Geography of Housing Discrimination

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Abstract

Discrimination in housing may vary systematically from one neighborhood to another. This article explores that possibility using a new approach based on data from fair housing audits. This approach compares real estate agents' decision to show a house to white customers with their decision to show the same house to black customers. The data are from the 1989 Housing Discrimination Study in Atlanta, Chicago, Los Angeles, and New York.

In all four areas, discrimination decreases with the distance between a house and the agent's office. This result is consistent with the hypothesis that agents are less likely to discriminate when a sale to a black customer is hidden from the white customers who make up the agents' main clientele. Moreover, agents in Atlanta and Chicago steer black customers toward heavily black neighborhoods.

Keywords: Housing discrimination; Racial steering; Real estate; Redlining

In this article we investigate the determinants of housing discrimination using audit data from four large urban areas. We focus on geography, that is, on factors that influence variation in discriminatory behavior across space. In particular, we ask two questions: Are real estate agents more likely to discriminate in places in which serving black customers would threaten their reputation among prejudiced white customers? Do real estate agents discriminate in places in which they perceive a low payoff, that is, a low probability of a transaction, from showing houses to black customers?

Many studies have used audit data to test hypotheses about the causes of discrimination. See Galster (1990), Ondrich, Stricker, and Yinger (1998, 1999), Page (1995), Roychoudhury and Goodman (1992, 1996), and Yinger (1986, 1991, 1995). This article builds on a new approach (Ondrich, Ross, and Yinger, 2001). In the first section of this article we describe the approach; in the second we explain how we build on it to investigate the geography of discrimination; and the third presents the results of our hypothesis tests. The final section contains our conclusions.

Studying Discrimination with a Unit-Based Data Set

Most of the research on this topic has made use of data from fair housing audits. An audit is a survey technique in which two people who are equally qualified for housing, but belong to different racial or ethnic groups, sequentially visit a landlord or real estate agent. During their separate visits, the teammates inquire about a particular house or apartment that has

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The authors are grateful to Youngsun Kwon for excellent research assistance.

been advertised. Discrimination exists if the minority auditors encounter systematically less favorable treatment than do their white teammates. One of the advantages of the audit methodology is that it provides a way to study the causes of discrimination. Any theory of the causes of discrimination makes predictions about the circumstances under which discrimination will occur, and audit data make it possible to determine which predictions are supported by the behavior of housing agents.[1]

This section presents a new approach to the use of audit data to study discrimination and describes the data set and econometric methods used in this study.

Focusing on Individual Housing Units

Most audit studies use an audit as the unit of observation; that is, they explore differences between audit teammates as a function of audit-level variables, such as the characteristics of the auditors, housing agents, or advertised housing unit. Using data from a national audit study, the 1989 Housing Discrimination Study (HDS), Ondrich, Ross, and Yinger (2001) implemented an approach in which an observation is defined by a housing unit.[2] To be specific, the sample consists of housing units that were inspected by at least one auditor, and the analysis determines the conditions under which a particular unit was withheld from the minority auditor.

This approach is made possible by two key features of HDS. First, HDS instructed all auditors to inquire about, and attempt to inspect, housing units similar to the advertised unit. Most auditors, therefore, inspected the advertised unit and one or more similar units. Second, the HDS auditors recorded the address of every unit they inspected. That information makes it possible to determine when one or both auditors inspected a unit and, in particular, to estimate the circumstances under which a unit will be shown to a white auditor but not to his or her black teammate.

As explained by Ondrich, Ross, and Yinger (2001), this new approach has several advantages over earlier audit-based approaches. First, the approach makes it possible to determine whether a real estate agent's decision to withhold a house from a minority customer depends on the characteristics of that particular house, not just on audit-level variables. That is, the approach expands the set of variables that can be used in hypothesis tests about the causes of discrimination. The new variables brought into play include whether the unit is the one that was advertised in the newspaper and was the basis of the audit; the characteristics of the unit, such as its asking price; and the characteristics of that unit's neighborhood, such as its distance from a largely minority area. Moreover, the introduction of unit-specific variables makes it possible to see whether discrimination depends on the extent to which a unit differs from the advertised unit, which is the unit each auditor asks about first.

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[1] For more on the strengths and weaknesses of the audit methodology, see Fix and Struyk (1993) and Yinger (1995).

[2] This data set is now more than one decade old, and discrimination might have declined since it was collected, in part, because of new federal antidiscrimination enforcement activities authorized by the 1988 Fair Housing Amendments Act. However, the available evidence does not support that possibility (see Yinger 1998b). Moreover, even if discrimination has declined, the causes of discrimination, which are the focus of this article, are unlikely to have changed.

Second, this new approach eliminates an endogeneity problem that arises in audit studies done previously, which used the average characteristics of shown units as explanatory variables. This problem arises because a real estate agent's decisions simultaneously determine the number of units shown to a customer (a dependent variable in the old approach) and the characteristics of those units (explanatory variables). In the new approach, an agent's decision to show a unit obviously cannot affect that unit's characteristics.

Third, this new approach expands the sample size from the number of audits to the number of units shown to either auditor and, therefore, increases the likelihood that the true underlying relationships will be correctly identified. That advantage is particularly important for this article, which focuses on separate regressions for four metropolitan areas. These regressions would not be possible with the audit sample sizes, roughly 100 in each area, but are quite feasible with the housing unit sample sizes, which are two or three times as large.[3]

Data from the Housing Discrimination Study

The data used in this article are taken from HDS, which is described in detail by Yinger (1995). More specifically, we use data from four so-called in-depth sites in HDS; these sites are large metropolitan areas in which a relatively large number of audits were conducted. These four areas are Atlanta, Chicago, Los Angeles, and New York, where 94, 103, 104, and 87 sales audits were conducted, respectively.[4] In these audits, teammates were matched according to sex and age, given the same training concerning how to behave during an audit, assigned similar socioeconomic characteristics for the purposes of the audit, and sent to the same real estate agency within a short time of each other. Following each visit to an agency, the teammates independently filled out a detailed survey form to indicate what they were told and how they were treated.

The initial inquiry for an HDS sales audit was determined by an advertised house randomly selected from the major metropolitan newspaper.[5] Audit teammates were assigned incomes and family characteristics that made them qualified for the advertised house and were instructed to ask the agency placing the advertisement whether the house was available. As noted earlier, each auditor was also instructed to ask about houses similar to the advertised house and to record the address of every house that he or she inspected. In the four in-depth sites, 274, 217, 205, and 287 houses, respectively, were shown to one or both auditors.[6]

[3] This approach also makes it possible to study the determinants of housing marketing behavior in general, not just of discrimination in marketing. See Ondrich, Ross, and Yinger (2001).

[4] Overall, HDS conducted 1,081 black/white sales audits in a representative sample of 20 metropolitan areas. Outside the in-depth sites, not enough audits were conducted to support an area-specific regression analysis.

[5] Single-family, detached houses as well as condominiums are included in the sales audits. To keep the presentation simple, we refer just to "houses" in the text.

[6] Some address information is missing, especially unit numbers for condominiums, which made up 16 percent of the housing units in the sample. As a result, we developed procedures to rule out the possibility that teammates saw the same unit when they saw units that had the same incomplete address information but differed in some observable characteristic, such as number of rooms or location in the building.

Real Estate Agents' Decisions to Show a Unit

Real estate agents have access to available housing units through two sources: their own files of houses they have been asked to sell and any multiple listing service to which they belong. Drawing on these sources, an agent must decide which available units to show each customer. In the context of an audit, an agent makes two decisions: whether to show a unit to the white customer and whether to show it to the black customer. These decisions lead to four possible outcomes for each house: the house is shown to both teammates, it is shown only to the white auditor, it is shown only to the black auditor, or it is not shown to either auditor.

Any model of these decisions must overcome two methodological hurdles. First, if a unit is not shown to either auditor, it does not appear, by definition, in our sample. Ignoring this fact could result in sample selection bias. Second, the three remaining outcomes are not independent, even after controlling for observable factors, such as the age of auditor or agent. This lack of independence is due to unobserved factors shared by audit teammates (see Yinger 1986). These factors reflect the fact that auditors are paired on the basis of various unrecorded characteristics, such as the following: general appearance; they receive similar training; they visit the same real estate agency in proximity to each other, so that the conditions encountered there are similar; and they inquire about the same advertised housing unit.

We solve these two problems by adding two twists to a standard model of a discrete choice, such as whether or not to show a housing unit. First, we treat the unobserved audit-specific effects as random effects and use the appropriate procedure to remove them from the analysis. Conditional on the value of the random effect, each visit to an agent can be treated as an independent event (controlling for observable factors). That is, the random effects and explanatory variables account for every factor shared between audit teammates, so that each visit to a housing agent can be treated as an independent event.

This independence makes it possible to use multinomial logit analysis to estimate a model of housing agents' choices over the domain of available houses (see McFadden 1974 and Börsch-Supan 1987). The advantage of the multinomial logit form over other multinomial models is the independence of irrelevant alternatives (IIA) property. Houses that the agent shows to neither auditor are not observed in the data, but IIA makes it possible, in a simple way, to condition on never observing that outcome.

Maximum likelihood estimation is used to estimate a multinomial logit model in which the dependent variable reflects housing agents' decisions for each observed house—whether to show it only to the white auditor, only to the black auditor, or to both auditors. The explanatory variables are the characteristics of the auditor, agent, and audit, along with the characteristics of the house itself and its neighborhood. Two sets of coefficients are presented, one reflecting the influence of each variable on the way auditors are treated and another reflecting the influence of each variable on differences in the way whites and blacks are treated, that is, on discrimination. Thus, significance tests of coefficients in this second set are equivalent to hypothesis tests about the causes of discrimination. The likelihood function is described in the appendix.

Unit-Based Approach and Geography of Discrimination

The unit-based approach (Ondrich, Ross, and Yinger 2001) provides a powerful way to study the causes of discrimination. In this section we explain how we adapt this approach to study the geography of discrimination, present our hypotheses about the causes of discrimination, and describe the variables in the empirical analysis.

Advantages of an Area-Specific Analysis

Many studies in the audit literature have recognized that neighborhood characteristics play an important role in discrimination. For example, Yinger (1986) showed that discrimination was quite different in different neighborhoods in Boston, and all studies cited earlier investigated the link between discrimination and the racial composition of a neighborhood. However, no existing study has been able to provide a general characterization of the geography of discrimination, largely because of a lack of data on the spatial relationships among the inspected housing units, the advertised unit, and the agent's office. Studies based on HDS face the additional obstacle that few of the houses that appear in a random sample of newspaper advertisements are located in heavily black neighborhoods (Turner and Mickelsons 1992). As a result, the impact of neighborhood racial composition on discrimination is difficult to determine.

The data set assembled for this study addresses these problems. We collected information on the distance between every unit and (1) the advertised unit, (2) the agent's office, and (3) a heavily black neighborhood.[7] The last variable helps overcome the limited variation in racial composition in the HDS data, because many tracts are located close to a heavily black area even if they have a relatively small black population themselves. Our key objective was to use these data to determine whether the geographic relationship of a house to the advertised house, to the agent's office, or to a heavily black area influences an agent's decision to withhold that house from black customers. A secondary objective was to determine whether the role of geography—if geography has a role—varies from one urban area to another.[8]

Hypotheses about the Geography of Discrimination

Many hypotheses about the causes of discrimination, along with related hypothesis tests, have appeared in the audit literature, as has been cited. In this section we focus on hypotheses and hypothesis tests that are related to geography.

One important hypothesis in the literature is called the "white-customer prejudice hypothesis." This hypothesis says that real estate agents invest in establishing contacts in a community

[7] The original HDS data set, and all previous studies that use it, employ estimates of various census variables for 1988. We merged the 1990 census with the HDS data to obtain more up-to-date and accurate location information.

[8] Ondrich, Ross, and Yinger (2001) pooled the audit results for all 20 urban areas in which HDS conducted black/white audits. Their regressions include variables to describe the characteristics of a unit's location and some of the geographic variables described here (which are generally insignificant). However, given the small sample sizes in some urban areas, they must constrain their coefficients to be the same everywhere, and they are not able to determine whether the geography of discrimination varies from one urban area to the next.

so that they will attract people who want to buy or sell a house. Agents who work in a community that contains many prejudiced white people may therefore hesitate to show houses to black customers in that community for fear of alienating their actual and potential white clients. This incentive may be particularly strong in neighborhoods that are threatened with tipping, that is, with a transition from largely white to largely black residents. Previous studies (Ondrich, Stricker, and Yinger 1998; Page 1995; Yinger 1986, 1995) have found relatively high discrimination in integrated areas, but have not been able to determine if this effect is larger in integrated areas threatened with tipping. Because tipping usually occurs in neighborhoods near largely black areas, we are able to answer that question by comparing discrimination in integrated neighborhoods near and far from heavily black areas. To be specific, the hypothesis predicts that discrimination in integrated neighborhoods will be higher when those areas are located near heavily black areas.[9]

In addition, incentives to discriminate that are associated with white-customer prejudice presumably are weaker for houses that are located far from an agent's office, at least under the assumption that the office is located near the community from which the agent derives most of his or her business. This hypothesis predicts, therefore, that discrimination in showing a particular house will decrease with the distance between that house and the agent's office.

A second set of hypotheses about the causes of discrimination builds on the view that real estate agents attempt to minimize the time and effort they devote to transactions that appear unlikely to occur. After all, the agent does not receive a commission if a transaction does not take place. This view provides a link to the geography of discrimination whenever agents believe that the likelihood that a transaction will take place for blacks in a particular location is different from the likelihood for whites. This type of belief could have several sources. First, agents could believe that black customers and white customers have different preferences concerning the racial composition of their neighborhoods. If agents believe that blacks prefer integrated neighborhoods and whites prefer white neighborhoods, for example, then agents may decline to show houses in white neighborhoods to blacks and houses in or near integrated neighborhoods to whites.[10] Agents may also have preconceptions about the types of houses that different groups prefer. If so, the likelihood that a unit is withheld from blacks may depend on the characteristics of the unit, or on an interaction between the characteristics of the unit and the unit's location. Agents might withhold most units in white neighborhoods from black customers, for example, but be willing to show blacks houses in white neighborhoods if those houses have characteristics that blacks are thought to prefer. We will look for evidence of this type of behavior by determining whether the probability that agents withhold units from blacks depends on the racial composition of a neighborhood or of nearby neighborhoods, and whether this probability depends on interactions between location variables and house characteristics.

[9] A related prediction of this hypothesis is that real estate agents will not discriminate in neighborhoods that are already largely black. In such neighborhoods agents cannot be blamed for introducing blacks, so selling to a black customer does not damage their reputation with prejudiced whites in other neighborhoods. We cannot test this prediction, however, because there are so few largely black neighborhoods in the HDS data.

[10] These beliefs are roughly consistent with surveys of racial attitudes toward neighborhood composition. See, for example, Farley et al. (1993).

Second, real estate agents may believe that blacks are likely to have a particularly difficult time obtaining a mortgage in certain neighborhoods.[11] If so, agents may neglect to show blacks houses in those neighborhoods because the agents believe that a transaction will not take place there even if the black customer wants to buy the house. We face severe constraints in attempting to test this hypothesis. We have merged the unit-based HDS data set with the 1990 Home Mortgage Disclosure Act (HMDA) data. These data provide information on most of the mortgage loan applications in the country by census tract and by the race of the applicant.[12] Thus, we know the number of loans and the number of loan denials by race in each census tract that contains one of the houses in our sample. Unfortunately, however, no mortgage applications were recorded for many of the census tracts in the four sites we are examining here, and very few of the census tracts in any of these sites recorded any mortgage applications from blacks.

As a result, we cannot calculate an expected denial rate for black applications in most tracts, let alone an expected denial rate for blacks relative to whites. Instead, we focus on two variables: the total number of mortgage applications and the overall loan denial rate in tracts with more than 10 applications. The first variable identifies neighborhoods with a great deal of turnover. The second variable identifies neighborhoods in which applicants for a mortgage are relatively likely to be turned down, which might be interpreted by real estate agents as a sign that a transaction is unlikely. We test the hypothesis that agents discriminate in anticipation of the way blacks will be treated in the mortgage market by determining whether the decision to withhold a unit from black customers depends on either of these variables.

It should be pointed out that all of these hypotheses concern profit-based discrimination. According to the civil rights laws in this country, discrimination is just as illegal if it is based on a search for profits as it is if it is based on animus toward people in a particular group.[13] As a result, empirical support for these hypotheses cannot be interpreted as a justification for discriminatory behavior; instead, such evidence simply helps to identify the incentives that lead real estate agents to practice illegal discrimination.

Variables

The variables used in the estimation are listed in table 1. The first set of variables are characteristics of the audit: the order in which teammates visited the housing agency, whether the teammates saw the same agent, and the maximum number of people encountered in the agency by either teammate. The first two variables are controls for the audit circumstances; the third provides a test of the hypothesis that smaller agencies, with more to lose from a loss of white clients, are more likely to discriminate.

[11] This belief could reflect mortgage discrimination. For evidence on this tropic, see Goering and Wienk (1996), Ladd (1998), Munnell et al. (1996), and Ross and Yinger (2002).

[12] For more on the 1990 HMDA data, see Avery, Beeson, and Sniderman (1996). These data undoubtedly understate the number of loans in many tracts, because some types of lenders were not required to fill out HMDA reports until 1993.

[13] For more discussion on civil rights laws in the United States and the issue of profit-based discrimination, see Schwemm (1992), Ross and Yinger (2002), or Yinger (1998a).

Table 1. **Definition of Variables**

Variable	Definition
Characteristics of the audit	
Order	Whether minority auditor went first
Same agent	Whether teammates saw the same agent
Number of people	Maximum number of people encountered in agent's office by either teammate
Comparison with advertised house	
Advertised house	House was the advertised house
Difference in bedrooms	Absolute value of difference in number of bedrooms between house and the advertised house
Difference in price	Absolute value of difference in asking price between house and the advertised house
Same tract	Whether the house was not the advertised house but was in the same tract as the advertised house
House characteristics	
Distance from agent's office	Distance between house and agent's office
Asking price	Asking price of the house
Number of bedrooms	Number of bedrooms in the house
Average value in tract	Average house value in the tract where the house was located
Integrated tract	Whether the tract where the house was located was more than 5 percent black
Total applications	Number of mortgage applications in 1990 in the tract where the house was located
Percentage of loans denied	Percentage of mortgage applications denied in the tract where the house was located (assuming at least 10 applications)
Distance to black concentration	Distance between house and nearest tract that was at least 30 percent black
Interactions with distance to black concentration	
Asking price	
Number of bedrooms	
Average value in tract	
Percentage of loans denied	

The second set of variables compare the advertised house and the house that defines an observation, which often are not the same. As discussed earlier, each audit begins with an advertised house, but often auditors are shown other houses as well. The first variable indicates whether the house is, in fact, the advertised house. This variable makes it possible to test the hypothesis that the withholding of a house from black customers is less likely when the house is an advertised unit, which is, by definition, a house whose availability has already been announced. The second set of variables also includes three variables that compare the house with the advertised house: the absolute value of the difference in number of bedrooms and in the asking price, and whether the house is in the same tract as the advertised house, but is not the advertised house itself.[14] When the house that defines an observation is, in fact,

[14] In a study based on the national HDS sample, it is possible to estimate the role of many more variables describing the relationship between the characteristics of a house and the characteristics of the advertised house. See Ondrich, Ross, and Yinger (2001).

the advertised house, the value of all these variables obviously equals zero. These variables make it possible to determine whether discrimination depends on the match between a house and a customer's initial request, which is defined by the advertised house.

The third set of variables describe characteristics of the house that define an observation. The first variable in this set, distance between the house and the agent's office, provides a test of the hypothesis stated earlier—agents discriminate less when they are "protected" by distance between the house in question and the community in which they have most of their contacts. The next three variables describe basic features of the house: its asking price, the number of bedrooms, and the average house value in its tract. These variables make it possible to determine whether an agent's decision to withhold a house from blacks depends on the characteristics of that house. Behavior of this type is consistent with the view that agents think blacks and whites prefer different types of units.

The last four variables in this category provide tests of various hypotheses about the geography of discrimination. The first variable identifies tracts in which at least 5 percent of residents are minority residents. This percentage is set low because, as noted earlier, the houses in the HDS sample are heavily weighted toward all-white tracts. The next two variables are the mortgage loan variables described earlier—a variable to measure mortgage activity and a variable to measure the likelihood of loan denial in tracts where mortgage activity takes place. These variables provide tests of the view that real estate agents' decisions to discriminate are influenced by their perceptions of conditions in the mortgage market. The fourth variable is the distance to the nearest tract that is at least 30 percent black. As noted earlier, this variable helps to identify neighborhoods that may be threatened with tipping. According to the white-customer preference hypothesis, discrimination should decrease with this distance measure, because distance provides some insulation against tipping and hence against the loss of an agent's business with prejudiced white customers.

The final set of variables in table 1 are interactions between one key geographic variable—the distance between a house and the nearest heavily black tract—and all the other characteristics of that house.[15] These variables make it possible to test the hypothesis, discussed earlier, that the geographic dimension of discrimination depends on both the location of a house and its characteristics.

As indicated earlier, the estimation method used in the article provides two sets of estimates: estimates of a variable's effect on the likelihood that white customers will be shown a unit and estimates of a variable's effect on the difference between the likelihood that black customers will be shown a unit and the likelihood that white customers will be shown a unit—that is, its effect on discrimination. The first set of coefficients describe agent marketing behavior, in general, and reveal whether agents are more likely to market certain types of houses, or houses in certain types of neighborhoods, to white customers. The second set of coefficients, which are based on interactions between the race of an auditor and the variables in table 1, provide tests of hypotheses about discriminatory behavior. Thus, we will focus on our estimates of the

[15] Our initial regressions contained six of these interactions. Two referees suggested that our results would be more precise and easier to interpret if we cut back this number. We followed their good advice. This change in the number of interaction variables has no substantive effect on the results.

coefficients in the second set. In some cases, the coefficients in this second set are based on double interaction variables, that is, on variables that are interacted both with race and with distance from a largely black area.

Estimation Results

Our estimated coefficients for all four urban areas are presented in tables 2 and 3.[16] Table 2 presents the first set of coefficients described above, that is, the coefficients that describe the treatment of white auditors; the associated *t*-statistics are also shown. A positive coefficient in this table indicates that an increase in the variable raises the probability that a unit will be shown. Table 3 presents the second set of coefficients (plus *t*-statistics), which describe the difference in treatment between blacks and whites. A positive coefficient in this table indicates that an increase in the variable results in a decrease in discrimination against blacks.

Tables 2 and 3 reveal several significant results that do not concern the geography of discrimination. As shown in table 2, agents in all four areas are significantly more likely to show advertised units than other units. Apparently, either agents are particularly willing to show units that, by definition, match a customer's request or else they do not advertise units unless they are eager to show them. Moreover, the results for Atlanta and Los Angeles indicate that agents are less likely to show units that differ from the advertised unit. In addition, in Los Angeles a housing unit is more likely to be shown if both auditors see the same agent; all agents use their own judgment about which houses to show, and the probability that either auditor will see a unit shown to the other auditor is higher if the same agent makes the showing decisions for both audit teammates.

A few nongeographic results concerning discrimination can be found in table 3. Agents in Atlanta are less likely to discriminate in showing the advertised unit than in showing other units; that is, if agents want to withhold a unit from blacks, they are reluctant to advertise it. Table 3 also indicates that in Chicago large real estate agencies are less likely to discriminate than are small agencies, which confirms a result in Yinger (1995) and supports the white-customer prejudice hypothesis.

Table 3 provides several striking results concerning the geography of discrimination. First, in all four urban areas, discrimination in showing a house decreases with the distance between the house and the agent's office. This result is significant at the 5 percent level in Atlanta and Chicago and at the 10 percent level in the other two areas. These effects are large in magnitude. With all other variables held constant at their sample values, moving from 1 to 10 miles away from an agent's office decreases the average probability of discrimination by 19.5, 44.7, 36.3, and 42.7 percentage points in Atlanta, Chicago, Los Angeles, and New

[16] The regressions for Atlanta and New York account for unobserved heterogeneity using the procedure described earlier. However, we could reject the hypothesis of unobserved heterogeneity in Chicago and Los Angeles, so the results for these two areas are based on a standard multinomial logit model, with the selection correction described earlier.

Table 2. **Estimated Effects on Probability of Showing Houses to White Auditors**

Variable	Atlanta	Chicago	Los Angeles	New York
Characteristics of the audit				
Order	0.1553	0.2341	–0.2529	–1.3839
	(0.292)	(0.392)	(–0.486)	(–2.137)
Same agent	–0.1009	–0.9788	1.8593	0.0390
	(–0.179)	(–1.656)	(3.205)	(0.062)
Number of people	–0.6357	–0.6457	–0.2088	–0.1271
	(–0.995)	(–2.223)	(–0.432)	(–0.498)
Comparison with advertised house				
Advertised house	3.3980	10.0630	3.9684	2.4052
	(4.084)	(2.692)	(5.004)	(3.104)
Difference in bedrooms	–2.8991	–7.6920	–3.8645	–0.8353
	(–2.648)	(–1.306)	(–2.611)	(–1.140)
Difference in price	–0.2980	–3.5430	–0.8102	0.3784
	(–0.194)	(–1.484)	(–2.450)	(0.704)
Same tract	1.4431	–11.6620	–0.0754	0.0819
	(1.670)	(–0.077)	(–0.068)	(0.083)
House characteristics				
Distance from agent's office	–0.0696	0.0707	–0.0628	–0.1937
	(–1.205)	(0.551)	(–0.597)	(–1.592)
Asking price	2.7239	3.6795	0.4553	–0.9743
	(1.483)	(1.346)	(0.556)	(–1.319)
Number of bedrooms	–0.8513	0.0900	2.0306	0.8140
	(–1.656)	(0.156)	(2.506)	(1.758)
Average value in tract	–0.0347	–0.1738	0.8505	–0.2322
	(–0.059)	(–0.425)	(1.372)	(–0.706)
Integrated tract	–0.6348	–0.6958	0.3337	–0.6967
	(–0.991)	(–0.893)	(0.523)	(–1.039)
Total applications	–0.0580	0.0279	0.1184	–0.7927
	(0.410)	(0.149)	(0.578)	(–3.255)
Percentage of loans denied	–8.5910	0.2488	–13.0960	–2.2911
	(–0.931)	(0.023)	(–1.019)	(–0.568)
Distance to black concentration	–0.1410	0.1020	–0.1310	0.8575
	(–1.575)	(0.609)	(–1.690)	(2.090)
Interactions with distance to black concentration				
Asking price	–0.2640	–0.5005	–0.0121	0.5202
	(–1.752)	(–1.505)	(–0.118)	(1.455)
Number of bedrooms	0.1969	–0.0541	–0.2859	–0.1005
	(2.179)	(–0.273)	(–3.031)	(–0.463)
Average value in tract	–0.0698	–0.2788	–0.0311	0.2997
	(–0.582)	(–1.526)	(–0.376)	(1.541)
Percentage of loans denied	–1.9742	–5.4350	–1.7535	6.0515
	(–1.176)	(–1.455)	(–1.132)	(2.012)

Note: Based on multinomial logit analysis, each entry indicates the effect of a variable on the probability that a house will be shown to a white auditor. Figures in parentheses are *t*-statistics; a value above 1.96 indicates significance at the two-tailed 5 percent level.

Table 3. **Estimated Differences in Effects on Probability of Showing Houses to White and Black Auditors**

Variable	Atlanta	Chicago	Los Angeles	New York
Characteristics of the audit				
Order	0.1294	-0.4393	0.2955	0.1115
	(0.318)	(-1.050)	(0.627)	(0.328)
Same agent	-0.6438	0.3652	-0.5946	-0.4798
	(-1.743)	(0.773)	(-1.111)	(-1.355)
Number of people	0.4350	0.4124	0.0921	-0.0366
	(0.866)	(2.246)	(0.200)	(-0.278)
Comparison with advertised house				
Advertised house	1.1787	-0.1211	-0.2595	0.0949
	(2.594)	(-0.229)	(-0.408)	(0.211)
Difference in bedrooms	0.0438	-0.4138	0.4884	-0.1166
	(0.094)	(-0.811)	(0.822)	(-0.296)
Difference in price	0.3476	0.5400	0.2028	0.9200
	(0.507)	(1.244)	(0.782)	(3.112)
Same tract	-0.3506	-0.3581	0.8829	-0.0857
	(-0.691)	(-0.644)	(1.236)	(-0.177)
House characteristics				
Distance from agent's office	0.0786	0.1863	0.1941	0.1346
	(2.281)	(2.310)	(1.848)	(1.937)
Asking price	-0.5030	-1.0616	-0.3344	-0.1059
	(-0.525)	(-1.384)	(-0.419)	(-0.240)
Number of bedrooms	0.3544	-0.1969	0.2336	-0.3585
	(0.902)	(-0.540)	(0.317)	(-1.376)
Average value in tract	0.7646	-0.2954	-0.1042	0.0408
	(1.854)	(-1.234)	(-0.188)	(0.221)
Integrated tract	0.1992	-0.8423	-0.7950	0.6618
	(0.429)	(-1.480)	(-1.357)	(1.758)
Total applications	-0.0790	-0.0956	0.0676	0.6168
	(-0.737)	(-0.819)	(0.384)	(3.389)
Percentage of loans denied	8.1116	-4.0613	12.1760	2.0777
	(1.377)	(-0.547)	(0.899)	(0.907)
Distance to black concentration	-0.1343	-0.0181	-0.0102	0.2398
	(-1.872)	(-0.210)	(-0.169)	(0.896)
Interactions with distance to black concentration				
Asking price	-0.0886	-0.0047	0.0673	-0.6968
	(-0.686)	(-0.027)	(0.751)	(-2.478)
Number of bedrooms	-0.0585	-0.0063	-0.0058	0.4297
	(-0.869)	(-0.067)	(-0.074)	(2.951)
Average value in tract	-0.1736	0.2915	-0.0712	-0.1267
	(-2.009)	(2.489)	(-1.051)	(-0.774)
Percentage of loans denied	-6.1265	-0.5582	-0.1563	-2.6973
	(-2.436)	(-0.225)	(-0.109)	(-1.209)

Note: Based on multinomial logit analysis, each entry indicates the effect of a variable on the difference in the probability that a house will be shown to a white auditor and the probability that it will be shown to a black auditor. Figures in parentheses are *t*-statistics; a value above 1.96 indicates significance at the two-tailed 5 percent level.

York, respectively.[17] These results provide strong support for the white-customer prejudice hypothesis.[18]

Second, an agent's decision to withhold a house from black customers sometimes depends on the house's location relative to a black concentration. Untangling the role of distance from a heavily black tract is complicated for two reasons. First, this variable is interacted not only with race (which yields the difference between tables 2 and 3) but also with several other variables (which produces the last panel of each table). Second, the effect of distance from a heavily black tract on the probability that a customer will see a house could reflect both redlining and steering. Redlining exists when houses that are closer to heavily black tracts are more likely to be withheld from both black customers and white customers.[19] Steering exists when discrimination, defined as more favorable treatment of white customers, increases with distance from a heavily black tract.[20]

We deal with these complexities using two different approaches. In our first approach we define the interaction terms so that the coefficient of distance from a heavily black tract (or of this distance variable interacted with the race of the auditor) indicates the effect of distance at the average value of the explanatory variables other than distance and race.[21]

The estimated coefficients tell us something about redlining and racial steering at the average values of the explanatory variables. As shown in table 2, our estimated coefficients for distance from a heavily black tract yield statistically significant evidence for redlining in New York. Moreover, as shown in table 3, we find evidence of racial steering in Atlanta, although the coefficient is significant only at the 10 percent level. This approach does not provide evidence of redlining or steering in any other area.

Our second approach is to calculate, at different distances from a heavily black tract, the probability that a house will be shown to the white auditor (P_W) and the probability that a

[17] These are decreases in the net measure of discrimination for units that are shown to at least one auditor. Decreases in unconditional net measures cannot be calculated because they require information on the share of units withheld from both auditors. If, as seems plausible, units far from agents' offices are withheld from both auditors more than are units close to agents' offices, these figures understate how much discrimination decreases with distance. However, there is no evidence that units far from agents' offices are more likely than those close by to be withheld from one auditor, regardless of ethnicity. In every area, whites are less likely to see a unit and blacks are more likely to see a unit as distance from the agent's office increases. Conditional and unconditional net measures are discussed in more detail for results concerning distance from a heavily black tract.

[18] A referee suggested to us that real estate agents may be more uncertain about the preferences of black than of white auditors (despite receiving the same information from audit teammates) and may also be more uncertain about the neighborhood characteristics of houses far from their offices than about those close by. Under these circumstances, an agent might be more willing to show distant houses to blacks than to whites in the hope that these houses will be in neighborhoods that appeal to blacks' unknown preferences. The search-model logic of this hypothesis also implies, however, that agents will show more total houses to blacks than to whites, a prediction that is strongly contradicted by the evidence. See Yinger (1995).

[19] For more discussion of redlining in housing and lending, see Federal Financial Institutions Examination Council (1999) or Yinger (1995).

[20] For more on steering, see Turner and Mickelsons (1992).

[21] Let D be distance from a largely black tract, R be an indicator of race (1 = African American), X be an explanatory variable, and $\bar{X}$ be its sample mean. Then the interaction term for white auditors (table 3) is $D(X - \bar{X})$ and the interaction term for the black–white difference is $D(R)(X - \bar{X})$. To clarify interpretation in the case of number of bedrooms, we define $\bar{X}$ as the integer closest to the sample average.

house will be shown to the black auditor (P_B). In this context, P_W is defined as the probability that a unit will be shown to both auditors plus the probability that it will be shown only to the white auditor; P_B has a comparable definition for the black auditor. We carry out these calculations for every house in the sample and then determine the probabilities for the average house. The first approach determines the effect of distance at the average value for all explanatory variables; the second approach determines the effect of distance for the average house. Because the model is highly nonlinear, these two approaches do not necessarily lead to the same answer.

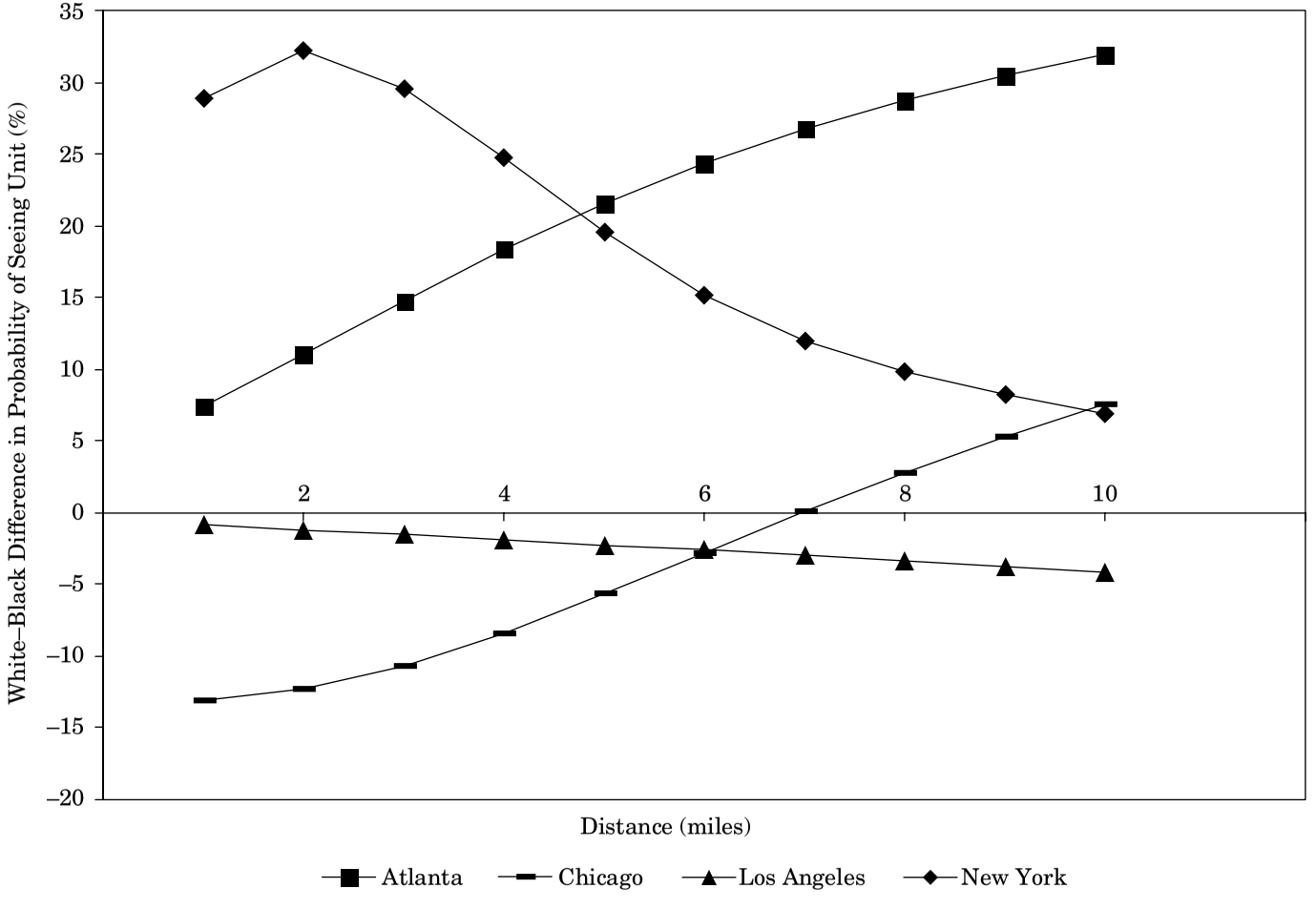
The second approach allows us to measure redlining and steering. In the case of redlining, we cannot observe the probability that a unit will be withheld from both auditors, but we can determine whether the race-neutral probability that a unit will be withheld from one auditor declines with distance from a heavily black tract. Specifically, we look at the changes in P_W and P_B as distance from a heavily black tract increases by 1 mile. If these two probabilities change in the same direction, the smaller of the two changes represents a common race-neutral effect. If this common change is negative, it indicates that redlining exists. For example, suppose that as the distance increases from 1 to 2 miles away from a heavily black tract, P_W decreases by 5 percentage points and P_B decreases by 2 percentage points. In this case, the common effect is 2 points; that is, regardless of race, an auditor's chance of not seeing a unit declines by 2 percentage points as a unit moves 1 mile farther from a heavily black tract. This is, of course, conditional on one of the auditors seeing the unit. We cannot observe redlining that takes the form of withholding units near heavily black tracts from all customers. That is, we may be able to observe some redlining, but we cannot prove that redlining does not exist.

In our model, steering exists when the difference between P_W and P_B increases with distance from a heavily black tract. That is, racial steering corresponds to a situation in which white auditors are favored over black auditors to the greatest extent in locations most distant from heavily black tracts.

We find no evidence of redlining in Atlanta, Chicago, or Los Angeles. In these three cities P_W and P_B move in opposite directions as distance from a heavily black tract increases. In New York, however, both P_W and P_B increase with distance from a heavily black tract. As the distance increases from 1 to 10 miles away from such a tract, P_W increases by 13.2 percentage points and P_B increases by 35.1 points. Thus, the common decline, our measure of redlining, is 13.2 percentage points; both black and white auditors are more likely to be shown a unit if it is located far from a heavily black tract instead of nearby. This finding reinforces the result identified using our first approach.

Our results for steering are summarized in figure 1. We find clear evidence of racial steering in Atlanta and Chicago. As the distance increases from 1 to 10 miles away from a heavily black tract, the difference between P_W and P_B, our measure of discrimination, increases by 24.5 percentage points in Atlanta and 20.7 points in Chicago. Houses located far from a black concentration are much more likely than other units to be withheld only from black customers. There is no sign of steering in Los Angeles, where the difference between P_W and P_B is essentially unaffected by distance from a heavily black tract. The Atlanta result reinforces our earlier result, but the Chicago result demonstrates that, because of the nonlinearity of the model, the effect at the average value of the explanatory variables need not be the same as the effect in the average observation.

Figure 1. **Discrimination and Distance from a Heavily Black Neighborhood**



Note: The graph plots the difference between the probability that a house will be shown to a white auditor and the probability that it will be shown to a black auditor, at various distances from the nearest neighborhood in which at least 30 percent of the residents are black. The graph is based on the estimated coefficients in table 3.

These results show that discrimination in housing sometimes takes the form of steering, but they do not provide clear support for any theory about the causes of discrimination. In fact, steering is consistent with both the white-customer prejudice hypothesis and the hypothesis that agents concentrate on transactions they believe are most likely to be completed. Specifically, steering could result because agents want to keep black buyers away from largely white neighborhoods, which are likely to be the agents' main customer base, or because agents believe, despite revealed preferences to the contrary, that black customers prefer to live near black concentrations.

As shown in the last panel of table 3, these steering results depend to some degree on the nature of the neighborhood, and the role of neighborhood characteristics may not be the same in every urban area.[22] Specifically, in Atlanta the pattern in figure 1 is stronger (i.e., the curve is steeper) in tracts with a higher average house value, but in Chicago the pattern is weaker in tracts with a higher average house value, controlling, in both cases, for the value of the unit to be shown. That is, in Atlanta steering is more likely for houses valued below the neighborhood average, but in Chicago it is more likely for houses valued above the neighborhood average. Moreover, in Atlanta, the pattern in figure 1 is stronger in tracts in which a higher share of loan applications are denied, controlling for average value and the value of the unit to be shown; that is, agents' tendency to steer is magnified when neighborhood conditions other than average value make it difficult for anyone to obtain a loan.

After accounting for all the coefficients involved, however, the Atlanta and Chicago results are not as different as they at first appear.[23] In high-value neighborhoods in both areas (controlling for asking price), discrimination decreases with distance from a black concentration. In addition, even though in low-value neighborhoods discrimination decreases with distance in Atlanta and increases with distance in Chicago, it also increases with distance in high-denial neighborhoods in Atlanta. Overall, therefore, these results indicate that in both Atlanta and Chicago, discrimination decreases with distance for houses with values that are far below the average in the surrounding neighborhood but increases with distance for houses with values that are much higher than would be expected given the quality of their neighborhoods, as indicated by average house values (Chicago) or loan denial rate (Atlanta).

In an audit setting, teammates inquire about the same house and are trained not to otherwise indicate any neighborhood or other preferences. These results show, therefore, that real estate agents treat the same inquiry differently depending on the race of the customer. Although these results cannot be definitively linked to any hypothesis about the causes of discrimination, one possibility is that agents believe some types of transactions with black customers are more likely to occur than others, either because of the perceived preferences of the black customers themselves or because of the difficulties blacks are expected to encounter in obtaining a mortgage in some locations. For example, the Atlanta and Chicago results are consistent with real estate agents' belief that lenders do not usually lend to black customers in neighborhoods far from black concentrations unless the house they want to buy is inex-

[22] Although no single interaction is significant in every urban area, the set of interactions is significant at the 5 percent level or above in every area.

[23] Interpretation of results in the last panel of table 2 or 3 involves consideration of the coefficients of the two variables that are interacted as well as the coefficient of the interaction term. In the case of average value in the last panel of table 3, for example, the coefficients of the following variables, all interacted with race, must be considered: average value, distance from black concentration, and average value multiplied by distance from black concentration.

pensive relative to surrounding houses. We have no direct information on agent beliefs, however, and more definitive interpretations must await further research.

In New York the difference between P_W and P_B is actually higher close to heavily black tracts than it is far away from them, which suggests that reverse steering might be at work. However, several results in table 3 cast doubt on this interpretation.[24] First, this counterintuitive result does not apply to houses with a higher than average asking price or with a lower than average number of bedrooms, controlling for asking price. These interaction results, like those discussed earlier, cannot be definitively linked to any hypothesis about the causes of discrimination. The finding that discrimination increases with distance for expensive houses might be explained by New York real estate agents' belief that far from black concentrations, loans to black customers are relatively unlikely for expensive houses or for small houses with many amenities. The finding that discrimination decreases with distance for inexpensive houses might be explained by the susceptibility to tipping of areas with moderately priced houses close to black concentrations; in this case, agents who want to preserve their existing white clients might be particularly unwilling to sell moderately priced houses to blacks near black concentrations. Further research is needed to sort that out.

Second, this apparent reverse-steering finding is to some degree offset by another finding shown in table 3—discrimination is lower in integrated areas than it is in all-white areas (significant at the 10 percent level). Taken together, these results suggest that near heavily black tracts, agents steer blacks toward integrated neighborhoods and away from all-white neighborhoods. That is, agents appear to "protect" white neighborhoods from black entry and to ensure that racial tipping, if it does occur, will be confined to neighborhoods that are already integrated to some degree. In contrast, far from heavily black tracts, where tipping is less likely and integrated neighborhoods are rare, this type of protection is not required. This type of behavior is consistent with the white-customer prejudice hypothesis.

The third set of results about the geography concern general conditions in the mortgage market. As noted earlier, the interaction between distance from a heavily black tract and the percentage of loans denied is negative and significant in Atlanta[25] (see table 3). Combined with the coefficients for distance from a heavily black tract and for percentage of loans denied separately, this result indicates that discrimination increases with percentage of loans denied far from a black concentration but decreases with percentage of loans denied near a black concentration.[26] We cannot offer a definitive interpretation of these results, because the

[24] Another reason to doubt this interpretation comes from the nature of our data. Figure 1 presents net measures conditional on a unit being shown to at least one auditor. An unconditional net measure must also include in its denominator the number of units shown to neither auditor. This number cannot be observed. However, if, as seems likely, the redlining behavior observed in New York for units shown to only one auditor carries over to units shown to neither auditor, the unconditional net measure could show a different pattern. Suppose, for example, that half the units 1 mile from a heavily black tract, but none of the units 10 miles from a heavily black tract, are withheld from both auditors. Then the conditional and unconditional net measures have the same value 10 miles from a heavily black tract, but 1 mile from such a tract, the unconditional measure equals the conditional measure (28.8 percent) divided by two (because the number of units—the denominator—is twice as large for the unconditional measure), or 14.4 percent. This flattens the line in figure 1 considerably, because it drops to only 6.9 percent at 10 miles.

[25] Also, table 2 reveals that in New York redlining is more pronounced in tracts in which a higher share of mortgage loans are denied.

[26] These results also imply that discrimination decreases with distance from a black concentration when the share of loans denied is small and increases with distance from a black concentration when the share of loans denied is large (and the distance is greater than 1 mile).

loan-denial variable could reflect something about either the standards of lenders working in the area or the nature of the applications in the area. One possible interpretation is that a high denial rate in locations near black areas provides different information to real estate agents than does a high denial rate in locations far from black areas. Agents interpret a high denial rate near black areas as a sign that many blacks are applying, so that other blacks are likely to be considered by lenders, or as a sign of poor neighborhood quality, which blacks are perceived to be willing to accept (holding asking price constant) to obtain more bedrooms or some other unidentified housing characteristic. In contrast, agents interpret a high denial rate far from black areas as a sign that lenders use tough underwriting standards and assume that blacks are unable to meet them. This assumption could reflect a perception that lending discrimination against blacks is more likely when underwriting standards are high or a perception that at any given income (and hence asking price) blacks have lower wealth than whites and are therefore less likely to obtain a loan, even without lending discrimination. In either case, some agents may believe that showing houses to a black customer in these locations is a waste of their time.

Finally, in New York there is less discrimination in tracts from which a relatively large number of mortgage applications originate (see table 3). This result plus the corresponding result in table 2 implies that the probability of seeing a house declines with the number of mortgage applications for whites but is essentially unaffected by the number of mortgage applications for blacks. Again, we cannot provide a definitive interpretation of this result, but one possibility is that a large number of mortgage applications is a sign of high turnover in a neighborhood and that agents believe whites, but not blacks, are looking for neighborhood stability. In changing neighborhoods, therefore, discrimination is offset to some degree by the agents' decisions to save time and effort by withholding some houses in those neighborhoods from white customers.

Conclusion

Audit data have opened the door to detailed investigation of the factors that cause housing agents to practice discrimination against people in some racial or ethnic groups. This article uses data from HDS to explore the causes of discrimination against black customers by real estate agents. The focus is on the geography of discrimination, that is, on factors influencing discrimination that vary with location, in four large urban areas: Atlanta, Chicago, Los Angeles, and New York.

This article uses a method developed by Ondrich, Ross, and Yinger (2001) in which the unit of observation is not an audit but is instead a house shown to either auditor. This shift in the unit of observation makes it possible to estimate a multinomial logit model of the decisions to show a house to the white auditor and to show it to the black auditor, accounting for the fact that units not shown to either auditor are not observed. The multinomial logit model identifies factors that have a significant effect on the probability that a house will be shown to the white auditor and factors that have a significant effect on the difference between the probability that the unit will be shown to the black auditor and the probability that it will be shown to the white auditor. The latter factors are, of course, the ones that influence discrimination.

We find that discrimination does, indeed, vary with geography. Moreover, some of the geographic patterns of discrimination are found across all areas, but others are unique to a specific area. These unique patterns cannot be observed in an analysis of national audit data.

The most striking pattern common to all four areas is that discrimination declines with distance between a house and the agent's office. This distance provides agents with some insulation against the possibility that white customers will be upset when the agents deal with black customers, so agents are more likely to show a house to blacks if it is located far from their offices. This result supports the view that agents act to protect their business with prejudiced white clients.

Discrimination also depends, in some areas at least, on the location of a house relative to heavily black tracts, but this dependence is not straightforward. In New York we find evidence of "redlining," which is defined as withholding housing near black concentrations from all customers. In Atlanta and Chicago we find evidence of "racial steering," which is defined as restricting black customers to houses near black concentrations. The patterns of redlining and of steering also appear to depend on various housing and neighborhood characteristics. In Atlanta, for example, the increase in discrimination associated with increased distance from a largely black tract (i.e., steering) is greater in tracts with a higher average house value. Although several of these relationships are consistent with existing theories of discrimination, none of them provide clear tests of these theories.

Finally, we find some preliminary evidence that decisions by real estate agents to withhold houses from black customers in some locations reflects agents' perceptions about the operation of the mortgage market in those locations. In Atlanta, in neighborhoods located far from black areas, discrimination is higher when mortgage loan applications in the neighborhood are relatively likely to be denied. In New York discrimination is lower in neighborhoods with many mortgage applications, a sign of neighborhood turnover. These results suggest that real estate agents sometimes believe that relatively tough underwriting standards are particularly hard on black customers (Atlanta) or that whites, but not blacks, are willing to pay for neighborhood stability (New York). The results are only suggestive, however, and fuller understanding of the link between mortgage markets and discrimination by real estate agents must await better neighborhood-level measures of mortgage market activity.

Overall, we find that racial discrimination in housing clearly has a geographic dimension. The resulting spatial patterns in discrimination have some elements in common across the four large urban areas we studied, but they also have elements that vary from one urban area to the next. The patterns we observe in the HDS data indicate that real estate agents sometimes withhold houses near their offices from black customers, presumably in an attempt to protect their business with prejudiced white customers. These patterns also suggest that agents may sometimes act on the belief that blacks and whites have different housing preferences and perhaps on the belief that blacks and whites face different opportunities in mortgage markets. These results demonstrate that often illegal discrimination in housing sales grows out of profit-maximizing behavior by real estate agents. This finding may help to explain why housing discrimination has proved to be difficult to eliminate and why continued fair housing enforcement activities are needed to ensure that minority households have the same opportunities for housing enjoyed by whites. In addition, these results may help fair housing officials improve the effectiveness of their enforcement activities by identifying locations where discrimination is most likely to occur. For example, investigations of

agents whose primary business is in the white community might be less likely to overlook discrimination if it is recognized that discrimination tends to be highest in neighborhoods near the agents' offices.

Appendix

The Likelihood Function

For all houses n=1,…,N shown to at least one auditor within an audit, let d_n^W (d_n^B) be the dummy dependent variable equal to one if n is shown to the white (black) auditor. We seek an expression for the unconditional likelihood contribution of the audit. Conditional on the random effect (intercept) pair (θ^W, θ^B) the conditional likelihood contribution of a single audit is given by $\prod_{n=1}^{N} \Pr(d_n^W, d_n^B \mid \theta^W, \theta^B)$. Letting the logit function be denoted by $L(z) = (1 + e^{-z})^{-1}$, we can write each component probability in the conditional likelihood contribution as follows:

$$\begin{aligned}\Pr(d_n^W, d_n^B \mid \theta^W, \theta^B) = {} & L(\theta^W + \boldsymbol{Z}^W \boldsymbol{\beta})^{d_n^W} (1 - L(\theta^W + \boldsymbol{Z}^W \boldsymbol{\beta}))^{d_n^W} \times \\ & L(\theta^B + \boldsymbol{Z}^B (\boldsymbol{\beta}+\boldsymbol{\delta}))^{d_n^B} (1 - L(\theta^B + \boldsymbol{Z}^B (\boldsymbol{\beta}+\boldsymbol{\delta})))^{1-d_n^B} / \\ & (1 - (1 - L(\theta^W + \boldsymbol{Z}^W \boldsymbol{\beta})) (1 - L(\theta^B + \boldsymbol{Z}^B (\boldsymbol{\beta}+\boldsymbol{\delta})))).\end{aligned}$$

The $\boldsymbol{Z}$ vectors, $\boldsymbol{Z}^W$ and $\boldsymbol{Z}^B$, are covariate vectors for the white and the black decisions, respectively. The numerator of this expression is simply the product of two typical binomial logit likelihood contributions, one for the white decision and one for the black decision. The denominator is needed to renormalize the probabilities of observable outcomes to sum to one because the event (d_n^W, d_n^B) = (0, 0) can never be observed in the data. Table A.1 demonstrates the calculation of these probabilities by examining the construction of the four probabilities for a pair of independent binomial logits (Y^W, Y^B). The conditional likelihood contribution has now been defined and is, in fact, equivalent to a specific trinomial logit for the observable outcomes. However, because the random effect pairs are unobserved, they must be integrated out of the analysis. This is done using a Heckman-Singer (Heckman and Singer 1984) nonparametric random effect distribution. Three distinct points of support (along with two of the three associated probabilities) were estimated for the random effect pair (θ^W, θ^B). Integrating out the random effect pairs from the conditional likelihood contribution gives the unconditional likelihood contribution. The likelihood function maximized using Quandt's GQOPT program is the product of unconditional likelihood contributions across all usable audits.

Table A.1. **Estimated Probabilities in Multinomal Logit Model**

		House Seen by White Auditor?	
		Yes	No
House Seen by Black Auditor?	Yes	$\exp\{\theta^W + \boldsymbol{Z}^W\boldsymbol{\beta} + \theta^B + \boldsymbol{Z}^W(\boldsymbol{\beta}+\boldsymbol{\delta})\} / D$	$\exp\{\theta^B + \boldsymbol{Z}^B(\boldsymbol{\beta}+\boldsymbol{\delta})\} / D$
	No	$\exp\{\theta^W + \boldsymbol{Z}^W\boldsymbol{\beta}\} / D$	$1 / D$

where

θ^W = unobserved random effect for white auditor
θ^B = unobserved random effect for black auditor
$\boldsymbol{Z}^W$ = vector of explanatory variables for white auditor
$\boldsymbol{Z}^B$ = vector of explanatory variables for black auditor
$\boldsymbol{\beta}, \boldsymbol{\delta}$ = vectors of parameters to be estimated
$D = 1 + \exp\{\theta^W + \boldsymbol{Z}^W\boldsymbol{\beta} + \boldsymbol{Z}^B(\boldsymbol{\beta}+\boldsymbol{\delta})\} + \exp\{\theta^W + \boldsymbol{Z}^W\boldsymbol{\beta}\} + \exp\{\theta^B + \boldsymbol{Z}^B(\boldsymbol{\beta}+\boldsymbol{\delta})\}$

Source: Ondrich, Ross, and Yinger (2001).

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