Neighbor Discrimination: Theory and evidence from the French rental market

Pierre-Philippe Combes, Bruno Decreuse, Benoît, Department of Economics) Schmutz, Alain Trannoy

Neighbor Discrimination

Theory and evidence from the French rental market*

Pierre-Philippe Combes [†] Benoît Schmutz [§]
Bruno Decreuse [‡] Alain Trannoy [¶]

June 22, 2015

Abstract

This paper describes a novel concept of customer discrimination in the housing market, neighbor discrimination. We build up a matching model with ethnic externalities where landlords differ in the number of apartments they own within the same building. Larger landlords discriminate more often only if some tenants are prejudiced against the minority group. Testing the null hypothesis whereby minority tenants are equally likely to have a large landlord provides a natural test for the existence of neighbor discrimination. In an empirical application, we show that this null hypothesis is rejected for African immigrants in the French private rental market. We then show that the local proportion of large landlords is positively correlated with African tenants' probability of living in public housing, whereas this is not the case of other demographic groups.

JEL codes: R21, J71.
Keywords: Customer Discrimination, Matching frictions, Neighborhood Externalities, Housing Market;

*This paper updates work registered as CEPR working paper 9160. Previous versions of this paper have circulated under the title "The Neighbor is King: Customer Discrimination in the Housing Market". It has benefited from the comments of Jim Albrecht, Pierre Cahuc, Jan Eeckhout, Cecilia Garcia-Peñalosa, Laurent Gobillon, Florence Goffette-Nagot, Morgane Laouénan, Thomas Piketty and Sébastien Roux. We also thank seminar participants at GREQAM, CREST, INSEE, Sciences-Po, Paris School of Economics, Rennes University, Aix-Marseille University, INED and Georgetown University, as well as conference participants in Dijon, Aix-en-Provence, Glasgow, London, Shanghai, Uppsala and Ghent. Data was made available by the Centre Maurice Halbwachs and the Centre d'Accès Sécurisé à Distance. This research was partly funded by the Direction de l'Animation de la Recherche, des Etudes et des Statistiques (Dares).

[†]Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS, ppcombes@gmail.com, http://www.vcharite.univ-mrs.fr/pp/combes. Also affiliated with the Centre for Economic Policy Research.

[‡]Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS, decreuse@univ-amu.fr, https://www.sites.google.com/site/brunodecreuseecon/

[§]Howard University and CREST, benoit.schmutz@howard.edu, http://sites.google.com/site/benoitschmutz

[¶]Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS, alain.trannoy@univ-amu.fr, http://www.vcharite.univ-mrs.fr/pp/ trannoy/index.htm

Introduction

The housing market is the quintessential customer market (Lang 2007). And yet, research on housing market discrimination has not benefited as much as it could have from Becker's (1957) theoretical insights into the rationale for customer discrimination. In particular, the respective roles played by landlords' and tenants' prejudice in the discrimination process are seldom clearly disentangled, even though the parallel is easily drawn between landlords and employers and between tenants and customers. According to Farley, Steeh, Krysan, Jackson, and Reeves (1994) "*most discriminatory behavior in the housing market is founded upon either the personal prejudice of agents or their belief that it is in their financial interest to cater to the presumed prejudice of their Anglo customers*". This paper develops a search model that exploits the heterogeneity of property rights on buildings. The model provides a strategy for testing for the existence of customer-based discrimination in the housing market, *neighbor discrimination*. We then implement the test on French data.

We pick France because African immigrants experience very poor housing market performances. According to the French housing Survey 2002, 46% of them lived in public housing (HLMs) against 15% for the whole population. Given the specific location of HLMs, this leads to a concentration of African immigrants within the most deprived neighborhoods, characterized by lower-quality public goods and higher crime rates: in 2002, 28% of them lived in an area targeted by the *Zone Urbaine Sensible* program, against 6% for the whole population. The presumption in this paper is that members of ethnic minorities are actually discriminated against in the private rental market by landlords and real estate agents who assume that their would-be French-born neighbors do not want to coreside with them. If this conjecture were true, this would be worrying for several reasons. First, unlike taste-based discrimination, neighbor discrimination is rooted in profit maximization. It is therefore more likely to persist, and probably more robust to anti-discrimination policies. Second, such a lack of housing opportunities in the severely supply-constrained French market impairs geographic mobility. This in turn may affect employment odds, thereby contributing to explain huge residual disparities in unemployment rates (see Decreuse and Schmutz (2012) and Gobillon, Rupert, and Wasmer (2014)). Finally, African immigrants are more often found in the rental market: only 22% owned their dwellings in 2002, against 56% for the whole population. Improving their housing outcomes will prove difficult if they are very exposed to discriminatory practices in the main market segment they have access to.

The idea we develop in this paper is as follows. If some Whites will not enter an apartment in a building in which some of the other tenants are Black, then the willingness of landlords to rent to Blacks will be affected. However, discrimination incentives crucially depend on the number of dwellings owned in the same building. We explore the implications of this idea in a stylized model of the rental market in which each building consists of two apartments. In some of these buildings, the two apartments are owned by two different landlords; in the others, the two apartments are owned by the same landlord. The incentives to cater to the prejudice of prospective White tenants differ between the two landlord types, namely, those owning a single apartment versus those owning both apartments in the same building. Unlike landlords who

own both apartments, single-unit landlords do not care that accepting a Black applicant may make it more difficult for the other landlord in the building to find a tenant; however, they do take into account the fact that if they accept a Black applicant today, they will face a more difficult situation tomorrow when their unit is back on the market, because the tenant in the other apartment will be more likely to be Black.

More precisely, we focus on the rental market and model landlords' decision-making process in a dynamic framework with ethnic heterogeneity, two-dwelling buildings, and matching frictions (Section 1). Rents are fixed and some Whites are prejudiced against Black tenants. Landlords have to choose whether they accept an applicant or wait for another one. Landlords are heterogenous with respect to the number of housing units they own within the same building: "dwelling landlords" own only one unit, while "building landlords" own both. Dwelling landlords sharing a building property play a dynamic game whose (Markovian) equilibria are studied. Building landlords run the building efficiently. The model predicts that all landlords have the same behavior when faced with unprejudiced White applicants. This result is robust to the consideration of alternative forms of discrimination, i.e. landlords' pure taste for discrimination and statistical discrimination. However, when there are prejudiced Whites, landlords who own two contiguous apartments discriminate more often than those who own a single apartment. Indeed, the latter only care about the impact of their selection decision on their ability to rent out the same apartment again in the future (dynamic externality), while the former also care about the impact of their decision on their current ability to rent out the other vacant lot (static externality).

The model provides a new test for the presence of customer discrimination. Other things equal, if building landlords discriminate more than dwelling landlords, then there are prejudiced tenants. This result is valid even though there may be multiple equilibria in the strategic game played by dwelling landlords. This first prediction may be tested on pair-based audits. A related prediction is that Black tenants less often have landlords who own several housing units within the same neighborhood only in the event of customer-based discrimination against Black applicants. This prediction is testable on regular survey data.

We provide an empirical application on French data (Section 2). We seek here to investigate whether some of the difficulties experienced by ethnic minorities in France (mainly people coming from former French colonies in Africa) may be attributed to customer discrimination. There is little legal room in France for price discrimination in the French rental market, which suits our fixed-price model. The asked rent is generally posted on the ad and landlords are not allowed to increase it unilaterally before signing the lease. Moreover, a set of laws and regulatory practices prevents them from fixing prices at their will on many segments of the private rental market. Price discrimination must be covert: it may involve the amount of the security deposit (two or three months), or temporary discounts in exchange for improving the quality of the dwelling. Our assumption here is that the bulk of discrimination, if any, has to come through quantity rationing.[1] This assumption is tested through the course of our empirical investigation.

[1] A similar phenomenon occurs in the labor market: African immigrants are paid less and suffer higher unemployment rates. However, while residual ethnic wage differentials are very small, residual unemployment disparity is quite large (Aeberhardt, Fougere, Pouget, and Rathelot 2010).

Section 2 conducts a first empirical test of the theory. This test relies on the assumption that, conditional on all *observable* characteristics of the dwelling, tenants do not directly derive utility from whether the landlord owns several contiguous apartments or not. Under this assumption, the conditional allocation of tenants across landlords' types only reflects the supply side of the market and does not raise selection issues regarding the choice of residence. Using data from the French National Housing Survey, we show that first-generation immigrants of African origin who live in privately-rented apartments are less likely to have a landlord who owns the entire building. This result is equivalent to rejecting the null hypothesis whereby minority tenants are equally likely to have a building landlord. According to our model, customer-based discriminatory practices in the French private rental market is the most plausible explanation of such a finding. Indeed, if landlords believe that rental arrears are more frequent for members of some ethnic minority, it is unlikely that this belief will be solely shared by owners of multi-dwelling landlords.[2] The same goes for true prejudice.

In the last part of section 2, we take advantage of our large-scale survey data to run an alternative, more indirect test of the theory. Using a methodology derived from the empirical literature on spatial mismatch on the labor market, we compute the share of dwellings owned by building landlords in each local housing market. We show that the probability of tenants of African origin to be living in public housing is positively correlated with this variable, whereas the correlation does not stand for any other ethnic group. Provided this probability partly reflects the difficulty to access the private rental market, this second result is also consistent with the assumption of customer discrimination in the French rental housing market.

Related Literature This paper pertains to different subfields of the huge discrimination literature. First, our reasoning is quite similar to that used in the segment of the literature which is concerned with identifying intentional discrimination from statistical data. For example, Knowles, Persico, and Todd (2001) and Anwar and Fang (2006) (see also the review by Persico (2009)) attempt at distinguishing racial prejudice from statistical discrimination. In a different perspective, Charles and Guryan (2008) focus on taste-based discrimination. We go back to the theory of discrimination and extract one specific rationale for discrimination out of the black box. We then derive an identification strategy, which relies on fairly weak assumptions regarding consumers' and suppliers' tastes. Thanks to the use of an original variable on the geography of landlords' real estate portfolios, we are able to isolate the impact of customer discrimination.

Customer vs neighbor discrimination.— Our paper is obviously related to the literature focused on customer discrimination in the labor market (Borjas and Bronars 1989, Nardinelli and Simon 1990, Holzer and Ihlanfeldt 1998, Combes, Decreuse, Laouénan, and Trannoy 2016). However, beyond similarities, neighbor and customer discrimination differ. Whereas in Becker's world customer discrimination takes place at the expense of workers who are not hired in order not to displease customers, here neighbor discrimination takes place at the expense of other customers that are excluded from the service to not bother the majority of customers. This leads quite spontaneously to a segregating equilibrium where some firms (landlords) choose to serve a given

[2] In France, tenant eviction is a lengthy process, which is even fully suspended during the winter period.

type of consumers. This feature relates neighbor and coworker discrimination where there can be male-dominated, female-dominated and mixed firms if it is assumed that male workers dislike working with females and vice-versa (Sasaki 1999). Here, we examine asymmetric neighbor discrimination, Blacks are assumed to have no prejudice against Whites.

Discrimination and search.— Our paper is also related to the theoretical literature on labor market discrimination in frictional environments. This literature is mostly focused on employer discrimination. While discrimination only affects wages in a frictionless environment, the combination of search frictions and hiring discrimination translates into higher unemployment probability (Black 1995, Bowlus and Eckstein 2002, Rosen 2003, Lang, Manove, and Dickens 2005). We build on this important result to study a specific type of quantity rationing in the housing market, a vacancy rate which can be understood as the result of a dynamic vacancy-minimization program and which may therefore only arise under search frictions.

To the best of our knowledge, we provide the first model of customer discrimination in the housing market in a dynamic search framework. Whereas search processes in this market are indisputably frictional,[3] there still are relatively few search and matching models of the housing market as a whole. After the seminal work of Wheaton (1990), most of the advances have been made in recent years (Albrecht, Anderson, Smith, and Vroman 2007, Ngai and Tenreyro 2014, Díaz and Jerez 2013, Albrecht, Gautier, and Vroman 2015, Carrillo 2012). These various papers study many interesting features of the housing market, such as the divide between tenants and homeowners or the fact that sellers are often also buyers. However, a lot remains to be done to match the level of research devoted to the labor market.[4] In this perspective, the characterization of the dynamic and static externalities associated with the acceptance of a minority tenant is new. The dynamic game when there are two dwelling landlords and the study of its Markovian equilibria are also new.

Empirics of discrimination in the housing market.— Our two tests aim to provide additional empirical evidence on housing market discrimination. In the US, price discrimination in the housing market has been studied since the 1960s, when the growing expansion of the Afro-American and Hispanic middle class was starting to modify the racial makeup of Suburbia (Rapkin 1966, King and Mieszkowski 1973). Numerous studies based on hedonic methodology and geographical discontinuities show that Blacks often have to pay a premium to enter formerly all-White neighborhoods (Yinger 1997). However, these papers do not provide evidence on discrimination in the making: how and why agents discriminate remains unknown and discrimination, if attested, remains a black box.

Pair-based audits highlight the role played by realtors. Many such audits have been conducted in the US since the late 1970s. For instance, using the results from an audit conducted in 1981 in Boston, Yinger (1986) shows that Black applicants are offered up to 30% fewer opportunities to visit housing units: two decades later, this gap narrowed but was far from having closed

[3]For recent empirical evidence on the existence of frictions on the US home-sale market, see Genesove and Han (2012), who examine how buyers' and sellers' time in the market respond to changes in buyer to seller ratio. Their estimates imply that the underlying elasticity of the matching function with respect to sellers is about .8, against .2 with respect to buyers.

[4]The structural estimation of housing search models is even more recent (Carrillo 2012).

(Zhao, Ondrich, and Yinger 2006). Another example could be found in the Housing Discrimination Study of 1989, where a series of audits on 25 US metropolitan areas led to another wave of evaluations (Ondrich, Stricker, and Yinger 1999). Recently, field experiments using newly available matching techniques, such as the Internet, have been conducted. Ahmed and Hammarstedt (2008) provide strong evidence for gender and ethnic discrimination in the Swedish rental market, by looking at the reaction of landlords who had posted an ad on the Web and were contacted by fictitious applicants with distinctively ethnic and gender names (see also Hanson and Hawley (2011) who conduct a similar study on U.S. cities).

The remainder of the paper proceeds as follows. Section 1 presents and analyses the search and matching model. Section 2 provides a direct test of the main prediction of the model and an indirect test based on the over-representation of some ethnic groups in the French public housing stock. Section 3 concludes. The Appendix contains the proof of the propositions and additional material.

1 Neighbor discrimination: theory

1.1 The model

We describe the rental pattern of a two-dwelling building in a context where some of the majority tenants are prejudiced against people from (ethnic) minorities. We distinguish two cases. In the first one, the building is owned by a unique landlord. In the second one, it is owned by two separate landlords who act non-cooperatively. We refer to dwelling landlords as type-1 landlords and to building landlords as type-2 landlords.

Set-up Time is continuous. The building comprises two apartments. Each apartment is occupied by a White tenant (w), a Black tenant (b), or is vacant (v). The state space of occupancy for each building is $\{v, w, b\} \times \{v, w, b\}$. Owners with a vacant dwelling meet applicants at constant rate η. The applicant may be White with probability $p_w = p$ or Black with complementary probability $p_b = 1 - p$. Prejudice is one-sided: nobody is prejudiced against Whites; Blacks are not prejudiced against Blacks; a fixed fraction α of the population of Whites is prejudiced against Blacks.[5] Prejudiced Whites refuse to enter a dwelling when the neighbor is Black. However, they do not move out if a Black tenant moves in next to them.[6] We briefly discuss the alternative case in Section 1.6.

When a Black applicant is willing to enter the dwelling, the landlord accepts with some probability. In all generality, such a probability may depend on many different factors such as time and building occupancy state history (including the current state). We restrict our attention to Markovian processes, whereby the acceptance probability depends only on contemporaneous building state. Let $\beta = (\beta_{bv}, \beta_{bw}, \beta_{bb}) \in [0, 1]^3$ denote the vector of stationary probabili-

[5] US studies show that more than 70% of Whites are not willing to move into a neighborhood which is more than 50% Afro-American, whereas more than 80% of Afro-Americans are willing to move into a neighborhood with only a few Black neighbors (Farley, Steeh, Krysan, Jackson, and Reeves 1994).

[6] This assumption is compatible with the behavior of US White households as described by Ellen (2000).

ties of entering state b when the other dwelling is in state $l = v, w, b$ respectively. Similarly, $\bar{\beta} = \left(\bar{\beta}_{bv}, \bar{\beta}_{bw}, \bar{\beta}_{bb}\right) \in [0,1]^3$ denote the vector of stationary probabilities for the other dwelling.

Landlords receive a *fixed* rent R that does not depend on a tenant's race. However, landlords may also be prejudiced against Black tenants. In such a case, the "net" rent is ethnic-specific with higher net rents for Whites than for Blacks, R_w and R_b respectively, with $R_w \geq R_b$. The difference $R_w - R_b$ is Becker's taste for discrimination.

Landlords cannot evict a tenant, but tenants leave the apartment they rent with flow probability q.

Dwellings' values Landlords, whatever their type, are risk neutral and discount time at rate r. Let $\Pi : [0,1]^3 \times [0,1]^3 \to \mathbb{R}^9$ denote the function of gains associated with the ownership of *one* apartment. The typical element is $\Pi^{kl}\left(\beta, \bar{\beta}\right)$, where $k, l = v, w, b$ denote the occupancy status of each dwelling. The dependence vis-à-vis β and $\bar{\beta}$ will be omitted whenever this does not cause a misunderstanding.

For all $i, j = w, b$, the elements of the gain function at a stationary state are recursively defined as follows:

$$r\Pi^{ij} = R_i + q\left[\Pi^{vj} + \Pi^{iv} - 2\Pi^{ij}\right], \tag{1}$$

$$r\Pi^{iv} = R_i + q\left[\Pi^{vv} - \Pi^{iv}\right] + \eta \sum\nolimits_l p_l \left(1 - \alpha_{li}\right) \bar{\beta}_{li} \left[\Pi^{il} - \Pi^{iv}\right], \tag{2}$$

$$r\Pi^{vj} = q\left[\Pi^{vv} - \Pi^{vj}\right] + \eta \sum\nolimits_k p_k \left(1 - \alpha_{kj}\right) \beta_{kj} \left[\Pi^{kj} - \Pi^{vj}\right], \tag{3}$$

$$r\Pi^{vv} = \eta \sum\nolimits_i p_i \beta_{iv} \left[\Pi^{iv} - \Pi^{vv}\right] + \eta \sum\nolimits_i p_i \bar{\beta}_{iv} \left[\Pi^{vi} - \Pi^{vv}\right], \tag{4}$$

where α_{kl}, $k, l = v, w, b$, is a shortcut notation with $\alpha_{wb} = \alpha$ and $\alpha_{kl} = 0$ in all other cases, and $\beta_{wl} = \bar{\beta}_{wl} = 1$ for all $l = v, w, b$.

The system (1)–(4) comprises nine linear equations. Changes in the occupation status of one dwelling generally affect the value of the other because having a Black neighbor leads prejudiced Whites to refuse the dwelling. Consider equation (2) for instance. It states that a dwelling occupied by a type-i tenant with no neighbor yields instantaneous profit R_i, but its value is likely to turn into Π^{vv} if the tenant leaves (an event occurring at rate q) as well as into Π^{il} if the other dwelling is occupied by a type-l tenant. This new tenant, who arrives at rate η, is of type l with probability p_l, accepts the dwelling offer with probability $(1 - \alpha_{li})$, and is accepted by the landlord with probability $\bar{\beta}_{li}$.

Dwelling landlords' strategies Landlords choose who they accept and who they refuse. In other words, they set the probability vectors β and $\bar{\beta}$. They accept or reject applicants in a non-cooperative way. We reduce the possible strategies to state-dependent strategies. For each owner the *strategy space* is reduced to $B = \{\beta_{bl}; \beta_{bl} \in [0,1], l = v, w, b\}$. The *profit function* of a particular landlord is $\Pi_1 : B \times B \to \mathbb{R}^9$ with typical element $\Pi_1^{kl}\left(\beta, \bar{\beta}\right) = \Pi^{kl}(\beta, \bar{\beta})$.

A *best-response strategy* to strategy $\bar{\beta} \in B$ is a strategy $\beta \in B$ such that

$$\beta \in \arg\max_{\tilde{\beta} \in B} \Pi\left(\tilde{\beta}, \bar{\beta}\right). \tag{5}$$

From equations (1)–(4), best-response strategies are such that

$$\beta_{bl} = \begin{cases} 1 \text{ if } \Pi^{bl}\left(\tilde{\beta}, \bar{\beta}\right) > \Pi^{vl}\left(\tilde{\beta}, \bar{\beta}\right) \\ [0,1] \text{ if } \Pi^{bl}\left(\tilde{\beta}, \bar{\beta}\right) = \Pi^{bl}\left(\tilde{\beta}, \bar{\beta}\right) \\ 0 \text{ else} \end{cases}. \tag{6}$$

A *symmetric Nash equilibrium* is a vector β^* such that

$$\beta^* \in \arg\max_{\tilde{\beta} \in B} \Pi\left(\tilde{\beta}, \beta^*\right). \tag{7}$$

A *pure-strategy symmetric equilibrium* is a symmetric Nash equilibrium with $\beta_{bl} = 0$ or $\beta_{bl} = 1$ for all $l = v, w, b$. We also define the set of pure-strategy equilibria B^* by $B^* = \{\beta^*; \beta^* \text{ is a pure-strategy symmetric equilibrium}\}$.

The game is dynamic and the set of conditions (7) includes subgame perfection requirements. Suppose for instance that the Nash equilibrium features $\beta^*_{bv} = \beta^*_{bw} = 0$, i.e. Blacks are discriminated against when the other dwelling is vacant or when it is occupied by a White tenant. If both dwellings start vacant, then there will never be Black tenants in the building. Landlords will never be confronted with a Black neighbor; they do not need to compute optimal strategies in such a case. However, subgame perfection requires that equilibrium strategies must also be optimal in situations that do not occur along the equilibrium path. Such conditions are important because they set individual-deviation gains. To pursue the example, suppose also that $\beta^*_{bb} = 1$, landlords do not discriminate against Blacks when the other dwelling is occupied by a Black. Deviating in the first stage then means accepting a Black tenant knowing that the other landlord may well accept a Black tenant in the future. This reasoning is crucial to establish that not deviating is the best strategy.

Building landlord's strategies The strategy set is now $B_2 = B \times B$. The profit function is $\Pi_2 : B_2 \to \mathbb{R}^9$ with typical element $\Pi_2^{kl}\left(\beta, \bar{\beta}\right) = \Pi^{kl}(\beta, \bar{\beta}) + \Pi^{lk}(\bar{\beta}, \beta)$. Building landlords maximize the value of the building rather than the value of each dwelling separately.

Since the externality takes place at the building level, type-2 landlords are able to make efficient decisions. Therefore, a *symmetric efficient strategy* results from

$$\hat{\beta} \in \arg\max_{\tilde{\beta} \in B} \Pi_2\left(\tilde{\beta}, \tilde{\beta}\right). \tag{8}$$

Such a strategy must satisfy

$$\hat{\beta}_{bl} = \begin{cases} 1 \text{ if } \Pi^{bl}(\beta,\beta) + \Pi^{lb}(\beta,\beta) > \Pi^{vl}(\beta,\beta) + \Pi^{lv}(\beta,\beta) \\ [0,1] \text{ if } \Pi^{bl}(\beta,\beta) + \Pi^{lb}(\beta,\beta) = \Pi^{vl}(\beta,\beta) + \Pi^{lv}(\beta,\beta) \\ 0 \text{ else} \end{cases} . \tag{9}$$

A *pure-strategy symmetric efficient strategy* is a symmetric efficient strategy with $\beta_{bl} = 0$ or $\beta_{bl} = 1$ for all $l = w, b, v$. We also define the set of pure-strategy symmetric efficient strategies $\hat{B}$ with $\hat{B} = \{\hat{\beta}; \hat{\beta} \text{ is a pure-strategy symmetric efficient strategy}\}$.

We will mainly focus on pure symmetric strategies. Thus, we will simply write $\Pi^{kl}(\beta) \equiv \Pi^{kl}(\beta,\beta)$.

1.2 The home-sale market case

We start with a simplified model where the quit rate is zero, $q = 0$. Landlords interact with applicants in the beginning of the building history, and accepted tenants stay in the building forever. This case also corresponds to the home-sale market. Such an interpretation requires the selling price to be defined as R_i/r.

The following result considers the case where there are no prejudiced tenants, i.e. $\alpha = 0$.

Proposition 1 UNPREJUDICED NEIGHBORS WITHOUT SEPARATION. *Assume $\alpha = 0$ and let $\sigma_w = \eta p/(r + \eta p)$. Then, $\hat{B} = B^* = \{(1,1,1)\}$ when $R_b/R_w \geq \sigma_w$, and $\hat{B} = B^* = \{(0,0,0)\}$ when $R_b/R_w < \sigma_w$.*

Proof: see Appendix A

Refusing a Black tenant features an option value. Blacks are discriminated against when this option value is higher than the value of the dwelling occupied by a Black tenant. With unprejudiced neighbors, the strategic interaction between dwelling landlords disappears. Consequently, only pure discrimination may take place, and it is equally likely for both types of landlords.

Pure discrimination occurs when the rent ratio R_b/R_w is sufficiently low. Then, landlords are willing to wait for a White tenant. The limit value σ_w increases with the rate at which Whites show up, and decreases with the discount rate r. More patient landlords (r small), in a rental market where the contact rate is high (η large) and there are few Blacks (p large) are more likely to discriminate.

That type-1 and type-2 landlords behave similarly when there are unprejudiced tenants lies behind our empirical strategy to test for the presence of neighbor discrimination on the rental market. If Blacks are discriminated against by building landlords and not by dwelling landlords, then there are prejudiced tenants.

We now characterize the equilibrium and efficient strategies when $\alpha > 0$.

Proposition 2 EQUILIBRIUM AND EFFICIENT STRATEGIES WITHOUT SEPARATION. *Assume $\alpha > 0$,*

and consider the following thresholds $\sigma_b = \eta(1-\alpha)p/[r+\eta(1-\alpha)p]$, $\sigma_w = \eta p/(r+\eta p)$,

$$\begin{aligned}\sigma_{1v} &= \sigma_w \frac{r^2 + r\eta(2-\alpha+p) + p\eta^2(3-\alpha-p-\alpha p)}{r^2 + r\eta(2+p(1-\alpha)) + p\eta^2(3-\alpha-p-\alpha p)} < \sigma_w,\\ \sigma_{2v} &= \sigma_w \frac{r^2 + 3r\eta + 2\eta^2 + \alpha(r^2 + r\eta - 2p^2\eta^2)}{r^2 + 3r\eta + 2\eta^2 - \alpha\sigma_w(r^2 + (1+2p)r\eta + 2p^2\eta^2)} > \sigma_w.\end{aligned}$$

Then,

(i) If $R_b/R_w < \sigma_b$, *then* $B^* = \hat{B} = \{(0,0,0)\}$;
(ii) If $R_b/R_w \in [\sigma_b, \sigma_{1v})$, *then* $B^* = \hat{B} = \{(0,0,1)\}$;
(iii) If $R_b/R_w \in [\sigma_{1v}, \sigma_w)$, *then* $B^* = \{(0,0,1),(1,0,1)\}$ *and* $\hat{B} = \{(0,0,1)\}$;
(iv) If $R_b/R_w \in [\sigma_w, \sigma_{2v})$, *then* $B^* = \{(1,1,1)\}$ *and* $\hat{B} = \{(0,1,1)\}$;
(v) If $R_b/R_w > \sigma_{2v}$, *then* $B^* = \hat{B} = \{(1,1,1)\}$.

Proof: see Appendix A

There are five possible equilibrium and efficient strategies. Such strategies are $(0,0,0)$—Blacks are always discriminated against—, $(0,0,1)$—Blacks are accepted when the other tenant is Black, and discriminated against otherwise—, $(0,1,1)$—Blacks are accepted whenever the other dwelling is occupied and rejected when it is vacant—, $(1,0,1)$—Blacks are discriminated against when the neighbor is White, and accepted otherwise, $(1,1,1)$—discrimination does not occur.

The main lesson of Proposition 2 is that Type-2 landlords discriminate more often than type-1 landlords. This phenomenon arises when the other dwelling is vacant. On the one hand, type-1 landlords face a coordination problem, whereas type-2 landlords do not. The coordination problem may lead to multiple equilibria. This occurs when the Black-White rental ratio R_b/R_w belongs to $[\sigma_{1v}, \sigma_w)$. The two equilibria are $(1,0,1)$ and $(0,0,1)$. In both equilibria, landlords discriminate when the neighbor is White and do not when she is Black. Their behavior differs when one of the dwellings is vacant. Discriminating in such a circumstance vehicles strategic complementarity. Suppose you are one of the landlords. If the other landlord discriminates, then the option value of keeping your own dwelling vacant is high; this leads you to discriminate. The opposite effect takes place when the other landlord does not discriminate, whereas your own dwelling is vacant. Such multiple equilibria can be Pareto-ranked. The value of a vacant dwelling is larger when both discriminate than whey they do not.

On the other hand, type-2 landlords internalize the externality induced by the acceptance of a Black tenant in a vacant building. This leads type-2 landlords to discriminate more than type-1, even when the latter coordinate on the most discriminatory equilibrium.

Formally, consider the limit situation where $R_b/R_w = \sigma_w$. Then type-1 landlords accept Black tenants in all circumstances. In particular, we have $\Pi^{bv}((1,1,1)) - \Pi^{vv}((1,1,1)) = 0$, which implies that they accept Black tenants when the other dwelling is vacant. In the same parametric situation, a type-2 landlord accounts for the value of the building. She accepts a Black tenant if

$$\Pi^{bv}((1,1,1)) - \Pi^{vv}((1,1,1)) \geq \Pi^{vv}((1,1,1)) - \Pi^{vb}((1,1,1)). \tag{10}$$

The left-hand side term between brackets corresponds to the wealth gain obtained for the first

dwelling. This gain is the same for both types of landlords. However, the right-hand side term accounts for the loss in value for the other dwelling. When $R_b/R_w = \sigma_w$, the former term is nil, but the latter term is positive. Type-2 landlords reject Black applicants as a result.

Type-1 and type-2 landlords behave similarly when the other dwelling is occupied. Landlords of different types adopt the same behavior because, in this case, $\Pi^{ib}(\beta) - \Pi^{iv}(\beta) = 0$, $i = b, w$, i.e. once occupied, the value of the second dwelling does not depend on the neighbor's color. It follows that $\Pi^{bi}(\beta) - \Pi^{vi}(\beta) = \Pi^{bi}(\beta) - \Pi^{vi}(\beta) - (\Pi^{bi}(\beta) - \Pi^{vi}(\beta))$, which, by definition, means that type-1 and type-2 landlords face similar gains.

In this simplified model without separation, type-1 landlords never discriminate when $R_b = R_w$. Conversely, type-2 landlords may or may not discriminate in the same case. Formally, the threshold σ_{2v} may be larger or lower than one. When it is larger than one, Black tenants may be discriminated against by type-2 landlords when the other dwelling is vacant.

1.3 The rental market case

We now turn to the general case where $q > 0$. Separation implies that neighbor discrimination is a more likely outcome than without separation. Accepting a Black tenant vehicles a dynamic composition effect, which is due to the other landlord's strategy. Such a composition effect is not important when the tenant stays in the dwelling forever; however, the landlord must take it into account when separation is likely.

Proposition 3 COMPARING TYPE-1 AND TYPE-2 LANDLORDS. *(i) If $\alpha = 0$, then there is a unique Nash equilibrium, which coincides with the efficient strategy. We have $\hat{B} = B^* = \{(0,0,0)\}$ if $R_b/R_w < \eta p/(r + q + \eta p)$, and $\hat{B} = B^* = \{(1,1,1)\}$ otherwise.*

(ii) If type-2 landlords choose not to discriminate in all circumstances, then not discriminating in all circumstances is also a Nash equilibrium of the two dwelling landlords' game—that is, for all $j = v, w, b$, $(1,1,1) \in \hat{B}$ implies $(1,1,1) \in B^*$.

(iii) If discriminating in all circumstances is a Nash equilibrium of the two dwelling landlords' game, then discriminating in all circumstances is also the efficient strategy of type-2 landlords—that is, for all $j = v, w, b$, $(0,0,0) \in B^*$ implies $(0,0,0) \in \hat{B}$.

Proof: see Appendix A

Part (i) extends Proposition 1 to the rental separation case. With unprejudiced neighbors, type-1 and type-2 landlords behave similarly. They reject Black applicants when the net rent ratio R_b/R_w is sufficiently low, i.e. when the taste for discrimination is sufficiently strong. The threshold increases with the rate at which Whites apply for the rental, and decreases with the rental separation rate and the discount rate.

Part (ii) and (iii) highlight two significant cases where type-2 landlords discriminate more than type-1. Given the other tenant's type, that type-1 landlords always discriminate implies that type-2 landlords also discriminate in all circumstances (Part (i)). Conversely, that type-2 never discriminate also implies that type-1 never discriminate (Part (ii)).

The presence of prejudiced neighbors means that accepting a Black tenant entails two effects. The first effect is static. Having a Black tenant today reduces the chances that the other dwelling

will be rented by a White tenant. Therefore the value of the other dwelling goes down. Type-1 landlords do not take this effect into account. The second effect is dynamic. Accepting a Black tenant today affects the future composition of the building. In turn, this composition may alter the chances of finding another tenant in case of separation. Both types of landlords face the dynamic effect, whereas only type-2 landlords internalize the static externality. They are more likely to discriminate as a result.

We cannot find analytical results for the intermediate cases where landlords discriminate in some situations and not in others. We therefore proceed to numerical simulations. The main purpose of such simulations is to show that given a particular vector of parameters' values, building landlords always discriminate more than dwelling landlords.

1.4 Numerical simulations

The model is parameterized on a monthly basis. Table 1 presents the values of the different parameters. The model outputs depend only on the ratio R_w/R_b and so we normalize R_b to 1. As the ratio grows, landlords become more and more prejudiced against Black tenants. We then cover the entire set of reasonable values for all the parameters: q between 0.7% and 7% means that the average duration of a rental is between 15 months and 150 months (in France the average length of stay is 72 months), r between 0.2% and 2% amounts to between 2.4% and 26.8% annual interest rate (high values correspond to liquidity-constrained individuals), η between 0.25 and 4 means that the average waiting period for a vacant unit before a possible match is between one week and four months (we have no reliable source of information about this parameter), and p and α describe the entire set of possible values. Pure discrimination is made possible up to a 20% net rent differential between Black and White tenants.

Table 1: Parameter values

	R_w/R_b	q	r	η	p	α
Value	$1+i/10$	$i/150$	$i/500$	$i/4$	$i/20$	$i/20$
Span of i	$0 \to 2$	$1 \to 10$	$1 \to 10$	$1 \to 16$	$1 \to 20$	$1 \to 20$

Notes: The first line of the table gives the actual value of the corresponding parameter that is used in the simulation, as a function of the counter i; the second line describes the range of values taken by the counter i.

Note that we do not weight the different cases. We implictly consider that all parameter configurations have the same probability of occurrence. This is of course not true. However, accounting for a less trivial weighting scheme does not change the qualitative results presented below.

Nash equilibria Table 2 describes the equilibrium outcomes of the game played by type-1 landlords.

There are five pure-strategy Nash equilibria: $(0,0,0)$, $(1,0,0)$, $(1,0,1)$, $(1,1,0)$ and $(1,1,1)$. Simulating the general model reveals a number of phenomena that the no-separation case can-

Table 2: Distribution of the symmetric Nash equilibria of the game played by type-1 landlords.

$(\beta_b^*, \beta_v^*, \beta_w^*)$	Nb observations	Proportion
$(0,0,0)$	642,868	33.48%
$(b,0,0)_{b\in(0,1)}$	88,707	4.62%
$(1,0,0)$	251,456	13.10%
$(1,0,0),(1,1,1)$	1,230	0.06%
$(1,0,0),(1,1,0)$	6,304	0.33%
$(1,0,0),(1,1,0),(1,1,1)$	1,020	0.05%
$(1,0,0),(1,0,1)$	6,271	0.33%
$(1,0,0),(1,0,1),(1,1,1)$	9,002	0.47%
$(1,0,0),(1,1,0),(1,0,1),(1,1,1)$	5,632	0.29%
$(1,0,1)$	6,497	0.34%
$(1,0,1),(1,1,1)$	15,497	0.81%
$(1,1,1)$	885,516	46.12%
Total	1,920,000	100%

not predict. First, there may be up to four equilibria at a time, against two at most in the no-separation case. Such multiple equilibria only arise in 2.5% of the simulations. Second, in 4.5% of the simulations there are no pure-strategy equilibria, whereas there are always pure-strategy equilibria in the no-separation case. Such configurations admit a mixed-strategy equilibrium of the form $(b,0,0)$, with $b \in (0,1)$. Landlords discriminate with certainty when the neighbor is White or when the other dwelling is vacant, whereas they discriminate with probability $1-b$ when the neighbor is Black.

There are seven situations where multiple equilibria are possible. To compare the equilibrium strategies with the efficient ones, we assume that landlords coordinate on the most-discriminating highest-payoff equilibrium. This assumption is the most conservative since this equilibrium is actually the closest one to the efficient strategy.

Equilibrium vs efficient strategies We can rank the different strategies, from the least discriminatory to the most discriminatory: $(1,1,1) \prec (1,0,1) \prec (1,0,0) \prec (b,0,0)_{b\in(0,1)} \prec (0,0,0)$. This allows us to recover the fundamental result stating that type-2 landlords always discriminate at least as much as type-1. This can be expressed as the following matrix, displayed in Table 3.

The matrix is upper triangular, which means that there are no cases where type-1 landlords discriminate more than type-2. The probability mass above the main diagonal is about 21%. Type-2 landlords, therefore, discriminate strictly more than type-1 landlords in 21% of simulations.

We now examine in depth the role played by each parameter. We start with the rent ratio R_w/R_b.

Pure discrimination The likelihood of discrimination increases with the rent ratio. Table B1 in Appendix B shows how equilibrium and efficient outcomes vary with the rent ratio. When the

Table 3: Equilibrium and efficient strategies

	$(1,1,1)$	$(1,0,1)$	$(1,0,0)$	$(b,0,0)$	$(0,0,0)$	Total
$(1,1,1)$	37.20%	5.79%	3.13%	0	0	46.12%
$(1,0,1)$	0	0	1.15%	0	0	1.15%
$(1,0,0)$	0	0	8.26%	0	6.37%	14.63%
$(b,0,0)$	0	0	0	0	4.62%	4.62%
$(0,0,0)$	0	0	0	0	33.48%	33.48%
Total	37.20%	5.79%	12.53%	0	44.47%	100%

Notes: Each column corresponds to a particular efficient strategy $(\hat{\beta}_b, \hat{\beta}_v, \hat{\beta}_w)$, whereas each line corresponds to a particular equilibrium strategy $(\beta_b^*, \beta_v^*, \beta_w^*)$. The number in each cell corresponds to the percentage of our simulations that engender this particular configuration. In case of multiple equilibria, we only consider the most-discriminating equilibrium.

rent ratio is equal to one, there always is a pure-strategy equilibrium; moreover, discriminating in all circumstances is neither an equilibrium, nor an optimal strategy. The frequency of the situations where there is no pure-strategy equilibrium then increases when the rent ratio decreases. Table B1 also shows that the differential behavior between landlord types does not change with the rent ratio: the probability mass above the main diagonal is roughly constant.

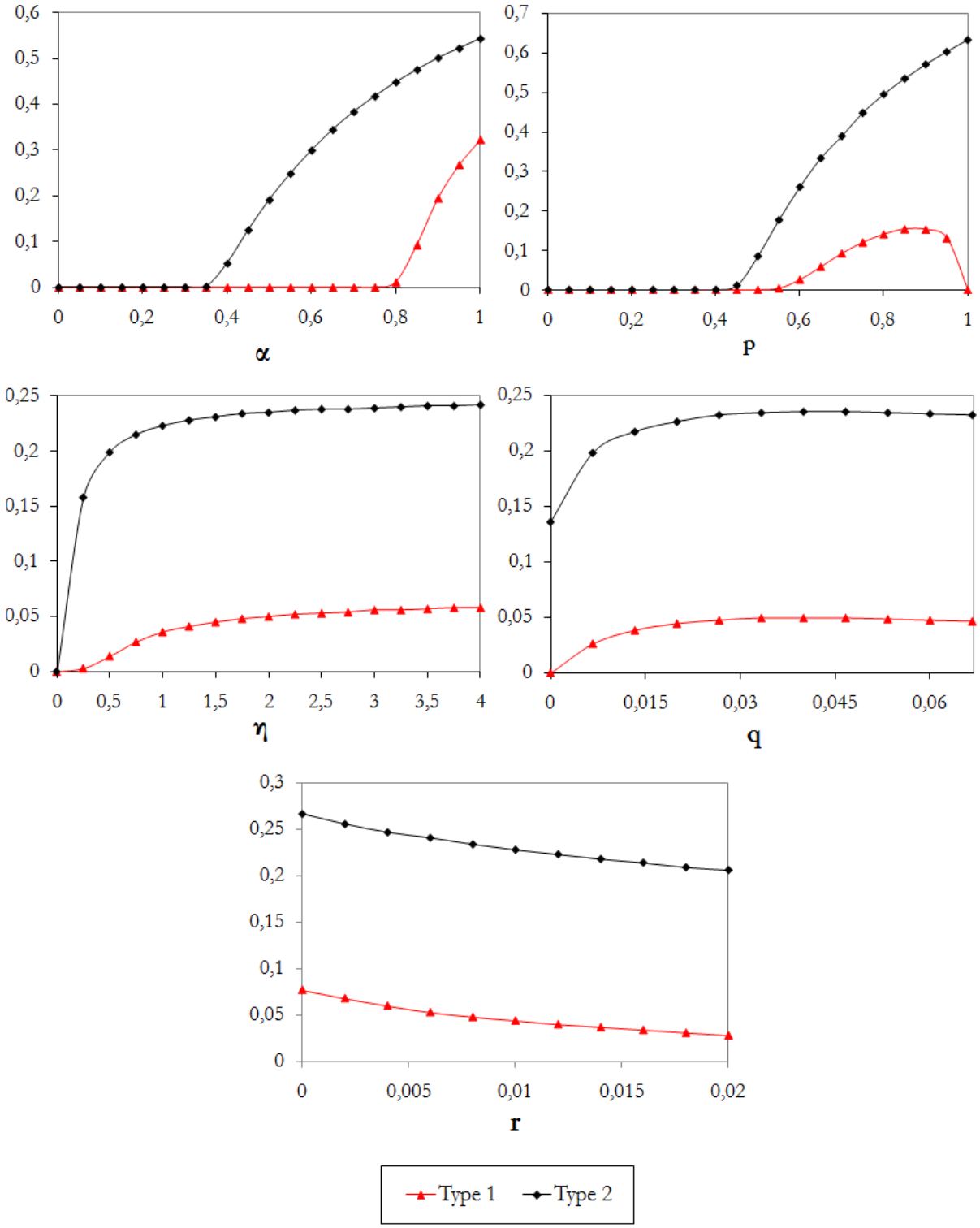
Role of the different parameters We now abstract from pure discrimination and focus on the occurrence of customer discrimination. Thus we set $R_w = R_b$. To highlight the role played by each parameter, we compute the percentage of simulations where discrimination occurs in equilibrium and in the efficient strategy for the different values of the parameters. Namely, we consider a binary variable equal to 1 if the landlord adopts anything but the $(1,1,1)$ strategy and 0 otherwise. We then average this variable on all possible situations for the other parameters. For instance, suppose that we wish to analyze the impact of parameter α. This parameter has 20 different values in our simulations. Therefore we average the binary variable on 32,000 observations for each value of α, corresponding to the different possible values of q, r, η, and p.

Figure 1 displays the results. On each plot, there are two curves. The curve with triangles is the proportion of cases where type-1 landlords discriminate whereas the curve with diamonds is the proportion of cases where type-2 landlords discriminate. The former curve is always below the latter, which reflects the general result whereby type-2 landlords discriminate more than type-1.

Three parameters have an unambiguous impact: α, η, and r. The other two parameters, p and q, have an ambiguous impact. The impact of α is straightforward. Increasing the proportion of prejudiced Whites leads both types of landlords to discriminate more often. There is a minimum value below which customer discrimination is never adopted. This threshold is around 35% for type-2 landlords and around 75% for type-1 landlords.

The effect of η is also unambiguous. Parameter η measures landlords' market power. Increasing the rate at which landlords receive applications makes it less risky to discriminate by ensuring that other applicants will be met shortly. The occurrence of discrimination is nil when

Figure 1: Probability of adopting customer discrimination as a function of the model parameters



Notes: Each diagram plots the probability that landlords adopt everything but the non-discriminating strategy when $R_w = R_b$. The probability is computed by averaging the results of the simulations for each parameter's value. The number of observations over which each point is computed is 32,000 for α and p, 64,000 for q and r and 40,000 for η. We extend the five graphs to include one additional point at the zero limit.

η is equal to 0. When η tends to infinity, the discrimination probability reaches 6.8% for type-1 landlords, and 24.9% for type-2 landlords.

Finally, the higher the discount rate, the less likely landlords are to discriminate. This is true for both types of landlords. Adopting a discriminatory strategy means preferring to keep the dwelling vacant against the hope of a better match in the future. A very high r will always make landlords prefer avoiding current vacancy, and choose not to discriminate. However, discrimination does not respond much to changes in discount rate. For each type of landlord, there is a maximum value of r above which none will ever choose to discriminate. This threshold is 11.8% for type-1 landlords, and 734% for type-2 landlords. These values are well above reasonable monthly discount rates.

As for α, the impact of the White proportion p is unambiguously positive on the probability that type-2 landlords adopt a discriminatory strategy. The minimum value below which no landlord discriminates is around 40% for type-2 landlords and around 50% for type-1 landlords. These values around one half are interesting in that they provide a relationship between customer discrimination and the fact that it will mostly matter to people who belong to an ethnic minority, minority here understood in quantitative terms.

However, p has an ambiguous impact on the behavior of type-1 landlords. An increase in p generally leads to an increase in discrimination. Landlords expect that, after separation, they are very likely to encounter a White applicant. This leads them to reject the current application of a Black tenant. When p gets close to 1, its effect becomes negative. The dynamic externality is no longer a concern. Each landlord knows that the other landlord will mostly meet White applicants. Thus they are sure that the other dwelling will either be occupied by a White tenant, or stay vacant. This leads them to accept Black applicants. When p is equal to one, the reasoning becomes obvious and so type-1 landlords never discriminate.

It follows that differences in discrimination behavior between landlord types increase with the proportion of Whites. These are maximized when p is close to one, in which case only type-2 landlords practice customer discrimination, whereas type-1 landlords do not.

Similarly, the impact of the separation rate q is ambiguous. There are two competing effects at work. On the one hand, a smaller q reduces the dynamic externality problem, since a tenant, once accepted, will stay for a long time. As explained above, in the extreme case when $q = 0$, type-1 landlords only discriminate because of a rent differential. On the other hand, a smaller q magnifies the static externality problem for the other apartment. The result from the combination of these mechanisms is that the relationship between the discrimination probability and the separation rate is bell-shaped. Type-1 landlords do not discriminate when q is above 1.41 (the mean stay is 3 weeks), against 8.02 for type-2 landlords (the mean stay is half a week). The corresponding rental durations are well below reasonable values for the average stay of a tenant in an apartment.

As for differences between landlord types, the static and dynamic externalities interact so that such differences increase with the separation rate. They are minimized in the no-separation case. The practical implication is that the test strategy should be more successful at detecting customer discrimination in the rental market than in the home-sale market.

1.5 From theory to the empirical strategy

Our model of neighbor discrimination predicts that building landlords discriminate more against Blacks than dwelling landlords only if there are prejudiced persons in the population of White tenants. This prediction leads to an eye-ball test of ethnic customer-based discrimination in the rental market.

The test strategy requires that the survey document the ownership and occupancy status of each housing unit so we can identify whether a dwelling belongs to a building landlord or not.

Prediction 1 DETECTING CUSTOMER DISCRIMINATION IN THE HOUSING MARKET *If Black tenants are less likely to have a type-2 landlord than White tenants, then there are prejudiced Whites in the rental market.*

In the absence of prejudiced Whites, Proposition 3 shows that type-1 and type-2 landlords behave similarly. Thus Black and White tenants are equally likely to have a building landlord. When there are prejudiced Whites, building landlords discriminate more than dwelling landlords. In this case, Black tenants are less likely to have a building landlord. Consequently, the only reason we could observe a difference in the model between dwelling and building landlords is because there are prejudiced White tenants.

1.6 Discussion

We assess the theoretical robustness of our test strategy to detect customer discrimination in the housing market by considering various possible extensions concerning landlords' prejudice, pecuniary externalities, endogenization of some parameters, stronger prejudice from consumers, and heterogeneity in building size.

Statistical discrimination The basic model accounts for taste-based discrimination. This arises because of neighbors' preferences that landlords internalize, or because of the landlords themselves who are directly prejudiced against Black tenants. However, Black tenants may also be discriminated against for statistical reasons. We now argue that this case is already accounted for through the difference in R_w and R_b. Consider the case where landlords believe that Blacks are more likely to deteriorate the apartment than Whites. We assume that the magnitude of deterioration is only discovered after tenant's departure. Members of the demographic group $i = w, b$ can be of one of the following two types: with probability d_i they deteriorate the building and the loss incurred by the landlord is Ω. With probability $1 - d_i$ the loss is 0. The parameter d_i is the belief shared by all landlords. The issue of statistical discrimination only makes sense when $d_b > d_w$. Whether such a belief is biased or not has no incidence for the rest of this discussion.

This yields the following gain functions:

$$r\Pi^{ij} = R_i + q\left[\Pi^{vj} + \Pi^{iv} - 2\Pi^{ij} - d_i\Omega\right], \tag{11}$$

$$r\Pi^{iv} = R_i + q\left[\Pi^{vv} - \Pi^{iv} - d_i\Omega\right] + \eta\sum\nolimits_l p_l\left(1 - \alpha_{li}\right)\bar{\beta}_{li}\left[\Pi^{il} - \Pi^{iv}\right], \tag{12}$$

leaving the equations for $r\Pi^{vj}$ and $r\Pi^{vv}$ unchanged. The only novelty is due to the inclusion of the generic terms $d_i\Omega$. Therefore, writing $\tilde{R}_i = R_i - d_i q\Omega$ makes it clear that the consideration of statistical discrimination does not affect the reasoning. The net rent is now diminished by the amount of the expected loss multiplied by the risk of occurrence. Statistical and taste-based discrimination are observationally equivalent.

Endogenization of the parameters We describe the acceptance strategies of landlords for given characteristics of the housing market. In the empirical part of the paper, such characteristics will be accounted for by area-specific fixed effects. However, from a theoretical perspective, many such characteristics could be made endogenous. The applicants' arrival rate η might depend on the proportion of Black applicants and on ethnic-specific rents net of maintenance costs. This would require specifying a matching function and the supply of buildings. Prejudice may also depend on the ethnic make-up of the population. Moreover, the proportion of Black applicants may respond to discriminatory behavior. In particular, if p were made endogenous, discrimination might lead to segregation through the constitution of a dual housing market where landlords would specialize in one type of tenant. These extensions would enrich the theoretical model and help better understand discrimination issues.

Rents could also be made endogenous. They could be bargained between the tenant and the landlord. Bargaining requires an outside option for the potential tenant to be set. Where the parties come to an agreement, the bargained rent would imply that the tenant's utility is between the reservation utility and the highest level compatible with landlord's acceptance. As the latter utility level must be lower for a Black tenant than for a White tenant, Black tenants would pay higher rents at given reservation utility. When the match surplus becomes negative, there is no rent compatible with landlord's acceptance and Black applications get rejected. The test strategy would be unaffected. Building landlords would still account for the negative externality that a Black tenant originates. In other words, building landlords would reject Black applicants more often than dwelling landlords. They would also make them pay higher rents. This extension receives no further elaboration, since statistical regressions presented in the next section do not conclude that minority tenants pay higher rents, regardless of landlord type.

Stronger definition of prejudice Suppose we add the possibility of white flight, with prejudiced Whites moving out as soon as they have a Black neighbor. How this stronger prejudice affects landlords' behavior depends on whether tenants' prejudice is observable or not. Both cases lead the conclusion that type-2 landlords should discriminate more than type-1. If tenant's prejudice is observable, then type-2 landlords with a prejudiced White tenant in their second apartment always reject Black applicants. Type-1 landlords, on the other hand, might care about knowing that they are about to make the neighbor move out, but this will not always prevent them from accepting a Black applicant. When there is no rental separation, type-1 landlords always accept Black applicants, whereas type-2 landlords always reject them. If prejudice is unobservable, then both types discriminate more often than with the previous definition of prejudice. However, type-1 landlords still do not care as much as type-2 landlords about the impact

of their acceptance decision on the probability that the other tenant might leave as a result.

Heterogeneity in building size and collusion behavior The next section will show that using real data implies comparing type-n landlords ($n \geq 2$), who own the entire building, to type-k landlords ($k \in \{1, ..., n-1\}$), who do not. For a given building of size n, former type-1 landlords may then greatly differ from one another. The main theoretical drawback of a framework with only two apartments in the building is that it makes it difficult to rule out the possibility of collusion between the two type-1 landlords of the same building. If both landlords cooperate, they can no longer be distinguished from a type-2 landlord. Both features (heterogeneity in building size and the possibility of collusion between type-1 landlords), if included in the model, would decrease the probability of observing Prediction 1 in the data. However, since the bias can only be downward, this does not affect the relevance of the test.

2 Neighbor discrimination: direct test

Our model provides us with a sufficient condition for neighbor discrimination, namely the discriminated group matches more often with type-1 landlords than with type-2 landlords in comparison with the non-discriminated group, other things being equal. We are looking whether this condition is verified in the French rental housing market. The dataset that we need has to fulfill three requirements: (*i*) clearly identify a potentially discrimated group, (ii) distinguish between landlords who own the entire building from others, (iii) offer a rich set of controls to pretend that our empirical test reasonably approaches a situation where we look at discriminated and non-discriminated groups while keeping all else equal. We first describe our dataset before showing that tenants with African origin are less likely to rent from a landlord who owns the entire building, controlling for various issues.

2.1 Data

Our dataset pools together three waves (1996, 2002 and 2006) of the French National Housing Survey (*Enquête Nationale Logement*, henceforth ENL).[7] The ENL is a detailed cross-sectional survey on a nationally-representative sample of around thirty thousand households, thirty-five thousand dwellings and seventy-five thousand individuals. The purpose of the ENL is to get a representative sample of housing units in France implying a unit-based sample design (not a cluster-based one). We have a rich set of variables describing the housing unit including the rent. In addition, have precise information on location. We know in which municipality the dwelling is located and, unless the information is missing, we even know the *ilot*, which corresponds to the census block. There are about 36,000 municipalities and 280,000 *ilots* in mainland France.

The group of potentially discriminated tenants For each individual of the dataset we know their current nationality, their place of birth and whether they were French at birth. However

[7] Previous waves lack critical information about the origin of the respondent.

the French political tradition prevents from collecting racial, ethnic or even religious information. Taking this constraint into account, we isolate a group of "Africans" composed of first-generation immigrants of African origin: both citizens of an African country and people born in Africa and not French at birth. We have the presumption that this group is a good candidate to be the most discriminated group. A large range of facts supports this view starting with the results of the poll conducted by the French body of Human Rights (*Commission nationale consultative des droits de l'homme,*) since 1990 about the feelings of the French population in terms of racism and discrimination (see the appendix in CNDH (2013)). In 2006, 90% of the respondents thought that racism was widespread in France and only 40% of them declared that they were not racist at all. To the question "Who are the main victims of racism in France according to your opinion?", 25% of the respondents answered "Arabs", 14%, "Maghrebians", 20%, "Blacks", and 26%, "Foreigners/Immigrants". Only 2% of the sample declared "Asians." Two main reasons can be invoked to explain such a clear pattern. First the main bulk of the colonial French Empire was in Africa and the stereotypes or the antagonism associated with the colonial past can persist. For instance, when respondants were asked to say whether Algeria evocates a positive or a negative feeling, a clear majority (50% against 22%) have a clear negative prejudice. The difference in religion and culture can also be a source of misunderstandings: only 20% have a positive opinion of the Muslim religion. If there is little doubt that we are focusing on a good candidate for discrimination, it can be thought that we are approaching it with the wrong concept, nationality. However, it is not as bad as one may think since the first reason reported by the 22% of the sample who said that they have suffered from discrimination is nationality (44%) before skin color (25%) and religion (12%). Still, this measure of ethnicity misses quite a number of cases because some people born in the colonies were given French citizenship at birth. The increasing number of second, third and even fourth-generation immigrants of African origin in France are also missing. It may be less of a concern since that same survey does not point toward racism against second-generation immigrants.

Our hypothesis is that if there is neighbor discrimination, it will be against this group while the "French-born" are not supposed to be discriminated against. We also consider the group of "non-African origin" (both non-French, non-African citizens and people born outside of France and Africa and not French at birth) as a group, intermediate between "the French-born" and "Africans". We do not have a strong feeling about whether this group should suffer from discrimination or not because it is clearly very heterogeneous in nature. This group should be subject to the same difficulties as all immigrants in terms of language or cultural knowledge of France but its members are less expected to be discriminated against for racial reasons. Because of its heterogeneity, we do not have strong priors regarding this group but we will display the coefficients associated with it for completeness.

We also seek to disentangle between discrimination for ethnic considerations and the difficulties experienced by recent migrants when coping with the codes of their new country. Consequently, we exclude from our sample all households whose respondents did not have a home of her own in France four years before, either because they were not in France, or because they were living in a hostel (or a dorm, etc.) or were hosted by other people. By doing so, we focus

on immigrants who are truly settled in France and may have started to integrate in the labor market. These two groups of not-too-recent first-generation immigrants represent respectively 3.4% and 5.6% of the population of households whose respondents had a place of their own four years before the survey.

Table C1 in Appendix C shows that Africans are over-represented both in the private rental market and in the market for apartments.[8] As a consequence, the share of tenants in privately-rented aparments within the African population (23.3%) is much higher than for French-born (12.1%) or for non-African (16.1%). Within this sub-population of tenants, Table C2 in Appendix C shows that African tenants differ in terms of individual characteristics, which are therefore important to control for in regressions. African respondents are less often women and are less educated, their household is less rich per consumption unit, has more members and more children.

The partition of landlords In order to test the theory the most straightforwardly, one would want to compare the occupancy of buildings owned by type-1 and type-2 landlords. However, such information is unavailable, because the sampling design is at the housing level not at the building level. However, we have by chance two informations about the landlord who has contracted with the tenant. We know whether it is a firm or a household and we know whether the apartment is located in a building owned by a single landlord or not. This variable is informed by the respondent herself or, if she does not know, by her neighbors or by the caretaker of the building.[9] Even if this variable does not allow us to identify the cases where the landlord owns part but not the entire building, it does give an idea as to the scale of building ownership. This concerns 40% of privately-rented apartments. This rate varies considerably across regions. Table C3 in Appendix C shows that both types of apartments are similar in terms of size and comfort. However, rents are somewhat lower and buildings are both older and smaller in case of building landlords. Finally, building landlords are not randomly allocated across France: they are fewer in densely populated areas and in areas with more single-parent families. All these features are accounted for in the specification we use to test for neighbor discrimination in the next subsection.

One may wonder why this variable was informed. Ironically, it is as if the designer of the ENL foresaw our model. A more prosaic explanation is that, to some extent, it is a legacy of the past. It is a well documented fact that there were a lot of "rentiers" in France in the XIXth and beginning of XXth century, as recently revisited by Piketty's work (Piketty, Postel-Vinay, and Rosenthal 2014, Piketty 2014): about 500,000 households. Not all but a good fraction of them received their rents from investment property ("immeubles de rapport"). A family owned an entire building (generally in Paris or the near suburbs, or in big cities such as Lyon and Marseille) and the rents were divided among the differents members of the family. This feature has not totally disappeared (Bessière and Laferrère 2002) and the variable was introduced in the

[8] Apartments are here broadly defined as dwellings which share a building with at least one other dwelling. The empirical analysis will focus on tenants living in this type of dwelling.

[9] The declarative nature of this variable may be a source of concern. However, given the sample structure of the survey, we cannot test its accuracy by, for instance, comparing the answers of two neighbors.

ENL to follow this kind of owners. We can presume that building landlords are richer or, at least, are descended from richer families than dwelling landlords. With the passing of generations, it was (and still is) usual for the co-ownership of the building across all the members of the family to be organized through the legal status of a non trading real estate company (*société civile immobilière*). Moreover, it is important to mention that corporations (specifically financial institutions, banks and insurance companies) left the French housing market at the end of the 1980s because they thought that the tighter regulations (Loi Quillot in 1982) were going to downgrade the rate of return or make the management of rental properties too complicated. So we argue that whatever the legal status of the ownership (as shown in Table C3, 6% of dwelling landlords and 27% of building landlords are registered as firms), the rental market is massively controlled by households in France. To the extent that there might be a difference of risk attitude between firms and households, the former being expected to be risk neutral and the second to be risk-adverse, there should not be a difference in risk aversion across legal status in our case. This observation is important because even if we do not introduce risk attitude in the model (all landlords are supposed to be risk neutral) the dynamic externality associated with neighbor discrimination can be more feared and then more internalized by risk-adverse owners.

2.2 Test of the main prediction

To test the main prediction of the model, we use the sub-sample of tenants in privately-rented apartments to estimate a probit model of the probability of having a building landlord. We regress this probability on a dummy variable which indicates whether the respondent is of African origin or not. If the coefficient on this variable is negative, there is customer discrimination according to our model. As already mentioned, this variable of multiple ownership does not identify all the intermediate cases where landlords own several apartments but not the entire building. The coefficient of interest we will be biased downwards because landlords who own several apartments but not the entire building may still be enclined to practice neighbor discrimination.

Table 4 shows that the marginal effect of African origin remains significantly negative, regardless of the specification. Column (1) shows a small but significant 3% unconditional difference between African immigrants and non-immigrants. It is interesting to see how the marginal effect varies with the set of controls. Column (2) controls for tenant characteristics and the effect goes up with respect to column (1). As explained before, African households are poorer and larger, while housing units owned by building landlords are typically cheaper and contain more rooms. Therefore, Africans should be over-represented in housing units owned by a building-landlord. When we control for their characteristics, the effect is now as high as 8 percentage points. However, we also have to account for the particularities of local housing markets. For this reason, in columns (3) and (4), we also control for location, through a set of département fixed effects.[10] Africans appear to be located in places where building landlords are less numerous, which reduces their likelihood of being discriminated against. They also tend to be

[10]Départements are roughly comparable to US counties. The 94 départements form a partition of continental France.

concentrated in large cities. Therefore our model predicts that building landlords discriminate much more than dwelling landlords in less dense areas (see the effect of the White proportion in Subsection 1.4). If location choices are exogenous, i.e. not at all related to the internalization of building landlords' discriminating behavior, the effect is 5 points only. If, at the other extreme, Africans' location choices respond to neighbor discrimination, the overall impact of discrimination is then 8 points. In other words, we estimate an upper and a lower bound of the effect of discrimination, which is between 5 and 8 percentage points depending on how much such discrimination has an impact on the location choices of discriminated populations. Finally, as shown in column (4), controlling for apartment characteristics, including the rent, doubles the explanatory power of the model without affecting this estimated lower bound.

Table 4: Probability of having a building landlord

	(1)	(2)	(3)	(4)
African immigrant	-0.0292**	-0.0818***	-0.0513***	-0.0539***
	(0.0144)	(0.0147)	(0.0163)	(0.0172)
non-African immigrant	-0.0133	-0.0509***	-0.0355**	-0.0417**
	(0.0164)	(0.0165)	(0.0176)	(0.0183)
Individual characteristics		X	X	X
Location fixed effects			X	X
Apartment characteristics				X
Time dummies	X	X	X	X
Nb observations	11,139	11,139	11,136	11,052
Pseudo R-squared	0.0113	0.0298	0.0915	0.180

Notes: (i) Marginal effects of a Probit model reported. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey. (iv) Individual and apartment characteristics: Those reported in Tables C2 and C3 (in Appendix C). (v) Location fixed effects: MSAs and départements.

Spatial sorting The distribution of multiple landlords across space is not random and maybe the departement fixed effects do not capture this well enough. In Table 5, we consider finer spatial controls. In column (2), we distinguish between MSAs and départments.[11] Each MSA is assumed to form a separate local housing market and residential location choice is more likely to be based on this partition, than on départements.

Finally, we acknowledge the fact that spatial externalities may take place at a higher level

[11] We use the 2010 definition of MSA (*aires urbaines*), which distinguishes between 765 MSAs in continental France and regroups half of all French municipalities. The definition of MSAs is functional: they are formed by a main employment center, with at least 1,500 jobs, and by all the surrounding municipalities that send at least 40% of their employed residents to that employment center. In 2008, 85% of the French population lived in a MSA. Households in our sample come from 276 different MSAs. However, we are more precise for the ten largest MSAs, for which we distinguish the main municipality of the MSA. For Paris MSA, in addition to isolating Paris municipality, we also distinguish between the 20 different boroughs (the *arrondissements*).

than the building and that location choices may take place at a very local level. As shown, notably, by Pan-Ké-Shon (2010), the features of African immigrants' residential mobility are quite specific. If, for unobserved reasons, African households voluntarily sort into neighborhoods where the building landlord rate is low, this sorting pattern will drive the result. Therefore, we also control for the shares of African and non-African immigrants in the population at a very local level: the municipality (column (3)) and the census block (column (4)).[12] Those shares are computed from the 1990 Census in order to mitigate the reflection problem.

Table 5: Spatial sorting

	(1)	(2)	(3)	(4)
African immigrant	-0.0539***	-0.0391*	-0.0390**	-0.0626**
	(0.0172)	(0.0212)	(0.0177)	(0.0255)
Non-African immigrant	-0.0417**	-0.0363*	-0.0328*	-0.0550*
	(0.0183)	(0.0216)	(0.0153)	(0.0240)
MSA Fixed effects		X		
Share in Municipality				
of African immigrants			-0.862***	
			(0.153)	
of non-African immigrants			0.625**	
			(0.283)	
Share in Census block				
of African immigrants				-0.008
				(0.099)
of non-African immigrants				0.147
				(0.160)
Controls	X	X	X	X
Nb observations	11,052	10,875	10,714	7,555
R-Squared	0.17	0.21	0.18	0.19

Notes: (i) Marginal effects of a Probit model reported. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey. (iv) Controls: Those considered in column (4) of Table 4.

As shown in column (3), living in a municipality with a higher share of immigrants will definitely impact one's probability of having a building landlord. However, this is not the case at the neighborhood level (column (4)), whereas taste-based residential sorting is more likely to take place at this level. Regardless of the specification, the specificity of immigrants as a whole keeps standing out, and African immigrants are always slightly more under-represented than non-African immigrants within the group of tenants in apartments owned by a building

[12] In this latter specification, the number of observation drops because of missing information on census block for about a quarter of our sample.

landlord. The issue of residential sorting will be further addressed in Section 2.4, which provides a discussion on the potential impact of neighbor discrimination on the ethnic segmentation of the rental market.

Legal status of the landlord As already explained in section 2.1, we believe that most building landlords who are administratively registered as firms are actually made of households, so that the legal status of the landlord may not be very informative to distinguish, for example, between different levels of risk aversion. However, we seek to take advantage of all the information available in the dataset. In addition, there may be different administrative requirements for landlords who file as firms, even when they are in fact a conglomerate of households. In order to account for the legal status of the landlord, which can also be considered as an outcome of the random search process for future tenants, we estimate a bivariate probit model of the joint probability of having a building landlord and a firm landlord, which therefore takes into account the correlation between these two characteristics. The marginal effects of being an immigrant household on the marginal probability of having a building landlord are computed in Table 6, which uses the same set of controls as Table 4. In spite of the high level of correlation between those two outcomes, indicated by the chi-squared statistic, the results are very stable when compared to Table 4.

Table 6: Legal status of the landlord

	(1)	(2)	(3)	(4)
African immigrant	-0.030**	-0.082***	-0.046***	-0.044***
	(0.014)	(0.015)	(0.015)	(0.015)
non-African immigrant	-0.012	-0.050***	-0.030*	-0.031**
	(0.016)	(0.017)	(0.016)	(0.016)
Individual characteristics		X	X	X
Location fixed effects			X	X
Apartment characteristics				X
Time dummies	X	X	X	X
Nb observations	11,120	11,120	11,120	11,037
χ^2 for LR test of $\rho = 0$	917	909	929	1,093

Notes: (i) Marginal effects of a bivariate probit model reported, on the marginal probability of having a landlord who owns the entire building; (ii) Standard errors in parentheses are computed using a Delta method. Significance: ***: 1%, **: 5%, *: 10% (iii) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey. (iv) Controls are the same as in Table 4.

2.3 Discussion

We discuss here the plausibility of the identifying assumptions of the model, leading to Prediction 1.

Price discrimination Both types of landlords must provide a similar good, so that all kinds of applicants are indifferently looking across both types. The set of controls we introduce makes it unlikely that the characteristics of the dwelling itself might be sufficiently different between the two types of landlords to explain the exclusion of Africans by differences in taste with respect to housing. Similarly, different prices between the two types of landlords should not play a significant role in this phenomenon: first, because of the French institutional design of the housing market we already commented on in the Introduction;[13] second, because our preferred specification in column (4) of Table 4 includes the rent among controls.

Table 7: Determinants of the rent

	(1)	(2)	(3)	(4)
African immigrant	0.216***	0.344***	0.0778***	-0.0209
	(0.0181)	(0.0175)	(0.0151)	(0.0134)
non-African immigrant	0.141***	0.263***	0.0295*	-0.0172
	(0.0214)	(0.0199)	(0.0169)	(0.0147)
Building landlord	-0.264***	-0.197***	-0.146***	-0.102***
	(0.0111)	(0.0103)	(0.00884)	(0.00797)
African × Building landlord	-0.00634	-0.0647**	-0.00723	-0.0134
	(0.0305)	(0.0278)	(0.0232)	(0.0200)
non-African × Building landlord	-0.0756**	-0.125***	-0.0215	0.00141
	(0.0352)	(0.0321)	(0.0268)	(0.0231)
Individual characteristics		X	X	X
Location fixed effects			X	X
Apartment characteristics				X
Time dummies	X	X	X	X
Nb observations	11,138	11,138	11,138	11,055
R-squared	0.135	0.283	0.512	0.642

Notes: (i) Ordinary-least-square regression of the log of rent by square meter (2006 euro). (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Controls are the same as in Table 4, except rent. (iv) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey.

This concern is also mitigated by Table 7, which presents the regression results of the rent paid by tenants as a function of tenant's origin, landlord's type, and the interaction of the two. All else equal, African tenants do not face higher rents, even when they rent from building landlords. Without any controls, African immigrants pay higher rents, but the effect disappears

[13] Typically, any significant increase between the posted price (on the ad) and asked price (before signing the lease) may be considered as an expression of misleading advertising and, as such, be prohibited by article 121-1 of the French Consumer Code.

when location controls are introduced. This is mainly due to the fact that immigrants live in larger cities where housing prices are higher. In any case, they do not pay higher rents when they rent from building landlords, even without controls. Building landlords do offer lower rents to all tenants, but this is largely due to the type of apartments they rent.

Landlords' prejudice Implicitly, the model assumes that both types of landlords are equally prejudiced. However, racial preferences might be correlated with the landlord type. For instance, building landlords may less often be immigrants and they are probably wealthier. However, the fact that wealth leads to more xenophobic political attitude is not verified by electoral studies (Bélanger, Nadeau, Turgeon, Lewis-Beck, and Foucault 2014). In terms of our model, the proportion of prejudiced landlords would be higher among type-2 landlords than among type-1. Or both types of landlords would be equally prejudiced, but only building landlords would have enough market power to discriminate at their will. This is possible. However, an arguably more relevant issue is that personal prejudice would play a greater role if the landlord also lived in the neighborhood. While our data does not indicate when the landlord also lives in the building, this situation is largely restricted to small buildings of two or three apartments, often located in rural areas and involving intergenerational coresidence (Bessière and Laferrère 2002). This specificity of the housing supply of building landlords could explain part of our result. Table 8 shows that this is not the case. The effect of being of African origin does not decrease if we restrict the sample to larger buildings.

Table 8: Building size

Nb of apartments	All	≥ 5	≥ 20	≥ 40
	(1)	(2)	(3)	(4)
African immigrant	-0.0539***	-0.0546***	-0.0448**	-0.0849***
	(0.0172)	(0.0160)	(0.0194)	(0.0253)
non-African immigrant	-0.0417**	-0.0498***	-0.0407**	-0.0237
	(0.0183)	(0.0169)	(0.0203)	(0.0318)
Controls	X	X	X	X
Nb observations	11,052	8,819	3,808	1,700
pseudo R-squared	0.180	0.133	0.127	0.187

Notes: (i) Marginal effects of a Probit model reported. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey. (iv) Controls: Those considered in column (4) of Table 4.

Finally, one may also think of other interactions between landlord and tenant, apart from coresidence. In particular, the payment of the rent constitutes another potentially regular interaction. If building landlords are more prejudiced and also tend to collect the rent more directly than dwelling landlords, this omitted variable bias could explain our result. We have information about this in the ENL, where households are asked whether the rent is collected by an

intermediary, or directly by the landlord. Indeed, 69% of tenants who have a building landlord declare that they give the rent directly to the landlord, against 55% of tenants with a dwelling landlord.[14] However, as shown in column (2) of Table 9, controlling for this factor does not affect our result.

Table 9: Taste-based discrimination, statistical discrimination and networks

	(1)	(2)	(3)	(4)	(5)
African immigrant	-0.058***	-0.055***	-0.052***	-0.062**	-0.061**
	(0.017)	(0.017)	(0.017)	(0.025)	(0.025)
non-African immigrant	-0.039**	-0.042**	-0.040**	-0.054*	-0.054*
	(0.018)	(0.018)	(0.018)	(0.029)	(0.029)
Rent paid directly	0.097***				0.067***
	(0.010)				(0.015)
Degradation of shared amenities		0.016			0.016
		(0.013)			(0.020)
Proxy for default			-0.010		-0.024
			(0.014)		(0.019)
Friends or relatives				0.180***	0.163***
				(0.016)	(0.016)
Controls	X	X	X	X	X
Nb observations	11,034	11,052	11,034	5,417	5,417
pseudo R-squared	0.187	0.181	0.181	0.211	0.214

Notes: (i) Marginal effects of a Probit model reported. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Rent paid directly: rent is paid directly to the landlord; proxy for default: has had difficulty paying the rent in the past two years; Degradation of common parts: the common parts of the building have been recently deteriorated; Friends or relatives: the vacancy was heard of through friends or family networks (iv) Sample: columns (1) to (3): All tenants in privately-rented apartments who had a place of their own in France four years before the survey; columns (4) and (5): Restricted to those who have recently moved in. (v) Controls: Those considered in column (4) of Table 4.

Statistical discrimination Statistical discrimination means that African immigrants would be, on average, worse tenants. They might cause greater maintenance costs or their probability of rent default may be higher because they occupy less protected jobs. Statistical discrimination is not an issue for our test strategy if both types of landlords react similarly to this situation. However, there are two reasons why they may actually behave differently.

The test strategy is not robust to omitted externalities at the building level. If unobservable characteristics correlated with origin make African tenants more likely to cause damage to shared amenities in the building, building landlords will be more likely to internalize this externality, regardless of tenants' prejudice. Africans are actually more likely to report having witnessed vandalism against the common parts of the building (25% of them against 16% for the rest of the tenant population). Interestingly, this statement is not robust to the control of indi-

[14]The difference is significant at the 1% confidence level.

vidual and apartment characteristics (not reported here). Nevertheless, the raw correlation may induce false beliefs, whereby Africans are more likely to deteriorate the shared amenities. In turn, building landlords would respond to such beliefs by discriminating more. This possibility is partly taken into account in column (2) of Table 9, where we control for whether the tenant witnessed such property damage.

As for the probability of rent default, building landlords, who dispose of a greater information set, may be more likely to know the differences in default risk between the different groups of tenants. If, in addition, unobserved characteristics correlated with ethnicity make African immigrants more likely to default on rent, this omitted variable may jeopardize our test strategy.[15] In the ENL, tenants are asked if they have had difficulty paying the rent over the past two years. The answer can be considered as a good proxy for default risk. African immigrants are, indeed, more likely to default on rent. The unconditional probability for African immigrants of answering "yes" to this question is twice as high as for the rest of the population of tenants (29% against 13%) and the gap does not fully close when controlling for household observed characteristics, such as current income.[16] To rule out this statistical discrimination story, column (3) of Table 9 therefore controls for the default variable.

Intermediated search One last possible issue involves differences in the marketing process for both types of landlords. For example, dwelling landlords may be more likely to use non-standardized advertising, where social networks help applicants be notified of a new vacancy. If, simultaneously, African applicants are more likely to mobilize social networks when they search, they will more often be matched with dwelling landlords. The model assumes that search is not intermediated, or that intermediaries play the same role for both types of landlords and both types of applicants. If the matching rate η were no longer homogeneous across all applicant-landlord pairs, this might lead to prediction 1 even when $\alpha = 0$.

The ENL provides information on the way private tenants have heard about the dwelling they currently occupy. However, this piece of information is only available for those who have moved in less than four years ago. It appears that African applicants do mobilize social networks more frequently: on average during the decade 1996-2006, 52% of African private tenants who had recently moved into a new apartment had heard about it from a friend or a relative, while this was only the case for 32% of the other private tenants in apartments. However, building landlords also seem to benefit substantially from such informal networks. If anything, they benefit from them even more than dwelling landlords, since, among all the tenants who had recently moved into their apartment, 45% of those with a building landlord had heard about their apartment from a friend or a relative, while this was only the case for 26% of the tenants facing a dwelling landlord. Column (4) in Table 9 focuses on this sample of tenants who moved in less than four years ago. It shows that controlling for the nature of the information channel does not

[15]This argument is actually rather weak. There is another effect at work: building landlords are more experienced landlords. They can more easily detect whether the individual is a high-default risk. They would statistically discriminate less often as a result.

[16]Part of the explanation probably stems from a higher volatility in earnings for this population, as shown in Decreuse and Schmutz (2012) for African immigrants.

affect the estimates. Finally, controlling for these four matters of concern simultaneously does not impact the coefficients either (column (5)).

2.4 Indirect test: the macroeconomic consequences of neighbor discrimination

So far, the results presented in section 2 strongly suggest that the null hypothesis whereby African immigrants are equally likely to contract with a building landlord can be rejected. Even though we provide several pieces of evidence supporting the idea that none of the identifying assumptions of the model is directly violated, this strategy is only valid to the extent we know enough about the landlords. This is the limit of the direct test of Prediction 1. However, while unobservable differences correlated with landlord type may still drive this microeconomic result, we believe that they are less likely to impact macroeconomic patterns regarding the segmentation of the rental market faced by African immigrants.

In this section, we show that the probability to live in public housing for African tenants is positively correlated with the local proportion of privately-rented apartments owned by building landlords, while this correlation does not stand for French-born and non-African tenants. Under the assumption that the conditional probability of living in public housing reflects a lack of access to the private housing market, this result is interpreted as additional evidence of the presence of neighbor discrimintion in the French private rental market.

Public housing as a mirror of discrimination In France, public housing is a very large and old public program that dates back to the 1920s. Publicly-subsidized, rent-controlled housing units represent 40% of the rental market, 15% of the total stock of main homes. It is generally denoted by the acronym HLM, which stands for *Habitations à Loyer Modéré*. Even if the HLM constellation is very diverse, in terms of quality, location and inhabitants, a large part of the HLM supply is located in derelict, suburban areas, which have become ethnic ghettos along the past thirty-five years (Laferrère and LeBlanc 2006). African immigrants are notably over-represented in the HLM complex and after controlling for differences in socioeconomic characteristics, the gap narrows but remains high (Fougère, Kramarz, Rathelot, and Safi 2013).

We argue that the over-representation of African immigrants in public housing partly reflects customer discrimination on the private housing market. People make residential choices, even HLM tenants. Notably, they choose whether trying to rent a place in the private market, or staying in HLM. Each option has expected gains net of costs, and individuals compare the gains attached to each option prior to selecting one of them. Discrimination in the private rental market alters residential choices through two effects. First, if some groups of HLM tenants are barred from some segments of the private rental market, they will need more time to find a place, hence they will automatically stay longer in HLM. This is the buffer stock effect. Second, the value of search in the private rental market is lower, which deters HLM tenants from even trying their luck. This is the discouragement effect.

Customer discrimination follows this general logic. If more neighbors are prejudiced, landlords are more likely to reject Black applicants, and this in turn increases the proportion of Blacks residing in HLM. However, unlike other forms of discrimination, the intensity of customer dis-

crimination should increase with the market size owned by building landlords. This provides another test of customer discrimination, which complements the first one in a natural way. Appendix D provides a more formal argument. It builds on the main lessons of the model in Section 1 to understand how customer discrimination affects the ethnic-specific proportions in HLM. This model as well as the previous reasoning lead to Prediction 2:

Prediction 2 CONSEQUENCES OF CUSTOMER DISCRIMINATION *In a given local housing market, the proportion of building landlords increases the probability that Black tenants live in HLM only if there is customer discrimination in the private rental market.*

Prediction 2 can be tested empirically using the same data as in Section 2. Prediction 1 examines how customer discrimination alters the assignment of tenants to dwelling type. Prediction 2 goes one step further and states how the composition of the rental market by dwelling type affects the percentage of Blacks in public housing.

Empirical strategy We focus on the sample of tenants i in the public and private markets. Each tenant lives in département $d(i)$, which we regard as a local housing market. Continental France is divided between 94 départements. Each département is characterized by a fraction of building landlords $Share_d$. The purpose of this Section is to examine the empirical impact of $Share_d$ on the difference in the net probability to live in public housing between French, African immigrants and non-African immigrants.

We use a two-step strategy. In the first step, we regress individual housing market outcomes (whether the tenant lives in public housing or not) on a (i) a dummy variable for African immigrants and a dummy variable for non-African immigrants, A_i and NA_i respectively, (ii) a set of individual characteristics, X_i, (iii) départements fixed effects, $\phi^F_{d(i)}$, and (iv) ethnic-specific département fixed effects (i.e., interaction variables between départements dummies and the two ethnic dummies for African and non-African immigrants).[17] In the second step, we regress the three sets of estimated ethnic-specific départements fixed effects on $Share_d$ and a set of département control variables, X_d.

First step. The first-step specification can be written as:

$$u_i^* = \beta_0 + \sum_{e=A,NA} \beta_1^e e_i + X_i\beta_2 + \phi^F_{d(i)} + \sum_{e=A,NA} \phi^e_{d(i)} \times e_i + \epsilon_i \tag{13}$$

where u_i^* is a latent variable that captures the probability of living in HLM for a given tenant i and ϵ_i is a mean-zero stochastic component representing the influence of omitted variables. The ethnic-specific département fixed effects, ϕ^A_d and ϕ^{NA}_d for African and non-African immigrants respectively, correspond to estimates of the residual ethnic HLM gap in each département. Such estimates are adjusted for département factors that affect HLM access for the three groups in a similar way and for ethnic differences in individual characteristics. To get consistent estimates for fixed effects, we use a linear probability model in this first step.

[17] For identification, département dummies exclude one location.

Second step. The second step takes place at the département level. The estimated ethnic-specific département fixed effects, $\widehat{\phi}^e_{d(i)}$ for $e = F, A, NA$, are successively used as the dependent variable. The département share of building landlords, $Share_d$, is the main independent variable of interest. We also consider a large number of département control variables, X_d.

The second-step specifications can be written as follows. For $e = F, A, NA$,

$$\hat{\phi}^e_d = \gamma^e_0 + \gamma^e_1 Share_d + X_d\gamma^e_3 + \varepsilon^e_d, \tag{14}$$

where ε^e_d is a mean-zero stochastic random term representing the influence of omitted variables. Prediction 2 is tested by assessing for which ethnic group γ^e_1 is significantly positive. According to our theory, ethnic discrimination implies $\gamma^F_1 = 0$ and $0 \leq \gamma^{NA}_1 \leq \gamma^A_1$.

Because the dependent variable is estimated in the first step, it is affected by measurement error, for which we have an estimate of the standard error. This measurement error must be accounted for in the second-step estimation. Therefore, each observation is weighted by the inverse sampling variance of $\hat{\phi}^e_d$, as proposed by Card and Krueger (1992). This strategy has been used in a variety of contexts, especially on the labor market. The two closest papers to our are Charles and Guryan (2008), who use it to assess the impact of state-wide racial prejudice on Black/White wage differentials in the US and Combes, Decreuse, Laouénan, and Trannoy (2016) who use it to assess the impact of the share of jobs in contact with customers and the proportion of non-immigrants, at the employment area level, on the unemployment gap between African immigrants and non-immigrants in France.[18]

Results *First step*— Table E1 in Appendix E displays the estimation results of increasingly complex specifications of an equation of the probability of living in HLM. The first column shows that the unconditional probability that tenants live in HLM is 21.5% higher for African immigrants, whereas it is only 3.5% higher for non-African immigrants. Once controlled for individual characteristics, this gap narrows to 11% for African immigrants and 2% for non-African immigratns (column (2)). In column (3), where we control for département fixed effects, the gap is reduced to 9%, which shows that space, as a whole, plays a significant role in explaining this gap. Finally, when we control for ethnic-specific département fixed effects, as shown in column (5), the average effect of being an African immigrant goes into these ethnic-specific location effects. This last specification corresponds to the one we use to compute the fixed effects that are taken as dependent variable in the second step.

Second step— Table 10 displays the estimation results of the second step, with an increasingly complete set of local controls. In Columns (1) to (3), no local control is included. The impact of building landlords on the effect of being French or of non-African origin are close to zero and imprecisely estimated, whereas this impact for African is equal to 0.38 and is precisely estimated. The R^2 confirm this difference since they are close to zero for French-born and non-African immigrants, and equal to 10% for African immigrants.

[18] Alternatively, one can use feasible generalised least squares to address this issue, as proposed by Combes, Duranton, and Gobillon (2008), who assess the importance of local determinants of spatial wage disparities. This leaves the results virtually unaffected.

Table 10: Second step estimation results

	F (1)	A (2)	NA (3)	F (4)	A (5)	NA (6)	F (7)	A (8)	NA (9)
$SHARE$	-0.055	0.384***	0.084	-0.072	0.353***	0.050	-0.050	0.355**	-0.003
	(0.112)	(0.109)	(0.198)	(0.0749)	(0.104)	(0.242)	(0.0591)	(0.159)	(0.317)
Region FE				X	X	X	X	X	X
Controls							X	X	X
Nb observations	92	90	90	92	90	90	92	90	90
R-squared	0.007	0.107	0.005	0.657	0.416	0.419	0.828	0.526	0.595

Notes: (i) The dependent variable corresponds to $\hat{\phi}_d^F$ in columns (1), (4), and (7); to $\hat{\phi}_d^A$ in columns (2), (5), and (8); and to $\hat{\phi}_d^{NA}$ in columns (3), (6), and (9); (ii) Right-hand side variables are estimated using a linear probability model in the first step; (iii) Weighted least squares regressions using the inverse of estimated variance of coefficients from first-step regression displayed in column (4) of Table E1; (iv) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10%; (v) Controls: proportion of HLM in total housing stock, total population, proportion of HLM built before 1960, proportion of HLM built between 1960 and 1972, short-run vacancy rate in HLM (less than three months), long-run vacancy rate in HLM (more than three months), yearly mobility rate in HLM, unemployment rate, proportion of immigrants in total population, proportion of immigrants in HLM population, proportion of single-headed families, proportion of families with at least three children; (vi) 20 region fixed effects are included in columns (4)-(9).

In order to make sure that this result is not driven by other local determinants, we first include region fixed effects in the second-stage regression. There are 21 regions in continental France. The results are presented in columns (4) to (6). Estimated values of γ_1^e are virtually unaffected by this set of controls, even though the R^2 jumps from 0 to respectively 66% and 41% for the regressions on French-born and non-African immigrants, and from 10% to 41% for the regression on African immigrants.

Finally, in columns (7) to (9), the regressions are estimated again controlling for two rich sets of département characteristics. These characteristics are meant to proxy HLM supply and demand factors that may be spuriously correlated with the local share of mutiple-dwelling landlords in départements where African immigrants are particularly over-represented in HLM. The quantity of the HLM supply is measured as the share of HLM in total housing stock, as measured in the 1990 Census. The quality of the HLM supply is proxied by the age structure of the HLMs. In particular, we control for the share of HLMs that were built between 1960 and 1972.[19] The next two control variables, short-run and long-run vacancy rate in HLMs, are indicators of tension on the public housing market. They combine supply-side and demand-side determinants: for example, if the vacancy rate is low, it may be because local HLMs are particularly attractive, or because people are particularly in need of alternative housing solutions. However, the distinction between short-run and long-run vacancy allows us to decompose these various effects a bit further. In particular, a high long-run vacancy rate is very likely to indicate that the local supply of HLMs is particularly unattractive.[20]

[19]Facing an acute housing shortage, this period witnessed a boom in HLM construction and HLMs built at that time were likely to be located in remote urban fringes. Moreover, due to time and public-finance constraints, most of these HLMs were made of cheap materials and many have quickly deteriorated.

[20]These variables on vacancy and construction come from a survey called "Enquête Parc Locatif Social" (Survey

The other five controls are demand-side characteristics. The unemployment rate, the rate of single-headed households and the share of families of three or more children are proxies of the fraction of the population the most in need of public housing; high proportions of immigrants in the total population may indicate that these groups are better integrated in the département. Finally, the proportion of immigrants within the population of HLM tenants is used to proxy two competiting phenomena: first, the competition effect in public housing access; second, the magnetic effect through agglomerating ethnic networks.[21] Once again, the results are virtually unaffected by the inclusion of these controls, even though the R^2 significantly increases in each of the three regressions.

3 Conclusion

The nature of the links between discrimination and urban patterns has long been argued about. However, most works on the subject miss the role played by the structure of real estate ownership, although it is a key background factor for apprehending the diversity of urban patterns. This paper is an attempt to illustrate why housing ownership structure matters, both theoretically and empirically. We construct a matching model with ethnic externalities where landlords are heterogenous with respect to the number of housing units they own within the same neighborhood. Regardless of their own preferences, landlords who own several units are more likely to discriminate against ethnic minorities if these minorities are subject to the prejudice of a fraction of the majority tenant population. The direct consequence of this prediction is then tested on French survey data. We focus on a sample of tenants in the private market. We show that first-generation immigrants of African origin who live in privately-rented apartments are less likely to have a landlord who owns the entire building. Moreover, they are more likely to live in public housing when the private rental market is more composed of landlords who own entire buildings. Our results suggest the existence of customer-based discriminatory practices against immigrants of African origin on the French housing market.

The main contribution of this paper is to provide a way to test for neighbor discrimination by distinguishing between dwelling landlords and building landlords. This general idea can be declined in a number of effective tests. We choose to use survey data where tenants' and apartments' characteristics are well-documented, whereas the owners' are not. Thus the identification strategy holds to the extent that landlords do not much differ in discriminatory attitudes and unobserved heterogeneity in dwellings' characteristics is not a strong concern. Of course, having data on landlords, or having data on similar landlords who own different estate portfolios in different buildings would be of considerable interest. The recent literature on field and laboratory experiments also offers a number of ideas to run a test different in form but similar in principle. This calls for additional empirical research to confirm our findings.

In France, housing market discrimination may partly explain why African immigrants, and especially African immigrants, remain stuck in public housing. These persons cannot easily take

on the Public Housing Market) which was led by public authorities in accordance with local public housing agencies. We use the 1996 wave of this survey.

[21] These five latter variables all come from the 1990 Census.

advantage of employment opportunities when such opportunities are located in another city or region. They thus suffer from a situation of regional spatial mismatch, which may account for part of their much higher unemployment rate (Combes, Decreuse, Laouénan, and Trannoy 2016). If this is the case, the social consequences of housing market discrimination can therefore be so negative that they justify the intervention of policymakers. It remains an avenue for further research to think about the best tools of such an intervention.

Finally, the theory of neighbor discrimination we put forward in this paper could in fact apply to a variety of settings, in other consumer markets, such as lunch counters or package tours, in effect to any good which may only be consumed in company with other consumers, a situation of co-consuming. This paper can be viewed as a first step toward a more general study of co-customer discrimination.

References

AEBERHARDT, R., D. FOUGERE, J. POUGET, AND R. RATHELOT (2010): "Wages and employment of French workers with African origin," *Journal of Population Economics*, 23(3), 881–905.

AHMED, A. M., AND M. HAMMARSTEDT (2008): "Discrimination in the rental housing market: A field experiment on the Internet," *Journal of Urban Economics*, 64(2), 362–372.

ALBRECHT, J., A. ANDERSON, E. SMITH, AND S. VROMAN (2007): "Opportunistic Matching In The Housing Market," *International Economic Review*, 48(2), 641–664.

ALBRECHT, J., P. A. GAUTIER, AND S. VROMAN (2015): "Directed Search in the Housing Market," *Review of Economic Dynamics*.

ANWAR, S., AND H. FANG (2006): "An Alternative Test of Racial Prejudice in Motor Vehicle Searches: Theory and Evidence," *American Economic Review*, 96(1), 127–151.

BECKER, G. (1957): *The economics of discrimination*. University of Chicago Press.

BESSIÈRE, S., AND A. LAFERRÈRE (2002): "La copropriété en forte progression," *Données Sociales*, pp. 475–486.

BLACK, D. A. (1995): "Discrimination in an Equilibrium Search Model," *Journal of Labor Economics*, 13(2), 309–33.

BORJAS, G. J., AND S. G. BRONARS (1989): "Consumer Discrimination and Self-employment," *Journal of Political Economy*, 97(3), 581–605.

BOWLUS, A. J., AND Z. ECKSTEIN (2002): "Discrimination and Skill Differences in an Equilibrium Search Model," *International Economic Review*, 43(4), 1309–1345.

BÉLANGER, E., R. NADEAU, M. TURGEON, M. S. LEWIS-BECK, AND M. FOUCAULT (2014): "Patrimony and French presidential vote choice: Evidence from the 2012 election," *French Politics*, 12, 59–68.

CARD, D., AND A. B. KRUEGER (1992): "Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States," *Journal of Political Economy*, 100(1), 1–40.

CARRILLO, P. E. (2012): "An Empirical Stationary Equilibrium Search Model Of The Housing Market," *International Economic Review*, 53(1), 203–234.

CHARLES, K. K., AND J. GURYAN (2008): "Prejudice and Wages: An Empirical Assessment of Becker's The Economics of Discrimination," *Journal of Political Economy*, 116(5), 773–809.

CNDH (2013): *La lutte contre le racisme, l'antisémitisme et la xénophobie*. La documentation française.

COMBES, P.-P., B. DECREUSE, M. LAOUÉNAN, AND A. TRANNOY (2016): "Customer Discrimination and Employment Outcomes: Theory and Evidence from the French Labor market," *Journal of Labor Economics*, 34(1).

COMBES, P.-P., G. DURANTON, AND L. GOBILLON (2008): "Spatial wage disparities: Sorting matters!," *Journal of Urban Economics*, 63(2), 723–742.

DECREUSE, B., AND B. SCHMUTZ (2012): "Residential mobility and unemployment of African immigrants in France: a calibration approach," *Annales d'Economie et de Statistique/Annals of Economics and Statistics*, 107-108, 51–92.

DÍAZ, A., AND B. JEREZ (2013): "HOUSE PRICES, SALES, AND TIME ON THE MARKET: A SEARCH?THEORETIC FRAMEWORK," *International Economic Review*, 54, 837–872.

ELLEN, I. (2000): *Sharing America's neighborhoods*. Harvard University Press.

FARLEY, R., C. STEEH, M. KRYSAN, T. JACKSON, AND K. REEVES (1994): "Stereotypes and segregation: neighborhoods in the Detroit Area," *American Journal of Sociology*, 100(3), 750–780.

FOUGÈRE, D., F. KRAMARZ, R. RATHELOT, AND M. SAFI (2013): "Social housing and location choices of immigrants in France," *International Journal of Manpower*, forthcoming.

GENESOVE, D., AND L. HAN (2012): "Search and matching in the housing market," *Journal of Urban Economics*, 72(1), 31–45.

GOBILLON, L., P. RUPERT, AND E. WASMER (2014): "Ethnic unemployment rates and frictional markets," *Journal of Urban Economics*, 79(C), 108–120.

HANSON, A., AND Z. HAWLEY (2011): "Do Landlords Discriminate in the Rental Housing Market? Evidence from an Internet Field Experiment in U.S. Cities," *Journal of Urban Economics*, 70(2-3), 99–114.

HOLZER, H. J., AND K. R. IHLANFELDT (1998): "Customer Discrimination And Employment Outcomes For Minority Workers," *The Quarterly Journal of Economics*, 113(3), 835–867.

KING, A. T., AND P. MIESZKOWSKI (1973): "Racial Discrimination, Segregation, and the Price of Housing," *Journal of Political Economy*, 81(3), 590–606.

KNOWLES, J., N. PERSICO, AND P. TODD (2001): "Racial Bias in Motor Vehicle Searches: Theory and Evidence," *Journal of Political Economy*, 109(1), 203–232.

LAFERRÈRE, A., AND D. LEBLANC (2006): "Housing policy: low-income households in France," in *A Companion to Urban Economics*, ed. by R. J. Arnott, and D. P. McMillen, pp. 159–178. Blackwell, Oxford.

LANG, K. (2007): *Poverty and discrimination*. Princeton University Press.

LANG, K., M. MANOVE, AND W. T. DICKENS (2005): "Racial Discrimination in Labor Markets with Posted Wage Offers," *American Economic Review*, 95(4), 1327–1340.

NARDINELLI, C., AND C. SIMON (1990): "Customer Racial Discrimination in the Market for Memorabilia: The Case of Baseball," *The Quarterly Journal of Economics*, 105(3), 575–95.

NGAI, L. R., AND S. TENREYRO (2014): "Hot and Cold Seasons in the Housing Market," *American Economic Review*, 104(12), 3991–4026.

ONDRICH, J., A. STRICKER, AND J. YINGER (1999): "Do Landlords Discriminate? The Incidence and Causes of Racial Discrimination in Rental Housing Markets," *Journal of Housing Economics*, 8(3), 185–204.

PAN-KÉ-SHON, J.-L. (2010): "The Ambivalent Nature of Ethnic Segregation in France's Disadvantaged Neighbourhoods," *Urban Studies*, 47(8), 1603–1623.

PERSICO, N. (2009): "Racial Profiling? Detecting Bias Using Statistical Evidence," *Annual Review of Economics*, 1(1), 229–254.

PIKETTY, T. (2014): *Capital in the twenty-first century*. Harvard University Press.

PIKETTY, T., G. POSTEL-VINAY, AND J.-L. ROSENTHAL (2014): "Inherited vs self-made wealth: Theory & evidence from a rentier society (Paris 1872?1927)," *Explorations in Economic History*, 51(C), 21–40.

RAPKIN, C. (1966): "Price discrimination against negroes in the rental housing market," in *Essays in Urban Land Economics – In honor of Leo Grebler*, ed. by L. Burns, and J. Gillies, pp. 333–345. University of California, Los Angeles.

ROSEN, A. (2003): "Search, Bargaining, and Employer Discrimination," *Journal of Labor Economics*, 21(4), 807–830.

SASAKI, M. (1999): "An Equilibrium Search Model with Coworker Discrimination," *Journal of Labor Economics*, 17(2), 377–407.

WHEATON, W. C. (1990): "Vacancy, Search, and Prices in a Housing Market Matching Model," *Journal of Political Economy*, 98(6), 1270–92.

YINGER, J. (1986): "Measuring discrimination with fair housing audits: caught in the act," *American Economic Review*, 76(5), 881–893.

——— (1997): "Cash in Your Face: The Cost of Racial and Ethnic Discrimination in Housing," *Journal of Urban Economics*, 42(3), 339–365.

ZHAO, B., J. ONDRICH, AND J. YINGER (2006): "Why do real estate brokers continue to discriminate? Evidence from the 2000 Housing Discrimination Study," *Journal of Urban Economics*, 59(3), 394–419.

A Proofs

Proof of Proposition 1

The result can be easily inferred from the limit properties of system (1)–(4) when α tends to 0.

Proof of Proposition 2

We solve system (1)–(4) for a given vector $\beta = (\beta_v, \beta_w, \beta_b)$. For $k = w, b$ and $l = v, w, b$, we obtain

$$r\Pi^{kl} = R_k, \tag{15}$$

$$\begin{aligned} r\Pi^{vb} &= \eta \frac{(1-p)\,\beta_b R_b + p\,(1-\alpha)\,R_w}{r + \eta\,[(1-p)\,\beta_b + p\,(1-\alpha)]} && (16)\\ r\Pi^{vw} &= \eta \frac{(1-p)\,\beta_w R_b + pR_w}{r + \eta\,[(1-p)\,\beta_w + p]} && (17)\\ r\Pi^{vv} &= \eta \frac{X_b R_b + X_w R_w}{\{r + \eta\,[(1-p)\,\beta_b + p\,(1-\alpha)]\}\,\{r + 2\eta\,[(1-p)\,\beta_v + p]\}} && (18) \end{aligned}$$

where:

$$\begin{aligned} X_b &= (1-p)\left\{ \begin{array}{c} r^2\beta_v + r\eta\,[\beta_v\,(1-p)\,(2\beta_b + \beta_w) + p\,(3-\alpha)] \\ +\eta^2\,[\beta_v\,(2\,(1-p)\,\beta_b + p\,(1-\alpha))\,(\beta_w\,(1-p) + p) + p\beta_w\,(\beta_b\,(1-p) + p\,(1-\alpha))] \end{array} \right\} \\ X_w &= p\left\{ \begin{array}{c} r^2 + r\eta\,[(1-p)\,(\beta_v\,(1-\alpha) + \beta_b + \beta_w) + p\,(3-\alpha)] \\ +\eta^2\,[\beta_v\,(1-\alpha)\,(1-p)\,((1-p)\,\beta_w + p) + (\beta_b\,(1-p) + p\,(1-\alpha))\,(2p + (1-p)\,\beta_w)] \end{array} \right\} \end{aligned}$$

Step 1. $\beta_b^* = \hat{\beta}_b = 0$ *if and only if* $R_b/R_w < \sigma_b$, *and* $\beta_w^* = \hat{\beta}_w = 0$ *if and only if* $R_b/R_w < \sigma_w$.

We have:

$$\Pi^{bb} - \Pi^{vb} = \Pi^{bb} - \Pi^{vb} - \left(\Pi^{bv} - \Pi^{bb}\right) = \frac{rR_b - (1-\alpha)\,p\eta\,(R_w - R_b)}{r\,[r + \eta\,((1-p)\,\beta_b + p\,(1-\alpha))]}. \tag{19}$$

This implies:

$$\Pi^{bb} - \Pi^{vb} < 0 \Leftrightarrow \Pi^{bb} - \Pi^{vb} < \Pi^{bv} - \Pi^{bb} \Longleftrightarrow R_b/R_w < \sigma_b = \frac{\eta\,(1-\alpha)\,p}{r + \eta\,(1-\alpha)\,p}. \tag{20}$$

We also have:

$$\Pi^{bw} - \Pi^{vw} = \Pi^{bw} - \Pi^{vw} - \left(\Pi^{wv} - \Pi^{wb}\right) = \frac{rR_b - p\eta\,(R_w - R_b)}{r\,[r + \eta\,((1-p)\,\beta_w + p)]}. \tag{21}$$

This yields:

$$\Pi^{bw} - \Pi^{vw} < 0 \Leftrightarrow \Pi^{bw} - \Pi^{vw} < \Pi^{wv} - \Pi^{wb} \Longleftrightarrow R_b/R_w < \sigma_w = \frac{\eta p}{r + \eta p}. \tag{22}$$

Step 2. $\beta_v^* = \hat{\beta}_v = 0$ *if* $R_b/R_w < \sigma_b$.

Assume that $R_b/R_w < \sigma_b$. From Step 1, $\beta_i^* = \hat{\beta}_i = 0$, $i = b, w$. Suppose that $\beta_b^* = 0$. Under this condition, we obtain:

$$\Pi^{bv} - \Pi^{vv} = \frac{(r + p\eta) R_b - p\eta R_w}{r(r + p\eta)}. \tag{23}$$

It is negative whenever $R_b/R_w < \sigma_w$, which is true by assumption.

Conversely, suppose that $\beta_v^* = 1$. Under this condition, we obtain:

$$\begin{aligned} \Pi^{bv} - \Pi^{vv} &= \frac{(r + p\eta)(r + \eta + p\eta)(r + (1-\alpha)p\eta)}{r(r + 2\eta)(r + p\eta)(r + (1-\alpha)p\eta)} R_b \\ &\quad - \frac{p\eta\left[r^2 + r\eta(1 - \alpha + 2p) + \eta^2(1-\alpha)p(1+p)\right]}{r(r + 2\eta)(r + p\eta)(r + (1-\alpha)p\eta)} R_w. \end{aligned} \tag{24}$$

It is positive if and only if $R_b/R_w > \frac{p\eta\left[r^2 + r\eta(1-\alpha+2p) + \eta^2(1-\alpha)p(1+p)\right]}{(r+p\eta)(r+\eta+p\eta)(r+(1-\alpha)p\eta)} > \sigma_b$, which is impossible. A similar reasoning gives $\hat{\beta}_v = 0$ if $R_b/R_w < \sigma_b$.

Step 3. $\beta_v^* = 0$ *if* $R_w/R_b \in [\sigma_b, \sigma_{1v})$, *and* $\beta_v^* = 0$ *or* $\beta_v^* = 1$ *if* $R_w/R_b \in [\sigma_{1v}, \sigma_w)$

Assume that $R_b/R_w \in [\sigma_b, \sigma_w)$. From Step 1, $\beta_b^* = 1$, whereas $\beta_w^* = 0$. Suppose $\beta_v^* = 0$. Under this condition, we obtain

$$\Pi^{bv} - \Pi^{vv} = \frac{(r + p\eta) R_b - p\eta R_w}{r(r + p\eta)}. \tag{25}$$

It is negative if and only if $R_b/R_w < \sigma_w$, which is true by assumption.

Alternatively, suppose $\beta_v^* = 1$. Under this condition, we find that $\Pi^{bv} - \Pi^{vv} \geq 0$ if and only if $R_b/R_w > \sigma_{1v} \in (\sigma_b, \sigma_w)$.

Step 4. $\beta_v^* = 0$ *if* $R_b/R_w \geq \sigma_w$

Assume that $R_b/R_w \geq \sigma_w$. From Step 1, $\beta_b^* = \beta_w^* = 1$. Suppose $\beta_v^* = 0$. Under this condition, we find $\Pi^{bv} - \Pi^{vv} < 0$ if and only if $R_b/R_w < \sigma_w$, which is impossible.

Conversely, suppose $\beta_v^* = 1$. Under this condition, we find $\Pi^{bv} - \Pi^{vv} \geq 0$ if and only if

$$R_b/R_w \geq \frac{p\eta(r^2 + (3-\alpha)r\eta + (2 - \alpha - \alpha p^2)\eta^2)}{r^3 + (3 + (1-\alpha)p)r^2\eta + (2 + p(3 - \alpha(2+p)))r\eta^2 + p(2 - \alpha - \alpha p^2)\eta^3}.$$

Let us call A the right-hand side term of this inequality. We have $A - \sigma_w$ is equal to

$$\frac{(-1+p)r\eta(r+\eta)}{(r + p\eta)(r^3 + (3 + p - \alpha p)r^2\eta + (2 - p(-3 + \alpha(2+p)))r\eta^2 - p(-2 + \alpha + \alpha p^2)\eta^3)} < 0$$

Step 5. $\hat{\beta}_v = 0$ *if* $R_b/R_w \in [\sigma_b, \sigma_w)$

Assume that $R_b/R_w \in [\sigma_b, \sigma_w)$. From Step 1, $\hat{\beta}_b = 1$ and $\hat{\beta}_w = 0$. Suppose that $\hat{\beta}_v = 0$. Under this condition, we find $\Pi^{bv} - \Pi^{vv} + \Pi^{vb} - \Pi^{vv} < 0$ if and only if

$$\frac{R_b}{R_w} < \sigma_w \frac{(1+\alpha)r + (2-p-ap)\eta}{r + (2-p-ap)\eta},$$

which is true by assumption. Similarly, we can show $\hat{\beta}_v = 1$ if and only if

$$\frac{R_b}{R_w} \geq \sigma_w \frac{(1+\alpha)r + (2-p-ap)\eta}{r + (2-p-ap)\eta}.$$

Step 6. $\widehat{\beta}_v = 0$ *if* $R_b/R_w \in [\sigma_w, \sigma_{2v})$ *and* $\widehat{\beta}_v = 1$ *if* $R_b/R_w \geq \sigma_{2v}$

Assume that $R_b/R_w \in [\sigma_w, \sigma_{2v})$. From Step 1, $\hat{\beta}_b = \hat{\beta}_w = 1$. Suppose that $\hat{\beta}_v = 0$. Under this condition, we find $\Pi^{bv} - \Pi^{vv} + \Pi^{vb} - \Pi^{vv} < 0$ if and only if $R_w/R_b < \sigma_{2v}$.

Step 7 (conclusion). Parts (i) to (v) follow from Steps 1 to 6.

Proof of Proposition 3

Part (i). When $\alpha = 0$, we have $\Pi^{ij}(\beta, \bar{\beta}) = \Pi^{ik}(\beta, \tilde{\beta})$ for all $j, k = v, w, b$ and all $(\beta, \bar{\beta}, \tilde{\beta}) \in B^3$. Dwellings' values no longer depend on the occupancy status of the other dwelling. Thus, we have

$$\arg\max_{\beta \in B} \Pi_2(\beta, \beta) = \arg\max_{\beta \in B} \Pi_1(\beta, .) = \arg\max_{\beta \in B} \Pi(\beta, .). \tag{26}$$

In addition, it becomes unnecessary to distinguish β_b from β_w and β_v.

To find the equilibrium, we define $(\tilde{\Pi}^b, \tilde{\Pi}^w, \tilde{\Pi}^v)$ such that, for $i = w, b$, we have

$$r\tilde{\Pi}^i = R_i + q(\tilde{\Pi}^v - \tilde{\Pi}^i), \tag{27}$$

$$r\tilde{\Pi}^v = \eta p(\tilde{\Pi}^w - \tilde{\Pi}^v) + \eta(1-p)\beta_b(\tilde{\Pi}^b - \tilde{\Pi}^v). \tag{28}$$

We have $\beta_b^* = 0$ if and only if $\tilde{\Pi}^b(0) < \tilde{\Pi}^v(0)$. Resolution yields $\beta_b^* = 0$ if and only if $R_b/R_w < \eta p/(r + q + \eta p)$.

Part (ii). We solve system (1)–(4) when $\beta = \bar{\beta} = (1, 1, 1)$. We then show that $\Pi^{jv} - \Pi^{jb} \geq 0$ for all $j = v, w, b$. The solving yields:

$$\Pi^{jv} - \Pi^{jb} = \alpha p \eta [(q + r)R_w + \eta(1-p)(R_w - R_b)]N^j/D \tag{29}$$

for all $j = v, w, b$, with $D > 0$ and $N^j > 0$.

Indeed,

$$
\begin{aligned}
D &= \left\{ \begin{array}{l} (q+r)^2 (2q+r) \\ +\eta (q+r) (q(3-\alpha p) + r(2-\alpha p)) \\ +\eta^2 \left(q\left(1-\alpha p^2\right) + r(1-\alpha p)\right) \end{array} \right\} \\
&\quad \times \left\{ \begin{array}{l} (q+r)^2 (2q+r)^2 + \eta (q+r)(2q+r)(q(5-\alpha p) + r(4-\alpha p)) \\ +\eta^2 \left[\begin{array}{c} 4q^2 \left(2(1-\alpha p) + \alpha p^2\right) + r^2 (5-3\alpha p) \\ +qr\left(10(1-\alpha p) + 3\left(1+\alpha p^2\right)\right) \end{array} \right] \\ +2\eta^3 \left[q\left(\alpha (1-p)^2 + (1-\alpha)\right) + r(1-\alpha p)\right] \end{array} \right\} > 0 \\
N^w/q &= \left\{ \begin{array}{l} 4q^3 + (r+\eta)(r+2p\eta)(r+\eta(1-\alpha p)) \\ +q^2 (8r + 2\eta(2 + p(3-\alpha))) \\ +q \left[\begin{array}{c} 5r^2 + r\eta(6 + p(7-3\alpha)) \\ +\eta^2 (1 + p(7 - 2\alpha(1+p))) \end{array} \right] \end{array} \right\} > 0 \\
N^b/q &= \left\{ \begin{array}{l} (q+r)(2q+r)^2 + 2p\eta^3 (1-a) \\ +\eta (2q+r)[q(2 + p(3-\alpha)) + r(2 + p(2-\alpha))] \\ +\eta^2 \left[\begin{array}{c} q(1 + p(5(1-\alpha)) + 2 + \alpha p) \\ +r(1 + p(4 - 3\alpha)) \end{array} \right] \end{array} \right\} > 0 \\
N^v &= \left\{ \begin{array}{l} (q+r)(2q+r)^3 + \eta (2q+r)^2 [q(3 + p(2-\alpha)) + r(3 + p(1-\alpha))] \\ +\eta^2 (2q+r) \left[\begin{array}{c} q(3 + p(3(1-\alpha) + 2 - \alpha p)) \\ r(1 + p(2-\alpha p)) + 2(1-\alpha p) \end{array} \right] \\ +\eta^3 \left[\begin{array}{c} q\left((1-\alpha p) + p\left(3 - \alpha\left(1 + p + p^2\right)\right)\right) \\ +r(1+p)(1-\alpha p) \end{array} \right] \end{array} \right\} > 0
\end{aligned}
$$

Part (iii). We solve system (1)–(4) when $\beta = \bar{\beta} = (0,0,0)$. We then show that $\Pi_1^{jv} - \Pi_1^{jb} \geq 0$ for all $j = v, w, b$. For $j = w, b$, we have

$$\Pi^{jv} - \Pi^{jb} = \frac{\alpha p q \eta R_w}{(q+r)(q+r+p\eta)(2q+r+(1-\alpha)p\eta)} \geq 0. \tag{30}$$

Moreover

$$\Pi^{vv} - \Pi^{vb} = \frac{\alpha p (2q+r) \eta R_w}{(q+r)(q+r+p\eta)(2q+r+(1-\alpha)p\eta)} \geq 0. \tag{31}$$

B The impact of statistical discrimination

Table B1: Equilibrium and efficient strategies as a function of the rent ratio

Panel 1: Equilibrium and efficient strategies when $R_w/R_b = 1$

	$(1,1,1)$	$(1,0,1)$	$(1,0,0)$	$(b,0,0)$	$(0,0,0)$	Total
$(1,1,1)$	77.25%	12.16%	6.16%	0	0	95.57%
$(1,0,1)$	0	0	2.27%	0	0	2.27%
$(1,0,0)$	0	0	2.16%	0	0	2.16%
$(b,0,0)$	0	0	0	0	0	0
$(0,0,0)$	0	0	0	0	0	0
Total	77.25%	12.16%	10.59%	0	0	100%

Panel 2: Equilibrium and efficient strategies when $R_w/R_b = 1.1$

	$(1,1,1)$	$(1,0,1)$	$(1,0,0)$	$(b,0,0)$	$(0,0,0)$	Total
$(1,1,1)$	22.02%	3.52%	2.13%	0	0	27.67%
$(1,0,1)$	0	0	0.78%	0	0	0.78%
$(1,0,0)$	0	0	14.02%	0	10.41%	24.43%
$(b,0,0)$	0	0	0	0	6.01%	6.01%
$(0,0,0)$	0	0	0	0	41.10%	41.10%
Total	22.02%	3.52%	16.93%	0	57.53%	100%

Panel 3: Equilibrium and efficient strategies when $R_w/R_b = 1.2$

	$(1,1,1)$	$(1,0,1)$	$(1,0,0)$	$(b,0,0)$	$(0,0,0)$	Total
$(1,1,1)$	12.34%	1.69%	1.09%	0	0	15.12%
$(1,0,1)$	0	0	0.39%	0	0	0.39%
$(1,0,0)$	0	0	8.60%	0	8.70%	17.30%
$(b,0,0)$	0	0	0	0	7.84%	7.84%
$(0,0,0)$	0	0	0	0	59.35%	59.35%
Total	12.34%	1.69%	10.07%	0	75.90%	100%

Notes: Each column corresponds to a particular efficient strategy $(\hat{\beta}_b, \hat{\beta}_v, \hat{\beta}_w)$, whereas each line corresponds to a particular equilibrium strategy $(\beta_b^*, \beta_v^*, \beta_w^*)$. The number in each cell corresponds to the percentage of our simulations that engender this particular configuration. In case of multiple equilibria, we only consider the most-discriminating equilibrium.

C Descriptive Statistics

Table C1: Tenure status by origin, whole population

	French-born	African	Non-African
Private rental (share)	0.195	0.278	0.215
Apartment (share)	0.368	0.774	0.487
Privately-rented apartment (share)	0.121	0.233	0.161
Nb observations	78,388	4,405	5,239

Note: Sample: All households who had a place of their own in France four years before the survey.

Table C2: Household characteristics by origin, population of interest

	French-born	African	Non-African
Share of women (household head)	0.41	0.24	0.35
Average age (household head)	46.1	45.4	49.7
Middle school degree (household head, share)	0.31	0.17	0.21
High school degree (household head, share)	0.10	0.07	0.07
University degree (household head, share)	0.35	0.24	0.26
Household income by consumption unit (2006 euro)	18,912	12,077	15,701
Household number of persons	1.83	2.76	2.28
Household number of children	0.39	1.09	0.62
Year of arrival in the dwelling	1994	1994	1992
Nb observations	8,710	1,440	989

Note: Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey.

Table C3: Characteristics of the dwelling by landlord type, population of interest

	Building landlord	Dwelling landlord
Number of rooms (logarithm)	0.96	0.83
Size in squared meters (logarithm)	4.06	3.96
Rent per square meter (2006 euro)	7.22	9.63
Balcony (share)	0.29	0.52
Private outdoor space (share)	0.09	0.04
Large bathtub (share)	0.57	0.69
Safety device (share)	0.31	0.41
Parking space (share)	0.28	0.37
Tenant suffers from cold (share)	0.18	0.16
Tenant suffers from noise (share)	0.47	0.45
Landlord is a firm (share)	0.27	0.06
Number of levels in the building	3.16	5.00
Number of apartments in the building	14.2	29.5
Building built between 1949 and 1974 (share)	0.25	0.39
Building built after 1974 (share)	0.19	0.30
Département population (1990 Census)	417,936	494,465
Public housing (1990 Census, département share)	0.15	0.14
Homeowners (1990 Census, département share)	0.51	0.49
Families with at least three children (1990 Census, département share)	0.09	0.08
Nb observations	4287	6769

Note: Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey.

D Theoretical extension

We consider the steady state of a continous-time matching model of the rental market. Tenants differ in ethnicity and in opportunity cost of search for a private rental. Landlords differ in the number of housing units they own, i.e. there are dwelling and building landlords.

The housing market differs from the labor market in that we observe very few persons deprived from housing. Thus people manage to find alternative housing arrangements. In the remaining, public housing acts as a complete safety net: people always have immediate access to a HLM, and HLM tenants cannot be evicted. On the contrary, they have to search for a private rental with no guarantee of success.

A tenant i of ethnic group $e_i = w, b$ has to choose whether to stay in HLM or search for a private rental. Tenants from both ethnic groups are exactly alike, apart from their probability x_e of being accepted by a private landlord whom they have met. Only Blacks may be discriminated against. Consequently, $x_w = 1$. Following Section 1, x_b depends on the probability of meeting a building landlord. We have

$$x_b = (1-\gamma)\left[Share \times \beta_2 + (1 - Share) \times \beta_1\right], \tag{32}$$

where $Share$ is the proportion of building landlords in the local market of privately-rented apartments, γ is the proportion of prejudiced landlords who will always refuse Black applicants, and β_2 (resp. β_1) is the probability for a Black applicant to be accepted by a building (resp. dwelling) landlord, given that this landlord is unprejudiced. Customer discrimination implies that building landlords discriminate at least as much as dwelling landlords. Thus $\beta_1 \geq \beta_2$.

The instant utility people derive from living in HLM is normalized to zero. We let a be the corresponding utility in a private rental, which accounts for the price differential with HLM and better amenities. The search cost is c. The ratio c/a is individual-specific and follows the type-independent distribution Ψ.

Meeting occurs at rate μ. Private tenants are never secured in their dwelling. With rate q they have to depart and go back to a HLM. Finally, r is the discount rate.

The expected utility derived from living in a HLM is U_e^{HLM}, whereas U_e^{PR} is the utility derived from living in a private rental. We have:

$$rU_e^{HLM} = \max\left\{0, -c + \mu x_i \left[U_e^{PR} - U_e^{HLM}\right]\right\}, \tag{33}$$

$$rU_e^{PR} = a + q\left[U_e^{HLM} - U_e^{PR}\right]. \tag{34}$$

Solving for (33) and (34), one gets that an HLM tenant enters search if and only if $c/a \leq \theta_e \equiv \mu x_e/(r+q)$. It follows that the proportion of HLM tenants ready to enter search is equal to $\Psi(\theta_e)$.

Let HLM_e be the long-run type-e tenant's probability of living in HLM. At each instant $q(1 - HLM_e)$ persons enter the HLM sector, and $\mu x_e \Psi(\theta_e) HLM_e$ leave it to live in a private rental. In steady state,

$$HLM_e = \frac{q}{q + \mu x_e \Psi(\theta_e)}. \tag{35}$$

Since the probability of being discriminated against is simply equal to $1 - x_e$, the expression $\mu x_e \Psi(\theta_e)$ captures both the buffer stock and the discouragement effects of discrimination. On the one hand, discrimination reduces the rate μx_e at which searching persons obtain private rentals. On the other hand, it reduces the proportion $\Psi(\theta_e)$ of people who search such dwellings. Thus discrimination implies that Blacks are more likely to live in HLM than the rest of the population.

We now examine the effect of the proportion of building landlords $Share$ on the HLM probability gap between Blacks and Whites $\Delta_{b,w} \equiv HLM_b - HLM_w$. This effect is given by

$$\begin{aligned} \frac{d\Delta_{b,w}}{dShare} &= \frac{dHLM_b}{dx_b} \times \frac{dx_b}{dShare} \\ &= (HLM_b)^2 \frac{\mu\Psi(\theta_b)}{q} [1 + \varepsilon(\theta_b)] (1 - \gamma) (\beta_1 - \beta_2) \geq 0, \end{aligned} \tag{36}$$

where $\varepsilon(t) \equiv t \times \Psi'(t) / \Psi(t)$.

Therefore this effect is positive if and only if building landlords discriminate more than dwelling landlords. This phenomenon only arises when there is customer discrimination in the rental market. This reasoning leads to the additional test of customer discrimination that we run throughout Section 2.4.

E Additional statistical results

Table E1: First step: Ordinary least squares estimates of the probability to live in HLM

	(1)	(2)	(3)	(4)
African immigrant	0.215***	0.117***	0.0895***	0.529
	(0.0107)	(0.0108)	(0.0107)	(0.939)
Non-African immigrant	0.0347***	-0.0186*	-0.0318***	0.697
	(0.0114)	(0.0110)	(0.0109)	(0.584)
Individual controls		X	X	X
Département FE			X	X
Département FE × African dummy				X
Département FE × non-African dummy				X
Nb observations	32,039	32,023	32,023	32,023
R-squared	0.012	0.100	0.152	0.167

Notes: (i) Ordinary least squares estimates of a linear probability model to live in HLM. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10%; FE stands for "fixed effects". (iii) Sample: All tenants who had a place of their own in France four years before the survey. (iv) The statistics on the fixed effects estimates once centered with respect to average fixed effect. (v) Source: INSEE, ENL 1996, 2002 and 2006