

LaCour-Little (1999) presents a comprehensive review of the substantial body of literature addressing whether minorities experience racial discrimination in obtaining mortgages. The gist of the standard argument is that if mortgages made to minorities are more profitable at the margin than mortgages made to non-minorities, minorities are experiencing economic discrimination. A number of studies lend support to one side, while another set of studies lend support to the other. Some of these papers address the denial rate of minority mortgage applications, while others address other issues such as default rates, and losses on defaulted loans made to minority borrowers. The studies show that minorities are more often denied financing—the questions revolve around whether this is due to racial prejudices (*i.e.*, non economic factors), or due to minority applicants having lower credit ratings, incomes or other factors.

This study takes a different tack than has thus far been addressed in the literature. It assesses how minority status affects mortgage loan closing outcome. First it addresses whether a minority is less likely to close on a locked loan application. Given that minority applications are more often denied, it follows that one would expect to see a lower closing rate. The more substantial contribution of this study is to assess whether minorities have less economically efficient closing outcomes. This issue is important, as one potential for economic discrimination, *ceteris paribus*, would be to show a tendency to deny minority applications if interest

rates rise, but be more likely to accept them if interest rates fall. Under such an environment, minorities would have less efficient closing outcomes.

Upon application for a residential mortgage, the potential borrower is typically offered the opportunity to lock in a current interest rate for the proposed loan. While this lock opportunity need not be taken at the time of application, all applications must lock before closing, as the paperwork has to be prepared for a known loan contract. Loan lock periods vary, with 45 and 60 days being the most common in this data set. After locking, the application becomes part of the “mortgage pipeline.”

There are several reasons for a locked application not closing. One reason, of course, is that the applicant may be denied the loan either because the appraisal of the property does not support the loan, or the income, employment or credit history does not meet the lenders standards. Another reason is that the processing of the documents may not be completed during the lock period, as it may be difficult to complete all the necessary verifications during that window.<sup>1</sup> Other reasons include that the applicant may decide to not close because he or she discovers defects in the property or title. Also some personal situation may occur during the application period such as change of job or illness so that the applicant may simply choose not to complete the transaction. Closing or fallout for reasons mentioned thus far do not appear interest rate related. Another reason for an applicant to not close a loan is that interest rates may have declined since the lock date, so it is no longer in the applicant’s best interest to close and the applicant chooses to “fall out.” The data used here does not provide the reason for fall out. It may be that the application was denied, or it may be the applicant’s choice, or it may be that the paperwork could not be completed during the period. This data cannot directly assess whether minority borrowers are more likely to be denied the loan. Many previous studies, however, establish that minority borrowers are denied loans at a higher rate than non-minority. Whether this higher denial rate is because of discrimination or due to weaker applicants remains an ongoing debate [see LaCour-Little (1999) for references].

Two earlier studies have assessed the probability of mortgage applications closing. Rosenblatt and Vanderhoff (1992) appear to be the first to publish closing probability research by directly assessing the probability of a locked application closing. McMurray and Thomson (1997) present further work using a larger, more varied, and more detailed dataset. The work presented here uses the McMurray and Thomson data augmented with racial identifiers. In addition to presenting the probability of a loan closing, this study extends previous work by assessing the efficiency of the closing decision, as this can shed new light on the non-economic discrimination minorities may face.

---

## The Data

The data is for applications made to a nationally-oriented mortgage originator during the January 1990 to January 1995 period, which includes periods of both

rising and falling interest rates. The data set includes FHA, VA and conventional applications for fixed- and variable-rate mortgages with 15- and 30-year amortization periods for both purchase and refinance. From about 44,000 loan applications, there are in excess of 55,000 interest rate locks. Most applications locked once, but about 9,000 experienced multiple locks. About 43% of the locks were for 45 days, and 38% for 60 days. Less than 0.2% of the locks were for greater than 90 days.

Because of the cost of processing applicants, funding during the original lock is the goal of mortgage originators. Two-thirds (66.54%) were funded during the original lock period. About 11% of the applicants terminated their application in this period,<sup>2</sup> and the remaining 22% went on to the next phase, either by allowing the interest rate to float for some period (*i.e.*, allowed the lock to expire), or by securing a new lock, prior to the expiration of the initial lock (9.5% of applicants). The overall closing rate was 61% for African Americans, 62% for Hispanics, 66% for Asians and 68% for others.

For this study, two dependent variables were created. To study the probability of a lock closing, the binary dependent variable, *CLOSE*, takes the value 1 if the loan closed during the lock, and 0 otherwise. To address the efficiency of closing, Treasury note futures were used as a reference instrument to measure interest rate changes and interest rate volatility. Both prices and implied volatilities were collected for each lock. Treasury note futures were chosen because (1) they have a similar duration to the most prevalent (*i.e.*, fixed rate) mortgages; (2) market prices are easily observed and collected; and (3) daily, implied volatilities could be obtained. The dependent variable used in the efficiency analysis is based on the Treasury note futures. The potential loan loss (*LOSS*) is measured as:

$$LOSS = (TF_T/TF_0 - 1) * Loan, \quad (1)$$

where:

- $TF_T$  = The price of the Treasury future at the terminal date;
- $TF_0$  = The price of the Treasury future at the lock date; and
- Loan* = The loan size (in dollars) of the mortgage applied for.

If interest rates rise, then Treasury futures fall in value, and correspondingly, the value of the delivered mortgage will be less than the note amount resulting in a loss to the originator. When interest rates fall, the opposite occurs, assuming the applicant closes the loan. If the closing process were perfectly efficient, the *LOSS* on every closing would be positive. In other words, if the applicants treated the lock as a pure financial option, and interest rates rose, they would close to benefit from their advantageous note rate. If interest rates fell, they would fall out (*i.e.*, apply for a loan somewhere else at a lower interest rate). If applicant-closing decisions are perfectly random with respect to interest rate, and interest rate

changes themselves are random, then *LOSS* would have an average value of \$0. If there is no interest rate response behavior by applicants, *LOSS* will be explained by the interest rate change between lock date and termination date. To control for the effect of interest rate change on the *LOSS* measure, a series of quarterly dummies is employed in the empirical model.

---

### Empirical Model Variables

With all empirical investigations, one is subject to the richness of the data set available. In Exhibit 1, data available to this study that are posited to influence the closing outcome are described. The loan approval decision typically requires an assessment of the property, and the employment, income, assets and credit worthiness of the borrower. Data was not available on the property. The primary variable relating to the borrowers income, is the payment to income ratio. Many of the variables describe details of the mortgage applied for or other applicant characteristics. The first noted hypothesized sign is for the probability of the lock closing. The second hypothesized sign is for the efficiency of the closing decision. Exhibit 2 presents descriptive statistics for these covariates.

---

### Regression Modeling Results

To address how minority status affects the probability of closing a mortgage loan application within the lock period, logistic regression is employed because of the desirable properties of regression analysis and the reasonable restriction to model closing probabilities in the [0,1] interval. Exhibit 3 presents the regression results. The first column presents the parameter estimate, followed by the estimated *p*-value, which in turn is followed with a measure of the impact this variable exerts on the probability of closing. The baseline probability, from which impact is measured, is the predicted closing probability when each continuous covariate is set to its average value (as shown in Exhibit 2), and the dummy variables are set to zero. This means the baseline probability is the predicted closing probability of the original lock for a 30-year, fixed-rate conventional mortgage application by a non-minority married man for an owner occupied single-family dwelling. The impact measure shows the percentage change (from the baseline probability) in the estimated closing probability as each continuous covariate value is individually increased by one standard deviation. For binary variables, the impact measure shows the effect of the variable taking the value 1. Because some variables that may be statistically significant may not be economically significant it is helpful to provide an impact measure for easy assessment of the economic significance of each covariate in a nonlinear regression model. Because an R-squared measure does not exist for logistic regression, this paper presents the square of the correlation between the predicted and actual outcomes, "correlation squared," which is analogous to the R-squared of linear regression (Maddala, 1988).

For the question at hand, that is, whether minority-closing outcomes are different than others, the negative regression coefficients for the first nine variables

## Exhibit 1 | Study Data

Variable	Hypothesized Sign	Description
<i>CLOSE</i>	N/A	The dependent variable for assessing closing probability. An indicator variable that takes the value 1 if the application closed, and 0 otherwise.
<i>LOSS</i>	N/A	The dependent variable for assessing closing efficiency. This is the originator's dollar loss at closing due to interest rate change over the lock period. It is either the amount of loss at closing, or the loss that would have been incurred if the loan had closed.
<i>ASIANxCONV</i>	- -	Indicator that the applicant is Asian multiplied by indicator that the loan is conventional. Similar variables are created for <i>ASIANxFHA</i> (Asian crossed with FHA indicator), <i>ASIANxVA</i> (Asian crossed with VA indicator) and <i>ASIANxREFI</i> (Asian crossed with refinance indicator). From previous studies [see LaCour-Little (1999) for references] it can be seen that minority applications are more likely to be rejected; thus, it is hypothesized that they are less likely to close an application. If minorities feel they are less likely to close a loan, they may be more inclined to close a loan with poor loan terms ( <i>i.e.</i> , close even though interest rates have fallen) and thus experience less efficient closes.
<i>BLACK-CONV</i>	-	As above, but for an African American applicant.
<i>HISPANIC-CONV</i>	- -	As above, but for a Hispanic applicant.
<i>FHA</i>	- -	Indicator that the loan applied for is an FHA loan. It is reasonable to expect that an FHA loan program will draw less qualified applicants and thus be less likely to close. Also, less qualified applicants may be less willing to pursue alternative closing options and thus experience less efficient closes.
<i>VA</i>	? -	Indicator that the loan applied for is a VA loan. Because this loan program is open only to qualified veterans it is difficult to establish priors about its likelihood of closing. If there is a benefit to a VA loan, closing would be less efficient as a larger goal will be to capture the benefit of the VA program.
<i>REFINANCE</i>	? +	Indicator that the loan sought is to refinance an existing loan. Because the loan itself is more optional, the likelihood of closing is not predicted. The closing decisions will be more efficient as there is little cost to fallout if interest rates fall.
<i>15-YEAR</i>	+ +	Indicator variable for a 15-year amortization period. Those who apply for a 15-year loan are probably more likely to qualify for a loan and thus will be more likely to close. Those who qualify for a 15-year loan are also more likely to consider their closing option and thus be more efficient in the outcome.

**Exhibit 1** | (continued)

## Study Data

Variable	Hypothesized Sign	Description
<i>ARM</i>	– –	Indicator variable for an adjustable-rate mortgage. Those who apply for an ARM may be doing so due to a weak financial position and thus are both less likely to close, and less likely to optimally exploit their closing option.
<i>VOLATILITY</i>	– +	The implied volatility of the reference interest rate instrument. The higher the volatility of an option, the more likely its exercise leading to a lower probability of closing and a higher probability of an efficient closing decision.
<i>DISCPOINT</i>	– ?	Amount of discount points an applicant pays. Higher discount points may erode the applicants ability to close the loan, and an applicant may have a distaste for paying points, even though they may be fairly priced, given the note rate. The effect of discount points on closing efficiency is not posited.
<i>LOCKDAYS</i>	– +	The number of days the interest rate lock is in effect. Because short locks only make sense if the application process is nearing the end and the applicant has chosen to proceed with the lock, short lock periods should indicate a higher closing probability. The longer the time until expiration of an option, the greater its time value leading to a positive effect of lockdays on closing efficiency.
<i>PMT/INC</i>	– –	Payment to income ratio. This variable is the monthly mortgage payment divided by the monthly family income, assuming the loan is amortized over 30 years. It measures affordability by capturing the relationship between income, loan amount and interest rate. As this ratio rises, affordability falls leading to lower projected closings. Those with high ratios are posited to proceed to closing, if it is offered, and thus be less efficient.
<i>SCHOOL</i>	+ +	The maximum years of schooling of the applicant or co applicant. It is hypothesized that more educated applicants have higher closing rates as they can better navigate the loan closing process leading to a higher closing rate overall. This higher education also suggests these applicants will be savvier respecting their closing option and will thus exercise more efficiently.
<i>AGE</i>	+ +	Applicant age. Older applicants will be more likely to successfully bring a loan to closure due to having had more experience in completing major financial transactions. As above, the applicant may be more knowledgeable regarding the option value.
<i>FEMALE</i>	? ?	Indicator that the applicant is a female (which does not prevent a male from being a co-applicant).

## Exhibit 1 | Study Data

Variable	Hypothesized Sign	Description
<i>SINGLE</i>	– +	Indicator that the applicant is single. Singles probably have a lower opportunity cost in not having a loan close as non-closure may disrupt only one person. This smaller opportunity cost of fallout decreases the likelihood of closing a loan, but increases the likelihood that an efficient close will be made.
<i>RENTAL</i>	– +	Indicator of a rental unit. Applicant is expected to be less likely to close as less personal disruption occurs from not closing. These applicants are expected to be more financially motivated to fall out if interest rates fall resulting in more efficient closes.
<i>MULTIUNIT</i>	– +	Indicator of a mortgage for a 2–4 unit building. At least one of the units in a multiunit structure will be a rental, so the rental affects noted above will be operative.
<i>SHORT-LOCK</i>	+ ?	Indicator of a short lock period (14 or fewer days). This variable, combined with <i>LOCKDAYS</i> allows for non-linearity in the effect of lock days.
<i>SHORT-RELOCK</i>	+ –	Indicator of a short relock period (14 or fewer days).
<i>RELOCK1</i>	+ –	Indicator variable for first relock. It seems the most likely reason for a relock is that the documentation needed to complete the closing could not be completed during the lock period. The applicant seems to want to proceed with the loan and thus will be more likely to close in the second period, and less likely to treat the lock as an option.
<i>RELOCK2</i>	+ –	Indicator variable for second relock.
<i>RELOCK3+</i>	+ –	Indicator variable third or greater relock.
<i>Q1-90-Q3-94</i>	N/A ?	Quarterly dummy variables used as control variables in the <i>LOSS</i> equation. These dummies track the general effect of interest rate changes on the <i>LOSS</i> variable. If there are no effects on loss from the above covariates, the determinant of whether the closing is efficient will be the change in interest rates during the lock period. If interest rates increase during the lock period, the closings will be efficient. If interest rates decrease during the period, the fallouts will be efficient.

(minority interacted with loan program for purchase) presented in Exhibit 3 confirms the expectation that minority applicants are less likely to close a mortgage application. Only five of the nine coefficients, however, show statistical robustness at the usual 5% level of significance. The lack of significance in some cases may be due to the low number of observations for some combinations (as

**Exhibit 2** | Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
CLOSE	0.680	0.467	0.00	1.00
LOSS (close)	61.291	1,339.910	-16,907.08	21,793.71
LOSS (fallout)	-36.126	851.664	-13,839.02	13,917.49
ASIANxCONV	0.015	0.121	0.00	1.00
BLACKxCONV	0.016	0.126	0.00	1.00
HISPANICxCONV	0.030	0.171	0.00	1.00
ASIANxFHA	0.008	0.088	0.00	1.00
BLACKxFHA	0.036	0.187	0.00	1.00
HISPANICxFHA	0.044	0.206	0.00	1.00
ASIANxVA	0.001	0.029	0.00	1.00
BLACKxVA	0.012	0.110	0.00	1.00
HISPANICxVA	0.007	0.085	0.00	1.00
ASIANxREFI	0.007	0.081	0.00	1.00
BLACKxREFI	0.008	0.089	0.00	1.00
HISPANICxREFI	0.015	0.120	0.00	1.00
FHA	0.350	0.477	0.00	1.00
VA	0.107	0.310	0.00	1.00
REFINANCE	0.246	0.431	0.00	1.00
15-YEAR	0.129	0.335	0.00	1.00
ARM	0.175	0.380	0.00	1.00
VOLATILITY	6.730	0.905	4.84	11.13
DISCPOINT	0.566	1.294	-4.25	9.50
LOCKDAYS	45.492	17.019	0.00	600.00
PMT/INC	0.164	0.074	0.00	3.42
SCHOOL	15.055	2.686	5.00	30.00
AGE	38.031	10.673	18.00	91.00
FEMALE	0.190	0.392	0.00	1.00
SINGLE	0.315	0.465	0.00	1.00
RENTAL	0.035	0.183	0.00	1.00
MULTIUNIT	0.022	0.145	0.00	1.00
SHORTLOCK	0.052	0.222	0.00	1.00
SHORTRELOCK	0.026	0.158	0.00	1.00
RELOCK1	0.165	0.371	0.00	1.00
RELOCK2	0.040	0.196	0.00	1.00
RELOCK3+	0.015	0.121	0.00	1.00

Note: N = 55,608.



**Exhibit 3** | Logistic Regression Estimates

Variable	Coefficient	p-value	Impact (%)
Intercept	0.5923	<0.0001	NA
ASIANxCONV	-0.3509	<0.0001	-9.9
BLACKxCONV	-0.2091	0.0071	-5.7
HISPANICxCONV	-0.1225	0.0545	-3.3
ASIANxFHA	-0.1432	0.1838	-3.9
BLACKxFHA	-0.3370	<0.0001	-9.5
HISPANICxFHA	-0.2784	<0.0001	-7.7
ASIANxVA	-0.0499	0.8684	-1.3
BLACKxVA	-0.2023	0.0174	-5.5
HISPANICxVA	-0.1344	0.2112	-3.6
ASIANxREFI	0.1091	0.4093	2.8
BLACKxREFI	0.0138	0.8985	0.4
HISPANICxREFI	-0.0090	0.9199	-0.2
FHA	-0.2287	<0.0001	-6.3
VA	-0.4318	<0.0001	-12.4
REFINANCE	-0.3934	<0.0001	-11.2
15-YEAR	0.0094	0.7623	0.2
ARM	-0.0747	0.0039	-2.0
VOLATILITY	0.0893	<0.0001	2.1
DISCPOINT	-0.0564	<0.0001	-1.9
LOCKDAYS	-0.0092	<0.0001	-4.2
PMT/INC	-0.9686	<0.0001	-1.9
SCHOOL	0.0399	<0.0001	2.7
AGE	-0.0039	<0.0001	-1.1
FEMALE	-0.0757	0.0052	-2.0
SINGLE	0.0197	0.3939	0.5
RENTAL	-0.3013	<0.0001	-8.4
MULTIUNIT	-0.3514	<0.0001	-9.9
SHORTLOCK	0.5583	<0.0001	12.6
SHORTRELOCK	0.3760	<0.0001	8.9
RELOCK1	-0.0009	0.9731	0.0
RELOCK2	0.0613	0.2050	1.6
RELOCK3+	0.2283	0.0044	5.6

Notes: Logistic regression estimates for factors affecting closing probability. The dependent variable is CLOSE, which takes the value 1 if the loan closed and 0 otherwise. The average closing rate is 68.0%, and the baseline-closing rate is 73.8%. The baseline sets all continuous variables to their mean and all indicator variables to zero. Impact measures the percentage change in the predicted value for the dependent variable if the continuous variables are increased by one standard deviation or an indicator variable takes the value 1. Correlation squared = 3.3%.

demonstrated by their small means). The impact numbers indicate that minorities are in the range of 1.3% to 9.9% less likely than others to close a locked application. The reason for this lower closing rate cannot be determined from this data, but it is reasonable to speculate that part of the reason is that minorities' applications are more often denied. HMDA data, as presented by Carr and Megbolugbe (1993) show the average rejection rate for whites is about 10% and for minorities in the 20%–25% range. Given that the non minority-closing rate is 68%, it appears that most of the fallout is due to reasons other than rejection. If the denial rate for minorities in this data were similar to HMDA data, then the most likely reason not to close a loan would be denial of the application as about 62% of the locks granted to minorities closed.

The next three variables show the results of minority applicants interacted with the refinance indicator. These results are not statistically different than zero, indicating that minorities are as likely as non-minorities to close loans for refinance. This result indicates that minorities, who have closed a loan on this dwelling in the past, are just as likely to close a loan application for refinance, as are non-minority applicants. The remaining covariates can be seen as control variables for the primary question of interest in this study. The effects of the remaining covariates on loan-closing outcomes are addressed in McMurray and Thomson (1997).

While analysis of the closing rate sheds little new light on the accept/denial controversy, the efficiency of close results can be exploited to test for a form of non-economic discrimination. Consider the scenario where the originator has a "taste for discrimination" that it exploits in the following way. Applications from minorities are taken, and if interest rates fall, so the loan can be sold for more than the face value, the originator is less likely to reject the applicant. If interest rates rise, and the loan would have to be sold at a loss, the application is tilted toward rejected. For non-minority applicants, assume the accept/reject decision is made without regards to interest rate change. Under such a scenario, the closed loans would be skewed with profitable minority loans, and the loss coefficient in the regression equation would be statistically negative (*i.e.*, on average the originator realizes a gain on minority applicants).

All of the closed loans were approved, so if approval rates were contingent on falling interest rates, more loans would be seen in this class that were inefficient for the minority applicant. A statistically robust negative coefficient for the closed loans of minority applicants, however, would not conclusively reflect non-economic discrimination by the originator. If minority applicants feel they are more likely to face discrimination in lending, they may also be more likely to choose to close a loan when interest rates have fallen if they believe that they have a lower probability of acceptance if they restart the loan application process with another originator. So if either the lender tends to skew loans to approval when interest rates fall, or if minorities are more inclined to accept what turns

out to be a poor lock, statistical inefficiency would be observed relative to non-minority applicants. If inefficiency is observed, it cannot be determined whether it is “self induced” by the applicant who closes a poor lock, rather than risk searching for another loan, or if lenders are more likely to approve a minority application when interest rates fall. In either case, lack of statistical difference indicates non-discrimination.

Consider the closed loans. Exhibit 4 shows one minority variable with statistical significance, *ASIANxCONV*. The \$141.22 regression coefficient means that, on average, Asians close loans when the value of the loan has fallen by \$141.22 relative to when the application was taken (*i.e.*, on average, a small interest rate rise occurred). In words, this result demonstrates that Asians applying for conventional loans tend to make efficient closing decisions. For the other minority groups and other loan programs for purchase, the minority effect is not significantly different than zero. The signs tend to be positive, which represents a loss for the mortgage issuer, further indicating no discrimination either induced by the mortgage bank, or the actions of the applicant. For refinance loans, the signs are negative (*i.e.*, the originator is making a small gain), but the results are not statistically different than zero at the 5% level of significance. Once again, there is no statistical evidence of racial discrimination.

For the loans that fall out, some are denials, and some fell for other reasons. If many of the reasons for fall out are not interest rate related (for example the house does not appraise a value high enough to support the loan), and that denial is rate is increased for minorities when interest rates rise, inefficient outcomes will be observed for minorities vis-à-vis other applicants. In other words, statistically positive coefficients would provide evidence of such discrimination.

When evaluating the applications that fell out, the conclusion regarding racial discrimination appears similar to that for the closed loans. The coefficient values for the minority indicators are positive indicating that if the loans had not fallen out, the mortgage originator would have incurred no loss if these loans had instead closed. In many cases the coefficients are similar to those for the closed loans, indicating no difference between the loans that close and those that fall out—in other words, the two sets of loans appear no different regarding their efficiency and there is no indication of denial/acceptance depending on interest rates movements since application. As with the closed loans, the fallout applications show negative (but non significant) regression coefficients for the refinance applications. There is no evidence of non-economic discrimination in the fallout applications.

The balance of Exhibit 4, for the purpose of this study, can be thought of as control variables. Few of the variables demonstrate statistical significance, indicating there must be major frictions in the mortgage pipeline that prevent applicants from exploiting their closing option in an efficient manner. Mortgage originators prefer, of course, that closing outcomes be random relative to interest

**Exhibit 4** | OLS Regression Estimates

Variable	Closed Loans		Fallout Loans	
	Coefficient	p-value	Coefficient	p-value
Intercept	-5,395.34	<0.0001	-4,264.68	<0.0001
ASIANxCONV	141.22	0.0293	105.98	0.2434
BLACKxCONV	90.34	0.1161	137.39	0.0942
HISPANICxCONV	-7.71	0.8679	63.57	0.3536
ASIANxFHA	71.47	0.4032	107.30	0.3251
BLACKxFHA	17.74	0.6733	16.95	0.7348
HISPANICxFHA	43.01	0.2643	58.62	0.2015
ASIANxVA	51.59	0.8394	180.95	0.5429
BLACKxVA	50.96	0.4809	52.59	0.5224
HISPANICxVA	-71.18	0.4299	81.86	0.4354
ASIANxREFI	-188.82	0.0730	-136.49	0.3079
BLACKxREFI	-55.69	0.5518	-94.33	0.3629
HISPANICxREFI	-47.79	0.5081	-33.85	0.7049
FHA	-1.23	0.9472	85.71	0.0012
VA	69.67	0.0110	73.72	0.0359
REFINANCE	41.77	0.0341	60.65	0.0246
15-YEAR	1.54	0.9469	-13.54	0.6726
ARM	-67.05	0.0012	23.74	0.3835
VOLATILITY	718.41	<0.0001	626.96	<0.0001
DISCPOINT	-32.60	<0.0001	-33.01	<0.0001
LOCKDAYS	6.56	<0.0001	-0.31	0.6714
PMT/INC	23.28	0.8312	-359.24	0.0022
SCHOOL	6.51	0.0158	-14.12	0.0002
AGE	-1.16	0.0945	1.52	0.1069
FEMALE	-38.94	0.0599	1.92	0.9441
SINGLE	25.18	0.1480	31.80	0.1771
RENTAL	73.16	0.0735	60.47	0.2472
MULTIUNIT	-35.57	0.5055	-40.14	0.4950
SHORTLOCK	201.00	<0.0001	78.18	0.2323
SHORTRELOCK	201.75	<0.0001	73.14	0.3869
RELOCK1	20.93	0.2927	-8.82	0.7404
RELOCK2	-64.32	0.0746	-7.22	0.8860
RELOCK3+	-166.84	0.0033	0.08	0.9992
Q1-90	1,143.18	<0.0001	1,154.17	<0.0001
Q2-90	-66.33	0.2715	21.08	0.7960
Q3-90	19.14	0.7316	-56.35	0.4670
Q4-90	-936.96	<0.0001	-1,269.23	<0.0001
Q1-91	133.54	0.0179	-103.67	0.1666
Q2-91	903.49	<0.0001	947.12	<0.0001
Q3-91	-46.72	0.4306	-286.82	0.0003
Q4-91	-82.62	0.1368	-406.43	<0.0001
Q1-92	266.26	<0.0001	297.09	<0.0001
Q2-92	-785.94	<0.0001	-967.37	<0.0001

**Exhibit 4** | (continued)

OLS Regression Estimates

Variable	Closed Loans		Fallout Loans	
	Coefficient	p-value	Coefficient	p-value
Q3-92	-573.96	<0.0001	-659.58	<0.0001
Q4-92	-380.68	<0.0001	-512.71	<0.0001
Q1-93	-953.71	<0.0001	-916.03	<0.0001
Q2-93	354.88	<0.0001	242.15	0.0003
Q3-93	271.17	<0.0001	231.49	0.0004
Q4-93	1,405.38	<0.0001	1,230.53	<0.0001
Q1-94	2,673.04	<0.0001	1,844.03	<0.0001
Q2-94	-597.33	<0.0001	-658.51	<0.0001
Q3-94	209.76	<0.0001	269.85	0.0003

Notes: OLS regression estimates for factors affecting closing efficiency. The dependent variable, LOSS, is described in Equation 1. The loans are separated into those that closed and those that fell out.  $N = 37,786$  for closed loans;  $N = 17,822$  for fallout loans. Adjusted  $R^2 = 32.5\%$  for closed loans and  $26.7\%$  for fallen loans.

rate changes, and to simply close as many applications as possible to make their overall business as proficient as possible.

## Conclusion

There remains great debate regarding whether minorities face discrimination in mortgage lending. Since the advent of the “Boston Fed” study (Munnell, Browne, McEneaney and Tootell, 1992), many studies that address this issue evaluate the denial rates of minority applicants, though some have also addressed the default and foreclosure process. This study takes a different look at this issue. First this article shows that the likelihood of closing a mortgage loan for purchase is from 1.3% to 9.9% lower for minorities, depending on which minority group or which type of loan is being studied. This is not *prima facie* evidence of discrimination, however, as there are many reasons for not closing, and the data at hand could not determine the reason for not closing. The closing rate for refinance applications was not statistically different between minority and others. More importantly, this study tests for a form of non-economic discrimination than can be detected by assessing the efficiency of the closing outcome. If mortgage originators practiced the differential treatment of being more likely to approve minority applications when interest rates fall (and the loans could be sold at a gain), and less likely to approve when interest rate go up, minority closing results would be found to be

less efficient. The empirical results show no evidence of discrimination using the efficiency analysis, as there is no statistical difference in closing efficiency for minority applicants.

---

## Endnotes

- <sup>1</sup> A recent *Wall Street Journal* article warned mortgage applicants to choose longer lock periods due the current high demand for home mortgages (Simon, 2002).
- <sup>2</sup> The mortgage originator regularly contacted applicants and thus can rapidly be determined when the applicant withdrew his or her application.

---

## References

- Carr, J. H. and I. F. Megbolugbe, The Federal Reserve Bank of Boston Study on Mortgage Lending Revisited, *Journal of Housing Research*, 1993, 4:2, 277–313.
- LaCour-Little, M., Discrimination in Mortgage Lending: A Critical Review of the Literature, *Journal of Real Estate Literature*, 1999, 7, 15–49.
- Maddala, G. S., *Introduction to Econometrics*, New York, NY: MacMillan Publishing Company, 1988.
- McMurray, J. P. and T. A. Thomson, Determinants of the Closing Probability of Residential Mortgages, *Journal of Real Estate Research*, 1997, 14, 55–64.
- Munnell, A. H., L. E. Browne, J. McEneaney and G. M. B. Tootell, *Mortgage Lending in Boston: Interpreting HMDA Data*, Federal Reserve Bank of Boston Working Paper, No. 92-1, 1992.
- Rosenblatt, E. and J. Vanderhoff, The Closing Rate on Residential Mortgage Commitments, *Journal of Real Estate Finance & Economics*, 5, 1992, 85–98.
- Simon, R., How to Keep that Great Mortgage Rate, *The Wall Street Journal*, August 27, 2002, D1, D3.)

---

*John P. McMurray, Freddie Mac, McLean, VA 22102-3110 or john\_mcmurray@freddiemac.com.*

*Thomas A. Thomson, The University of Texas–San Antonio, San Antonio, TX 78249-0637 or tthomson@utsa.edu.*