

## **Does Differential Treatment Translate to Differential Outcomes for Minority Borrowers? Evidence from Matching a Field Experiment to Loan-Level Data**

Andrew Hanson  
Marquette University

Zackary Hawley  
Texas Christian University

Hal Martin  
Federal Reserve Bank of Cleveland

**Working Paper 17-14**  
**June 2017**

The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

This paper was originally published as *Working Paper no. 17-03* by the Federal Reserve Bank of Cleveland. This paper may be revised. The most current version is available at

<https://www.clevelandfed.org/~media/content/newsroom%20and%20events/publications/working%20papers/2017/wp%201703%20differential%20treatment%20and%20outcomes%20minority%20borrowers.pdf?la=en>.

w o r k i n g  
p a p e r

17 03

**Does Differential Treatment Translate to  
Differential Outcomes for Minority  
Borrowers? Evidence from Matching a  
Field Experiment to Loan-Level Data**

Andrew Hanson, Zackary Hawley, and  
Hal Martin



FEDERAL RESERVE BANK OF CLEVELAND

**Working papers** of the Federal Reserve Bank of Cleveland are preliminary materials circulated to stimulate discussion and critical comment on research in progress. They may not have been subject to the formal editorial review accorded official Federal Reserve Bank of Cleveland publications. The views stated herein are those of the authors and are not necessarily those of the Federal Reserve Bank of Cleveland or the Board of Governors of the Federal Reserve System.

Working papers are available on the Cleveland Fed's website:

**<https://clevelandfed.org/wp>**

**Does Differential Treatment Translate to  
Differential Outcomes for Minority Borrowers?  
Evidence from Matching a Field Experiment to Loan-Level Data**

Andrew Hanson, Zackary Hawley, and Hal Martin

This paper provides evidence on the relationship between differential treatment of minority borrowers and their mortgage market outcomes. Using data from a field experiment that identifies differential treatment matched to real borrower transactions in the Home Mortgage Disclosure Act (HMDA) data, we estimate difference-in-difference models between African American and white borrowers across lending institutions that display varying degrees of differential treatment. Our results show that African Americans are more likely to be in a high-cost (subprime) loan when borrowing from lenders that are more responsive to them in the field experiment. We also show that net measures of differential treatment are not related to the probability of African American borrowers having a high-cost loan. Our results suggest that differential outcomes are related to within-institution factors, not just across-institution factors like institutional access, as previous studies find.

Keywords: discrimination, mortgage lending, loan outcomes.

JEL classifications: G2; J15.

Suggested citation: Hanson, Andrew, Zackary Hawley, and Hal Martin, "Does Differential Treatment Translate to Differential Outcomes for Minority Borrowers? Evidence from Matching a Field Experiment to Loan-Level Data," Federal Reserve Bank of Cleveland, Working Paper no. 17-03.

---

Andrew Hanson is at Marquette University ([andrew.r.hanson@marquette.edu](mailto:andrew.r.hanson@marquette.edu)). Zackary Hawley is at Texas Christian University ([z.hawley@tcu.edu](mailto:z.hawley@tcu.edu)), and Hal Martin is at the Federal Reserve Bank of Cleveland ([hal.martin@clev.frb.org](mailto:hal.martin@clev.frb.org)).

## I. Introduction

There are substantial documented differences in lending *outcomes* between white and minority borrowers. Recent findings show outcome differences for minority borrowers in the form of higher delinquency rates and more foreclosures (Bayer, Ferreira, and Ross 2016a and Bhutta and Canner 2013), the price paid for credit (Ghent, Hernández-Murillo, and Owyang 2014 and Bayer, Ferreira and Ross 2016b), and higher denial rates (Bhutta and Canner 2013).<sup>1</sup> These studies document the persistence of outcome differences even after conditioning on relevant factors that are typically not available in previous studies, most notably borrower credit scores. There are also substantial documented differences in borrower *treatment* between whites and minorities. Using an in-person audit design Ross, Turner, Godfrey, and Smith (2008) find that lenders in Chicago are less likely to follow up, offer details about loans, submit requested information, and give coaching to minority clients than they are to whites. Using an e-mail based correspondence experiment Hanson, Hawley, Martin, and Liu (2016) find that a national sample of lenders is less likely to respond, less likely to follow-up, and less likely to offer details to African American clients than whites.

Despite evidence that both differential outcomes and differential treatment exist, there is no empirical work that convincingly links the two.<sup>2</sup> Even in differential outcome studies that offer the most comprehensive controls for borrower, lender, and area characteristics, missing variables prevent researchers from claiming that differential treatment of minorities directly causes outcome differences. Differential treatment studies on the other hand, often tightly

---

<sup>1</sup> See Ross and Yinger (2002) for a comprehensive review of pre-2000 studies of mortgage discrimination. These studies focus on differential outcomes and work to isolate race as the cause of outcome differences with a focus on limiting omitted variable bias.

<sup>2</sup> Collins (2004) estimates the relationship between differential treatment and outcomes indirectly by examining the impact of state-level anti-discrimination laws on segregation and property values. Collins (2004) reports that these laws have essentially no impact on segregation or property values in African American neighborhoods.

identify treatment differences using experiments or audits, but are limited to more general interactions like response or information provision and cannot examine the terms or underwriting of a real loan.

This paper is the first to examine the link between differential treatment of minority borrowers and differential outcomes for minority borrowers. Understanding the link between differential treatment and differential outcomes helps to inform how to reconcile observable outcome differences between groups. If differential treatment is not strongly linked to differential outcomes, reconciling between-group differences may rely on changing underlying characteristics of borrowers or improving access to lenders. If differential treatment is strongly linked to differential outcomes, reconciling between-group differences may be narrowed by enforcing fair-lending standards or lender training.

Using the results of an industry-wide field experiment matched to loan-level data on mortgage applications, we examine how differential treatment of minority borrowers at the lender-level affects individual minority borrowing outcomes. Identifying lenders at the institution-branch level, we make difference-in-difference comparisons between African American and white borrowers across branches practicing varying levels of differential treatment. We implement both a standard difference-in-difference model and a model using branch-level fixed effects, and examine how both net and gross levels of differential treatment affect loan outcomes.

Our results show that African Americans are more likely to be in a high-cost (subprime) loan when borrowing from branches of lending institutions that are more responsive to them in the field experiment. We also show that net measures of differential treatment are not related to the probability of African American borrowers having a high-cost loan. The magnitude of our

results suggests that for a one standard deviation increase in the African American response rate (35 percentage points), African Americans have a 2.4–2.5 percentage point increase in the likelihood of being in a high-cost loan. These results suggest that differential outcomes are related to within-institution factors like client steering. This finding is unique, as recent studies of borrowing outcomes suggest that white-minority differences are largely a function of cross-institution factors like differential access.

The remainder of the paper begins by describing the experiment used to identify differential treatment in the mortgage industry. Section III is an overview of the Home Mortgage Disclosure Act (HMDA) data on lending outcomes and how this data is matched to the experiment. Section IV describes the empirical methodology for estimating the relationship between differential treatment and differential outcomes of minority borrowers. Sections V and VI present our primary results and several robustness checks. The final section of the paper concludes.

## II. Identifying Differential Treatment

Hanson, Hawley, Martin, and Liu (2016) design and implement a field experiment to test for differential treatment between African American and white borrowers by Mortgage Loan Originators (MLOs).<sup>3</sup> The original experiment is a matched-pair correspondence study, using e-mail communication with MLOs from borrowers with names that are highly likely to belong to only one racial group. Correspondence studies of discrimination have been conducted in the rental market (Ahmed & Hammarstedt 2008; Hanson & Hawley 2011; Carlsson & Ericksson 2014), the labor market (Bertrand & Mullainathan 2004; Bursell 2007; Nunley et al. 2014), and

---

<sup>3</sup> The original experiment also includes a credit score treatment that we do not consider here.

in other markets such as peer-to-peer lending (Pope & Sydnor 2011). Oh and Yinger (2015) provide a recent comprehensive review of both traditional paired testing and correspondence studies in housing and mortgage markets, while Bertrand and Duflo (2016) review correspondence studies conducted in several markets, including rental housing.

The subjects of the experiment in Hanson et al. (2016), MLOs, are an initial contact point for most borrowers when searching for a mortgage. They are licensed sales people that have discretion about how they interact with clients. MLOs for instance, may offer general financial advice to clients, specific recommendations about obtaining a loan, an opinion about credit scores, and terms of a loan. The experimental sample includes 5,181 MLOs (10,362 e-mails) and is geographically representative of the United States by population (sample sizes in each state are proportional to state populations). The sample of MLOs in the experiment is 70 percent white, and 5 percent non-white, with 25 percent of the sample racially unidentified. 42.5 percent of MLOs in the sample are male, 37 percent female, and 20.5 percent gender unidentified.

The overall response rate from the experiment is 67.0 percent. The gross response rate to white clients is 68.31 percent, while the gross response rate to African Americans is 65.68 percent. The gross response rate difference reveals a differential treatment of 2.63 percent in the full sample of MLOs, statistically meaningful at the one percent level. The Hanson et al. (2016) experiment tests for discrimination on a number of dimensions where MLO treatment may differ, but we focus on two measures—the gross initial response rate to African Americans and net initial response rate (African American response rate minus white response rate).<sup>4</sup>

---

<sup>4</sup> The original experiment tests for differential treatment along several other dimensions including propensity to follow up and the type of information (if any) included in a response. We attempted to use these other measures of differential treatment to examine differential outcomes, but these results generally produce a null finding. We suspect that this null finding is because our other measures of differential treatment are a function of the initial response, and represent a much smaller proportion of MLOs once we match to the HMDA data.



Both of our measures are aggregated to the branch level of lending institutions to match with the HMDA data as described in the next section. The gross response rate to African Americans is the branch-level aggregate response rate from MLOs to African Americans in the field experiment. The gross response rate measures the overall responsiveness of the branch to African American inquiries irrespective of how the branch responds to white clients. The net response rate is the gross response rate to African Americans minus the gross response rate to whites from the field experiment.

### III. HMDA Data

We combine data on treatment from the experiment with data on borrowers and loans made available through the Home Mortgage Disclosure Act (HMDA). HMDA requires most lenders<sup>5</sup> to collect detailed information about loan applications, including the race of the borrower and location of the property in question. The HMDA data includes a variety of borrower and loan characteristics for both applicants and originated loans. For each application, a lender reports the race of the applicant, the location of the property, the borrower's income, the loan amount, and other loan characteristics such as type of loan, whether the property will be owner-occupied, and the rate spread if loans are designated as high-cost.

HMDA data serves as the underpinning of many studies on differential outcomes by race in mortgage lending. In seminal work, Munnell et al. (1996) supplements HMDA data with credit characteristics of borrowers, showing that racial differences in denial rates are partially (but not fully) accounted for by these characteristics and that substantial differences in denial rates remain. More recent work on differential outcomes using HMDA include Bayer, Ferreira,

---

<sup>5</sup> Regulators exempt certain institutions, primarily small ones, from reporting in HMDA. See <https://www.ffiec.gov/hmda/reporterhistory.htm> for details.

and Ross. (2016a, 2016b), Bhutta and Canner (2013), and Ghent, Hernández-Murillo, and Owyang (2014). For more on the construction and limitations of HMDA data, see Avery, Brevoort, and Canner (2007).

We measure differential outcomes using HMDA data in this study. We examine loans made in calendar year 2012, the year that the MLO experiment was conducted. The outcome of interest is the propensity of a borrower to be in a high-cost loan, defined in HMDA as a loan with an annual percentage rate (APR) that is at least 1.5 percentage points higher than the prevailing treasury rate of comparable maturity for first liens, and 3.5 percentage points higher for subordinate liens.<sup>6</sup>

Linking the experiment and HMDA data involves several steps. We first aggregate the MLO response behavior to the branch level. The experiment includes 2,684 branch offices across 50 states and the District of Columbia. Branches are then matched to an institution in the HMDA data (individual loan applications in HMDA are identified by institution, but not by branch office). Of the offices in the MLO data, 2,233 are matched to institutions in the HMDA records. Finally, individual loans in HMDA are matched to the branch level. Because loans in HMDA are tied to institutions, not branch offices, we use the proximity of the property a loan is made for to establish the link. In our primary specification, we assume that a loan for a property in a given census tract originates from a branch of the same institution located in that census

---

<sup>6</sup> We also investigate rates of denial, but find no link between differential treatment in the experiment and that outcome in the HMDA data.

tract, if such an office exists.<sup>7</sup> Of the 9,783,966 originated loans in the HMDA data, 27,648 can be matched to an office in the MLO data using this procedure.<sup>8</sup>

We report summary statistics for the HMDA data in Table 1. Because our matched sample comprises a small subset of the available HMDA data, we show statistics for four subsets of the data for purposes of comparison. (Standard deviations are enclosed in brackets.) Column 1 reflects all HMDA applications in 2012. Of these, 17.25 percent are insured by the Federal Housing Administration, almost 90 percent of loans are for owner-occupied property, applicants have an average income of \$109,159, and make loan requests for \$210,657 on average. In terms of race, 4.8 percent of loans identify the primary applicant as African American and 70.7 percent as white.<sup>9</sup>

Loan applications in the HMDA data can fail to result in loan origination for many reasons, including denial by the underwriter and withdrawal by the applicant. Column 2 restricts the sample to only those loans that were originated. Of these loans, 3.03 percent are considered by HMDA guidelines to be high-cost, and have a rate spread that exceeds the prevailing treasury rate of comparable maturity by 3.15 percentage points on average. Some differences exist between originations and all loans. For instance, FHA loans comprise 17.25 percent of all loan applications but only 13.34 percent of originations. Notably, African American applicants comprise 4.81 percent of all applications, but only 4 percent of originated loans. This is the

---

<sup>7</sup> Because there may be multiple offices of the same institution in a given census tract, we combine the MLO data for such offices into one “joined office” for purposes of analysis. There are 31 instances of such joined-office tracts, reducing the functional number of offices to 2,197.

<sup>8</sup> We consider other measures of proximity in a set of robustness checks, including loans made for properties in census tracts immediately adjacent to an office’s tract, and loans in census tracts within a fixed distance from the office’s tract.

<sup>9</sup> Because the unit of observation is the application, HMDA does not report when more than one application is made by the same borrower for the same purpose. Borrowers who shop around, or who apply more than once in the same period, will have applications that appear as separate observations.

opposite of the trend for white applicants, who comprise 70.74 percent of all applications and 79.05 percent of originated loans.

If we restrict the sample further to examine only originated first liens among African American or white applicants (column 3), we observe similar values for many variables. The most notable difference is the lower average rate spread for first liens, something that is expected given that first liens tend to be less costly than subordinate liens, and that the HMDA threshold for reporting a rate spread is lower for first liens. We also report summary statistics for income and loan amount by race in this column. The average income of African American applicants in this group is 74 percent that of whites, and the loan amounts of African Americans are 85 percent of white borrowers.

Column 4 summarizes the data according to the same restrictions in column 3, with the additional restriction that the loan is matched to a branch office in our MLO experiment. This column shows that our matched sample captures fewer (and less expensive) high-cost loans, lower income applicants, lower loan amounts, and branches that serve a disproportionately larger number of white clients (compared to African Americans).

#### IV. Methodology

By matching the field experiment on borrower treatment to HMDA data, we are able to examine outcome differences between African American and white borrowers across branch offices with different levels of differential treatment. We estimate the relationship between treatment and borrowing outcomes using a difference-in-difference specification. The specification controls for the race of the borrower, and we are interested in the interaction between borrower race and differential treatment, controlling either for branch-level fixed effects or the branch-level

differential treatment (depending on the specification). Our specifications are designed to estimate the marginal effect of differential treatment on the propensity for different outcomes between white and African American borrowers at similar (or in the case of the fixed effects specification, the same) institutions. Our base specifications are:

$$(1) Y_{i,j} = \alpha + \beta_1(D = 1 \text{ if borrower race is African American})_i + \beta_2(\text{Branch Response Rate to African Americans})_j + \beta_3(D = 1 \text{ if borrower race is African American} * \text{Branch Response Rate})_{i,j} + X'_{j}\delta_j + Z'_i\gamma_i + \varepsilon$$

and

$$(2) Y_{i,j} = \alpha + \beta_1(D = 1 \text{ if borrower race is African American})_i + \beta_2(D = 1 \text{ if borrower race is African American} * \text{Branch Response Rate})_{i,j} + \delta_j + Z'_i\gamma_i + \varepsilon$$

where  $Y_{i,j}$ , the outcome of interest, is an indicator equal to one if a loan made to individual  $i$  at branch  $j$  was a high interest or “subprime” loan. The specification in (1) controls for various loan-level ( $Z'_i$ ) and branch-level ( $X'_j$ ) characteristics, while branch level characteristics drop out of the fixed effects specification (2). The set of individual-level characteristics contained in the HMDA data that we use for controls are: the loan amount, applicant income, if the loan was FHA insured, if the home is to be owner-occupied, and the gender of the applicant. The set of branch-level characteristics contained in the HMDA data that we use for controls are: the total number of loans made at the branch, census-tract median family income, census-tract-to-metropolitan-area median income ratio, and the percentage of minorities living in the census tract.

We estimate each model using two different measures of differential treatment indicated by the variable *Branch Response Rate*. The first is the gross response rate to African Americans from our field experiment, the second is the net response rate (African American response rate minus white response rate).<sup>10</sup>

We estimate each model conditional on a loan being made (removing application denials),<sup>11</sup> being a first lien, and the primary applicant being identified as either white or African American. All standard errors for model (1) estimates are clustered at the branch level. All standard errors for model (2) estimates are clustered at the institution level. In this study, an “institution” is a company that makes loans reportable under HMDA, and a “branch” is a specific loan office of an institution.

## V. Results

Table 2 shows the results of estimating (1) and (2) using the gross response rate to African Americans as the measure of differential treatment. The first four columns of Table 2 show standard difference-in-difference results, and columns (5) and (6) show results from the fixed effects specifications.

The Table 2 results suggest a strong positive relationship between MLO response to African Americans in the field experiment and the propensity for African Americans to receive a high-cost loan from that branch ( $\beta_3$  in specification (1) and  $\beta_2$  in specification (2)). The

---

<sup>10</sup>We investigated two alternative measures of net discrimination– the response ratio (white/African American) and a dummy variable indicating that whites have a higher response rate than African Americans at a particular branch. These alternative measures produce similar results as the raw net measure results presented here.

<sup>11</sup> We estimated models that use application denial as the dependent variable with the same specifications in (1) and (2). This estimation shows a large, negative relationship between both gross response and net response and denial of loans to African Americans, but the standard errors on these results are generally 1.5-2 times point estimates, making them highly unreliable.

magnitude of the results, with coefficients ranging from 0.0691 to 0.0729, suggests that when the response rate to African Americans increases by 10 percentage points, the likelihood that an African American is in a high-cost loan (conditional on obtaining a first lien mortgage) increases by between .69 and .73 percentage points. Alternately, for a one standard deviation increase in the African American response rate (35 percentage points), African Americans have a 2.4–2.5 percentage point increase in the likelihood of being in a high-cost loan. The magnitude of the results is consistent across specifications that control for loan and branch level characteristics, and when using the branch-level fixed effects. The coefficient of interest is statistically different than zero at conventional levels in all specifications.

Table 3 shows results of estimating (1) and (2) using the net response rate to African Americans as the measure of differential treatment. As in Table 2, the first four columns of Table 3 show standard difference-in-difference results, and columns (5) and (6) show results from fixed effects specifications.

The net measure of differential treatment (African American response rate minus white response rate) has essentially no relationship with the probability that an African American borrower receives a high-cost loan. The sign on the coefficient of interest is positive, but is between 1/10<sup>th</sup> and 1/3<sup>rd</sup> the magnitude of the gross-measure results, and is not statistically significant in any specification. We take the results in Table 2 to mean that there is no evidence to suggest that the probability of an African American being in a high-cost loan is a function of the net discrimination rate.

These results show that lenders who respond more to African Americans, measured by gross response rate, also place them into higher interest loans more often compared to white borrowers at the same branch. Lenders who, on net, respond to African American clients

differently do not place African American borrowers into high-cost mortgages at a higher rate. These findings are consistent with the idea that MLOs target African American clients and then steer them into high-cost loans.

Although consistent with targeting and steering African American clients, the result could arise through more than one channel. For instance, these results are also consistent with lenders specializing in high-cost loans and actively seeking minority clients. Minority clients are, on average, higher risk as measured by credit scores, making them more likely to qualify only for subprime loans. Alternatively, lenders may target African American clients not because they specialize in high-cost loans but because they provide incentives for employees to originate such loans. The incentives for the originators are such that high-cost products create a larger return for the institution as well as the originator. Acknowledging this practice, the Consumer Financial Protection Bureau now enforces the Mortgage Loan Originator Compensation Rule (a 2013 amendment to the Truth in Lending Act) banning the practice of tying loan points, fees, or rates directly to the compensation of originators.

Regardless of the actual channel that links treatment in the experiment with outcomes, because the specification includes branch fixed effects, our results must be driven by some within-institution factor.<sup>12</sup> Coupled with the field experiment findings, these results suggest that African-American borrowers face difficulties when trying to find a mortgage loan originator (Hanson et al., 2016), and when they do find a lender that is responsive to inquiries about mortgages, African-American loan-seekers may then receive high-cost loans at a disproportional rate than similar white applicants at the same branch of a lending institution.

---

<sup>12</sup> Our result is also consistent with credit score divergence between African American and white clients who borrow from the same branch of an institution. We note that this would have to be credit score divergence in addition to the factors we control for such as borrower income.



## VI. Robustness Checks

In this section we offer several robustness checks on our primary results, as well as a falsification test. First, because the match between loans and their branches is based on an assumption about being in the same census tract, we test alternate assumptions to match loans to branches. Next, we examine the possibility that our primary results are biased by using a sample that includes lenders that may never make high-cost loans. Finally, we present a falsification test.

### *Alternative Matching of Loans with Lenders*

It is necessary to make a match between loans and particular branches of lending institutions in the HMDA data to merge them with an observation in the field experiment. For our primary results, we use only loans where the census tract location of the borrower is an exact match with the census tract location of the lending institution branch. This is a conservative approach, and leaves out many loans made to borrowers from a local branch where the borrower lives in a nearby census tract. We offer two sets of alternative assumptions about the match between borrower and branch here. First, a borrower matches a branch if the loan was made from that institution and the borrower is located in a census tract that is within a specified distance—we use .5, 1, and 1.5 mile ranges, in addition to any loan made within the same census tract. Second, a borrower matches a branch if the loan was made from that institution and the borrower is located in an adjacent census tract that is within 2 miles of the branch census tract (in addition to any loan within the same census tract).

Table 4 shows results using the set of alternative matches between borrowers and branches using the gross response rate to African Americans as the measure of differential

treatment. We report only the fixed effects specifications, estimated with and without controls, but all models show a similar result. The results using just the .5 mile distance measure only add about 500 observations, while the results using the 1.5 mile distance measure add about 18,000 observations. The primary results are unaffected by the expansion of the sample by broadening the definition of a match between borrowers and a branch where the loan was made. The point estimates are nearly identical to the primary estimation. Results are statistically significant at the one percent level in most specifications.

Using borrowers matched to branches from adjacent tracts within 2 miles (in addition to own-tracts), lowers our point estimates slightly from the primary specification. These estimates add the most observations to the dataset, around 21,000, and show that for a 10 percentage point increase in the African American response rate, African Americans have a .5 percentage point increase in the likelihood of being in a high-cost loan, or for a one standard deviation increase in the response rate to African Americans, they have a 1.75 percentage point increase in the likelihood of being in a high-cost loan. These results are statistically significant at the one percent level.

We test the same set of alternative matches between borrowers and branches using the net response rate for African Americans as the measure of differential treatment. As with the primary results, and despite adding over 21,000 observations in some specifications, these results (not reported) are again small in magnitude and not statistically significant. There appears to be no relationship between net response in our field experiment and the propensity for African American borrowers to be in high-cost mortgages.

#### *Restricting the Sample to High-Cost Lenders*

The original estimation sample includes all loans matched to a branch that was part of the original field experiment. This includes a variety of branches across a wide geography; however, some of these branches may not include high-cost loans as part of their business model. If this is true, and African Americans and whites have a different propensity to search for lending institutions that results in one group being differentially likely to end up at a high-cost lender, then our standard difference-in-difference results could be biased as they would include both the propensity to end up in a high-cost loan at a given lender and the propensity to be at a high-cost lender in the first place. Fixed effects estimation should account for these differences, but only if there is enough overlap in institutions where both whites and African Americans purchase mortgages.

As a way to measure how much the estimates reflect the search process and how much they reflect what happens within a branch or institution, we estimate our primary model restricting the sample to only branches that actually made a high-cost loan in our data. Table 5 shows the restricted results using gross response rates to African Americans. We also check the same restriction on the net response rate (results not reported). In both cases, the results are consistent with our primary findings—African Americans are more likely to be in a high-cost loan at branches where gross response rates in the field experiment were higher, but no more likely to be in a high-cost loan at branches where net differences in response rate were larger.

The magnitude of the coefficients in the restricted sample, shown in Table 5, is slightly larger than the primary estimates, suggesting that search practice may play a small role, but even abstracting from search differences, the estimated magnitudes suggest that a 10 percentage point increase in the response rate to African Americans is associated with an increase in the probability they are in a high-cost loan by .75–.77 percentage points (a one-standard deviation

increase in response rate increases the probability of being in a high-cost loan by 2.6–2.7 percentage points). As with the primary results, these results are statistically significant at conventional levels.

Restricting the sample to only high-cost lenders does not change the null finding for net response differences. These models produce estimates that are positive, but in most cases near zero in magnitude, and not statistically significant.

#### *Falsification Test: White Outcomes as a Function of White Response*

Our primary results show that African Americans are more likely to be in a high-cost loan when borrowing from lenders that are more responsive to them in a field experiment. This suggests a strong link between lender treatment and differential outcomes for African American borrowers. These results are relative to outcomes for white borrowers, and control for branch-level fixed effects, eliminating many concerns about potential omitted variables. What the primary results might miss is that the interaction between own-race response and steering into high-cost loans might not be peculiar to African Americans. It might be the case that more responsive lenders to white clients are also more likely to steer whites into high-cost loans. We test this possibility in a falsification test, re-estimating equations (1) and (2), but using a dummy variable for a white borrower in place of African American, and the white response rate from our experiment as the interaction (controlling for this response rate in the difference-in-difference specifications, and the branch-level effect in the fixed effects specifications).

Table 6 shows estimation results for the probability a white borrower is in a high-cost loan using the gross white response rate from the field experiment. The gross response rate to white clients has a negative effect on the propensity for whites to be in a high-cost loan across

specifications, although only one specification yields even marginally statistically meaningful results. We interpret these results to show that there is no evidence that the probability of whites being in a high-cost loan is a function of whites being targeted by lending institutions.

## VII. Conclusion

This paper is the first to examine the link between differential treatment and differential outcomes for minority borrowers. Using the results of an industry-wide field experiment matched to loan-level data on mortgage applications, we show that African Americans have an increased likelihood of being in a high-interest loan at lending institutions that are more likely to respond to their inquiries about a mortgage. We find no evidence that net measures of treatment between whites and African Americans are correlated with outcome differences, suggesting that the mechanism is a within-institution factor like client steering. Our findings are robust to a number of alternative specifications including different assumptions for matching loans to branches and different sample restrictions.

Our primary result suggests that differences between white and African American lending outcomes cannot be fully explained by the borrower characteristics other than race (e.g., income and loan characteristics) that we observe. They suggest that if regulators are interested in further shrinking the race differential in outcomes, they might look more carefully at actions taken by lenders (such as marketing and communications) early in the lending process, and might develop analytic tools to focus on the branch or even the individual lender. The finding that being in a high-cost loan is a function of response to African American clients implies that interventions intended to eliminate differential outcomes by race may need to be more nuanced than traditional enforcement of fair lending standards.

## References

- Ahmed, Ali, Mats Hammarstedt.** 2008. "Discrimination in the rental housing market: A field experiment on the Internet." *Journal of Urban Economics* 64 (2): 362-372.
- Avery, Robert, Kenneth Brevoort, and Glenn Canner.** 2007. "Opportunities and Issues in Using HMDA Data." *Journal of Real Estate Research* 29 (4): 351-380.
- Bayer, Patrick, Fernando Ferreira, and Stephen L. Ross.** 2016a. "The Vulnerability of Minority Homeowners in the Housing Boom and Bust." *American Economic Journal: Economic Policy* 8 (1): 1-27.
- Bayer, Patrick, Fernando Ferreira, and Stephen L. Ross.** 2016b. "What Drives Racial and Ethnic Differences in High Cost Mortgages? The Role of High Risk Lenders." *Working Paper*.
- Bertrand, Marianne, and Esther Duflo.** 2016. "Field Experiments on Discrimination." Forthcoming in Abhijit Banerjee and Esther Duflo, (Eds.) *Handbook of Field Experiments, Volume 1*. North Holland.
- Bertrand, Marianne, and Sendhil Mullainathan.** 2004. "Are Emily and Greg More Employable Than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination." *American Economic Review* 94 (4):991-1013.
- Bhutta, Neil, and Glenn B. Canner.** 2013. "Mortgage market conditions and borrower outcomes: Evidence from the 2012 HMDA data and matched HMDA-credit record data." *Federal Reserve Bulletin* 99 (4): 1-58.
- Bursell, Moa.** 2007. "What's in a name? - A field experiment test for the existence of ethnic discrimination in the hiring process." *Working Paper*.
- Carlsson, Magnus, and Stefan Eriksson.** 2014. "Discrimination in the rental market for apartments." *Journal of Housing Economics* 23: 41-54.
- Collins, William J.** 2004 "The housing market impact of state-level anti-discrimination laws, 1960–1970." *Journal of Urban Economics* 55 (3): 534-564.
- Ghent, Andra C., Ruben Hernandez-Murillo, and Michael T. Owyang.** 2014. "Differences in subprime loan pricing across races and neighborhoods." *Regional Science and Urban Economics* 48: 199-215.
- Hanson, Andrew, and Zackary Hawley.** 2011. "Do landlords discriminate in the rental housing market? Evidence from an internet field experiment in US cities." *Journal of Urban Economics* 70 (2-3): 99-114.
- Hanson, Andrew, Zackary Hawley, Hal Martin, and Bo Liu.** 2016. "Discrimination in mortgage lending: Evidence from a correspondence experiment." *Journal of Urban Economics* 92: 48-65.

- Munnell, Alicia, Geoffrey Tootell, Lynn Browne, and James McEneaney.** 1996. "Mortgage Lending in Boston: Interpreting HMDA Data." *American Economic Review* 86 (1): 25-53.
- Nunley, John, Adam Pugh, Nicholas Romero, and Richard Alan Seals, Jr.** 2014. "An Examination of Racial Discrimination in the Labor Market for Recent College Graduates: Estimates from the Field." *Working Paper*.
- Oh, Sun Jung, and John Yinger.** 2015. "What Have We Learned from Paired Testing in Housing Markets?" *Cityscape* 17 (3): 15-59.
- Pope, Devin, and Justin Sydnor.** 2011. "What's in a Picture? Evidence of Discrimination from Prosper.com." *Journal of Human Resources* 46 (1): 53-92.
- Ross, Stephen L., Margery Austin Turner, Erin Godfrey, and Robin R. Smith.** 2008. "Mortgage lending in Chicago and Los Angeles: A paired testing study of the pre-application process." *Journal of Urban Economics* 63 (3): 902-919.
- Ross, Stephen, and John Yinger.** 2002. *The Color of Credit*. Cambridge: MIT Press.

Table 1. HMDA Summary Statistics

	(1)	(2)	(3)	(4)
High Interest Loan (D=1)		0.0303	0.0306	0.0208
		[.1714]	[.1721]	[.1426]
APR		3.1569	2.9564	2.4674
		[2.1064]	[2.0223]	[.9788]
FHA Insured (D=1)	0.1725	0.1334	0.1446	0.0991
	[.3778]	[.34]	[.3517]	[.2988]
Owner Occupied (D=1)	0.8957	0.8889	0.9	0.9055
	[.3056]	[.3142]	[.2999]	[.2926]
Applicant Income	109.1586	114.8831	111.7095	104.4802
	[155.4564]	[156.7011]	[149.1792]	[131.3244]
Applicant Income of African Americans			83.2131	79.9619
			[104.3307]	[69.2706]
Applicant Income of Whites			112.9769	105.0336
			[150.7394]	[132.3386]
Loan Amount	210.6574	218.2461	205.1951	173.6425
	[387.9197]	[441.1667]	[179.076]	[139.2153]
Loan Amount of African Americans			176.0439	158.6839
			[117.1471]	[105.2151]
Loan Amount of Whites			206.6341	173.9861
			[181.4655]	[139.8828]
African American Applicant (D=1)	0.0481	0.04	0.047	0.0225
	[.2139]	[.196]	[.2117]	[.1482]
White Applicant (D=1)	0.7074	0.7905	0.953	0.9775
	[.4549]	[.4069]	[.2117]	[.1482]
Observations	18,691,551	9,783,966	7,852,940	17,191

Standard deviations in brackets. Column 1 reflects all HMDA records. Column 2 reflects the subset of applications that were originated. Column 3 contains originated first-lien loans to either white or black applicants. Column 4 contains loans that can be matched to the experiment and that meet the restrictions of those in column 3.



Table 2. Gross Response and African American Probability of High Interest Loan

	(1) DiD, No Controls	(2) DiD, Loan Level Controls	(3) DiD, Institution Level Controls	(4) DiD, All Controls	(5) Fixed Effects, No Controls	(6) Fixed Effects, Loan Level Controls
African American Borrower (D=1)	-0.0229 (0.0160)	-0.0258 (0.0172)	-0.0234 (0.0153)	-0.0245 (0.0168)	-0.0175** (0.00846)	-0.0189** (0.00953)
Response Rate to African Americans	-0.00598 (0.00547)	-0.00706 (0.00549)	-0.00680 (0.00545)	-0.00743 (0.00548)		
AA Borrower*AA Response Rate	0.0717** (0.0289)	0.0716** (0.0298)	0.0729** (0.0285)	0.0713** (0.0297)	0.0695*** (0.0263)	0.0691** (0.0272)
FHA Insured Loan (D=1)		0.00102 (0.00586)		-0.000228 (0.00587)		0.00206 (0.0115)
Owner Occupied (D=1)		0.000389 (0.00499)		0.00177 (0.00505)		0.00505 (0.0101)
Income		1.17e-05 (1.05e-05)		1.15e-05 (1.05e-05)		1.07e-05 (1.16e-05)
Loan Amount		-8.54e-05*** (1.58e-05)		-5.71e-05*** (1.36e-05)		-6.38e-05*** (1.71e-05)
Male Borrower (D=1)		-0.00418 (0.00287)		-0.00524* (0.00289)		-0.00329 (0.00248)
Census Tract Median Income			-6.69e-07*** (1.23e-07)	-5.18e-07*** (1.29e-07)		
Census Tract Minority Percent			-0.0250* (0.0134)	-0.0214* (0.0126)		
Census Tract to MSA Income Ratio			-0.000215*** (4.19e-05)	-0.000147*** (4.08e-05)		
Loan Application Record Count			-6.34e-09*** (2.16e-09)	-4.75e-09** (2.12e-09)		
Observations	15,533	15,022	15,533	15,022	15,533	15,022
R-squared	0.002	0.008	0.009	0.012	0.236	0.235

Standard errors in columns (1)-(4) clustered at the branch level. Standard errors in columns (5) and (6) clustered at the institution level.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3. Net Response and African American Probability of High Interest Loan

	(1) DiD, No Controls	(2) DiD, Loan Level Controls	(3) DiD, Institution Level Controls	(4) DiD, All Controls	(5) Fixed Effects, No Controls	(6) Fixed Effects, Loan Level Controls
African American Borrower (D=1)	0.0301** (0.0144)	0.0266* (0.0143)	0.0306** (0.0145)	0.0278* (0.0144)	0.0331** (0.0146)	0.0312** (0.0147)
Response Rate to African Americans	-0.00190 (0.00620)	-0.00233 (0.00608)	-0.00159 (0.00621)	-0.00218 (0.00615)		
AA Borrower*AA Response Rate	0.0244 (0.0284)	0.00865 (0.0259)	0.0226 (0.0287)	0.00630 (0.0263)	0.0149 (0.0155)	0.00603 (0.0159)
FHA Insured Loan (D=1)		0.00317 (0.00641)		0.00221 (0.00642)		0.00382 (0.0122)
Owner Occupied (D=1)		0.00371 (0.00512)		0.00492 (0.00522)		0.00836 (0.0112)
Income		1.50e-05 (1.11e-05)		1.42e-05 (1.11e-05)		1.22e-05 (1.28e-05)
Loan Amount		-9.17e-05*** (1.75e-05)		-6.28e-05*** (1.51e-05)		-6.72e-05*** (1.95e-05)
Male Borrower (D=1)		-0.00530* (0.00303)		-0.00637** (0.00306)		-0.00488* (0.00253)
Census Tract Median Income			-6.82e-07*** (1.36e-07)	-5.25e-07*** (1.44e-07)		
Census Tract Minority Percent			-0.0260* (0.0144)	-0.0235* (0.0136)		
Census Tract to MSA Income Ratio			-0.000217*** (4.51e-05)	-0.000145*** (4.38e-05)		
Loan Application Record Count			-6.39e-09*** (2.32e-09)	-4.58e-09** (2.33e-09)		
Observations	14,042	13,571	14,042	13,571	14,042	13,571
R-squared	0.001	0.008	0.009	0.012	0.246	0.243

Standard errors in columns (1)-(4) clustered at the branch level. Standard errors in columns (5) and (6) clustered at the institution level.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 4. Gross Response and African American Probability of High Interest Loan: Alternative Matches

	(1) .5 Mile Radius, FE, No Controls	(2) .5 Mile Radius, FE, Loan Level Controls	(3) 1 Mile Radius, FE, No Controls	(4) 1 Mile Radius, FE, Loan Level Controls	(5) 1.5 Mile Radius, FE, No Controls	(6) 1.5 Mile Radius, FE, Loan Level Controls	(7) Adjacent Tracts, FE, No Controls	(8) Adjacent Tracts, FE, Loan Level Controls
African American Borrower (D=1)	-0.0180** (0.00853)	-0.0193** (0.00955)	-0.0106 (0.00915)	-0.0113 (0.0102)	-0.0247* (0.0130)	-0.0258* (0.0140)	-0.0134 (0.0103)	-0.0142 (0.0111)
AA Borrower*AA Response Rate	0.0677*** (0.0256)	0.0673** (0.0264)	0.0611*** (0.0214)	0.0609*** (0.0225)	0.0683*** (0.0211)	0.0694*** (0.0222)	0.0504*** (0.0175)	0.0505*** (0.0184)
FHA Insured Loan (D=1)		0.00246 (0.0113)		0.00422 (0.0103)		0.00448 (0.00717)		0.00392 (0.00639)
Owner Occupied (D=1)		0.00466 (0.00974)		-0.00179 (0.00731)		-0.00287 (0.00575)		-0.00149 (0.00696)
Income		8.79e-06 (1.06e-05)		2.79e-06 (7.35e-06)		-1.10e-06 (2.91e-06)		2.78e-07 (5.75e-06)
Loan Amount		-5.71e-05*** (1.56e-05)		-3.53e-05*** (1.16e-05)		-1.76e-05 (1.10e-05)		-4.66e-05*** (9.79e-06)
Male Borrower (D=1)		-0.00286 (0.00237)		-0.00261 (0.00187)		-0.00186 (0.00125)		-0.00149 (0.00145)
Observations	16,136	15,603	21,441	20,707	33,761	32,587	36,858	35,471

Standard errors clustered at the institution level.

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 5. Gross Response and African American Probability of High Interest Loan: High-Cost Lender Sample Restriction

	(1) DiD, No Controls	(2) DiD, Loan Level Controls	(3) DiD, Institution Level Controls	(4) DiD, All Controls	(5) Fixed Effects, No Controls	(6) Fixed Effects, Loan Level Controls
African American Borrower (D=1)	-0.0246 (0.0172)	-0.0278 (0.0185)	-0.0253 (0.0164)	-0.0265 (0.0181)	-0.0191** (0.00931)	-0.0211** (0.0106)
Response Rate to African Americans	-0.00621 (0.00584)	-0.00727 (0.00586)	-0.00679 (0.00580)	-0.00745 (0.00583)		
AA Borrower*AA Response Rate	0.0751** (0.0307)	0.0756** (0.0317)	0.0770** (0.0303)	0.0755** (0.0316)	0.0750*** (0.0285)	0.0755** (0.0296)
FHA Insured Loan (D=1)		0.000664 (0.00629)		-0.000773 (0.00631)		0.00223 (0.0124)
Owner Occupied (D=1)		0.00110 (0.00535)		0.00264 (0.00544)		0.00525 (0.0108)
Income		1.59e-05 (1.30e-05)		1.53e-05 (1.31e-05)		1.34e-05 (1.40e-05)
Loan Amount		-9.29e-05*** (1.75e-05)		-6.28e-05*** (1.52e-05)		-6.96e-05*** (1.92e-05)
Male Borrower (D=1)		-0.00454 (0.00311)		-0.00564* (0.00313)		-0.00362 (0.00268)
Census Tract Median Income			-7.21e-07*** (1.36e-07)	-5.56e-07*** (1.43e-07)		
Census Tract Minority Percent			-0.0269* (0.0149)	-0.0229 (0.0141)		
Census Tract to MSA Income Ratio			-0.000229*** (4.55e-05)	-0.000158*** (4.45e-05)		
Loan Application Record Count			-7.17e-09*** (2.21e-09)	-5.45e-09** (2.12e-09)		
Observations	14,324	13,839	14,324	13,839	14,324	13,839

Standard errors in columns (1)-(4) clustered at the branch level. Standard errors in columns (5) and (6) clustered at the institution level.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 6. Falsification Test: White Response and White Probability of High Interest Loan

	(1) DiD, No Controls	(2) DiD, Loan Level Controls	(3) DiD, Institution Level Controls	(4) DiD, All Controls	(5) Fixed Effects, No Controls	(6) Fixed Effects, Loan Level Controls
White Borrower (D=1)	-0.0107 (0.0249)	0.00610 (0.0222)	-0.00472 (0.0255)	0.00993 (0.0229)	-0.00270 (0.0153)	0.00473 (0.0151)
Response Rate to Whites	0.0196 (0.0325)	0.0379 (0.0304)	0.0248 (0.0323)	0.0421 (0.0305)		
W Borrower*W Response Rate	-0.0210 (0.0321)	-0.0398 (0.0301)	-0.0268 (0.0319)	-0.0441 (0.0301)	-0.0364 (0.0268)	-0.0460* (0.0277)
FHA Insured Loan (D=1)		0.00280 (0.00604)		0.000671 (0.00614)		0.00473 (0.0118)
Owner Occupied (D=1)		0.000740 (0.00506)		0.00284 (0.00522)		0.00684 (0.0102)
Income		1.67e-05 (1.10e-05)		1.65e-05 (1.10e-05)		1.64e-05 (1.45e-05)
Loan Amount		-8.88e-05*** (1.62e-05)		-5.78e-05*** (1.40e-05)		-6.84e-05*** (1.88e-05)
Male Borrower (D=1)		-0.00572* (0.00293)		-0.00676** (0.00290)		-0.00568** (0.00251)
Census Tract Median Income			-7.34e-07*** (1.31e-07)	-5.91e-07*** (1.38e-07)		
Census Tract Minority Percent			-0.0126 (0.0179)	-0.0100 (0.0180)		
Census Tract to MSA Income Ratio			-0.000227*** (4.51e-05)	-0.000165*** (4.47e-05)		
Loan Application Record Count			-6.71e-09*** (2.29e-09)	-5.25e-09** (2.30e-09)		
Observations	15,700	15,175	15,700	15,175	15,700	15,175

Standard errors in columns (1)-(4) clustered at the branch level. Standard errors in columns (5) and (6) clustered at the institution level.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1