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Neighbor Discrimination

Theory and evidence from the French rental market*

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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 being confined to public housing projects, whereas this is not the case of other demographic groups.

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

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Introduction

The housing market and more precisely the rental market is the quintessential customer market (Lang 2007). And yet, empirical 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. This paper develops a search model to illustrate that some landlords may have more interest than others to care about tenants' prejudice. It derives an empirical strategy for testing for the existence of customer discrimination in the housing market: *neighbor discrimination*. We then implement the test on French data.

The main intuition is that the extent of neighbor discrimination in the rental market depends on the ownership structure within buildings. Some buildings with several flats are entirely owned by a unique landlord (hereafter, *building landlord*), while it is more common that in many buildings, landlords own a single flat (hereafter, *dwelling landlords*). Suppose that among the majority group in the population of potential applicants, the "Whites", some will turn down an offer in a building in which some of the other tenants are part of a "Black" minority. The intuition suggests that neighbor discrimination should be more important with building landlords than with dwelling landlords. Indeed, unlike the former, the latter do not care that accepting a black tenant may make it more difficult to find a tenant for the other landlords in the building.

We develop this idea in a model of landlords' decision-making process in a dynamic framework with ethnic heterogeneity, two-dwelling buildings, fixed rents and matching frictions (Section 1). Dwelling landlords sharing a building property play a dynamic game whose (Markovian) equilibria are studied; building landlords maximize the value of the building. The model highlights two externalities due to the presence of prejudiced Whites. Accepting a Black tenant today generates a *static externality* whereby it becomes more difficult to fill in the other vacant lot today because prejudiced Whites refuse to rent. It also generates a *dynamic externality* whereby it will be more difficult to fill in the same flat in the future because the tenant in the other apartment will be more likely black. Both externalities provide a rationale to discriminate because they reduce the value of the building. However, only the building landlords can internalize the static externality.

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. 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 second prediction is testable on regular survey data.

Section 2 conducts an empirical test of the theory. We seek here to investigate whether some

of the difficulties experienced by ethnic minorities in France (in particular people coming from former French colonies in Africa) may be attributed to neighor discrimination. We pick France because there is little legal room 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. 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]

The 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 building landlord. The probability difference amounts to between 5 and 9 percentage points, which represents between 12.5% and 22.5% of the unconditional probability. We obtain these results by means of a regression framework where we account for potential confounding factors and also by a test based on propensity score matching. According to our model, neighbor discrimination in the French private rental market is the most plausible explanation of such a finding.

Lastly, in section 3, we take advantage of our large-scale survey data to run an alternative, more indirect test of the theory. 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 hypothesis of neighor discrimination in the French rental housing market.

This finding is worrisome 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. The pity is that because they are poorer on average than the rest of the population, 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. Second, 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

[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).

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. To some extent, this population is trapped within public housing ghettos. Finally and equally importantly, 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 large residual disparities in unemployment rates as documented by Decreuse and Schmutz (2012), Gobillon, Rupert, and Wasmer (2014) and Combes, Decreuse, Laouénan, and Trannoy (2016a).

This paper pertains to different subfields of the large discrimination literature. Our strategy is quite similar to the literature 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.

Our model is derived from 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. Whereas search processes in this market are indisputably frictional,[2] 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. In this perspective, the characterization of the dynamic and static externalities associated with the acceptance of a minority tenant is new.

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). Pair-based audits highlight the role played by realtors. Many such audits have been conducted in the US since

[2]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.

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 (Zhao, Ondrich, and Yinger 2006). Recently, field experiments using newly available matching techniques, such as the Internet and name as ethnic proxies, have been conducted (see Ahmed and Hammarstedt (2008) on Sweden and Hanson and Hawley (2011) on U.S. cities).

The notion of spatial externality is at the core of the paper and is related to the literature on residential segregation. For example, Cutler, Glaeser and Vigdor (1997) building upon Schelling (1972) tipping model coined the term "decentralized racism" for Whites willing to pay for living in predominantly white neighorhoods. When living in dense areas, the closest neigbors are those next door and here the considered externality is limited to the building. This very local externality is what makes neighbor discrimination different from other contexts of customer discrimination.

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 section 3 illustrates a relationship between neighbor discrimination and the over-representation of some ethnic groups in the French public housing stock. Section 4 concludes. The Appendix contains additional empirical results. The online Appendix includes proofs of the theoretical results and other simulations.

1 Neighbor discrimination: theory

We first describe the benckmark model before presenting theoretical and simulation results. We then discuss some variants of the model and finally show how the results can be used to derive an empirical test of neighbor discrimination.

1.1 The model

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

Time is continuous. Landlords, whatever their type, are risk neutral and discount time at rate r. The building comprises two identical apartments. Each apartment is occupied by a White tenant (w), a Black tenant (b), or is vacant (v). Landlords receive a *fixed* rent R that does not depend on tenant's race. In the benchmark model, landlords are not prejucided against Blacks. In a variant of the model, landlords may also be prejudiced against Blacks and in that case, the difference $R_w - R_b > 0$ is Becker's taste for discrimination.

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 $p_b = 1 - p$. Preju-

dice is one-sided: a fixed fraction α of the population of Whites is prejudiced against Blacks.[3] Prejudiced Whites refuse to rent a dwelling when the neighbor is Black. However, they do not move out if a Black tenant moves in next to them.[4] We discuss the alternative case in Section 1.4. Landlords cannot evict a tenant, but tenants leave the apartment they rent with flow probability q.

When a Black applicant is willing to enter the dwelling, the landlord accepts with some probability β. In all generality, such a probability may depend on many different factors such as time and building occupancy state history (including the current state). The current state of one apartment is either a black tenant, a white tenant or vacancy. The same goes for the other apartment. The state space of occupancy for a building is therefore $\{v, w, b\} \times \{v, w, b\}$. We restrict our attention to Markovian processes, whereby the acceptance probability depends only on contemporaneous occupancy state. Let $\beta = (\beta_{bv}, \beta_{bw}, \beta_{bb}) \in [0,1]^3$ denote the vector of strategies of accepting a Black applicant (state b) when the other dwelling is in state $l = b, w, v$ respectively. Similarly, $\bar{\beta} = \left(\bar{\beta}_{bv}, \bar{\beta}_{bw}, \bar{\beta}_{bb}\right) \in [0,1]^3$ denote the vector of strategies for the other dwelling. We first give the profit associated to each pair of strategies.

Dwellings' values Let $\Pi : [0,1]^3 \times [0,1]^3 \to \mathbb{R}^9$ describes the function of gains at a stationnary state corresponding to the ownership of *one* apartment which is defined for all pairs of strategies. 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 $\bar{\beta}$ is omitted whenever this does not cause a misunderstanding. There are 9 different gain functions but it turns out that by saving notations we can write out only four of them to generate all. For all $i, j = w, b$, the elements of these gain functions are recursively defined as follows:

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

$$r\Pi^{iv} = R + q\left[\Pi^{vv} - \Pi^{iv}\right] + \eta \sum\nolimits_j p_j \left(1 - \alpha_{ji}\right) \bar{\beta}_{ji} \left[\Pi^{ij} - \Pi^{iv}\right], \tag{2}$$

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

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

where α_{ij} is a shortcut notation with $\alpha_{wb} = \alpha$ and $\alpha_{kl} = 0$ in all other cases, and $\beta_{wj} = \bar{\beta}_{wj} = 1$ for all j. The system (1)–(4) comprises nine linear equations.

The first two lines are about the value of an occupied appartment depending on whether the other one is vacant or not. The last two lines deal with the value of a vacant appartment depending on whether the other one is occupied or not. Changes in the occupation status of one dwelling affect the value of the other one because having a Black neighbor leads prejudiced Whites to refuse the dwelling. In brackets, we have the expected capital gain due to the change in occupancy status.

[3] 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).

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

We now comment the economic meaning of these four equations. Consider equation (1). The right-hand side (RHS) states that a dwelling occupied by a black or white tenant yields instantaneous profit R, but its value Π^{ij} switches to Π^{vj} if the tenant leaves (an event occurring at rate q) as well as to Π^{iv} if the other dwelling becomes vacant. The RHS of (2) states that the value of an occupied dwelling is likely to turn into the value of a vacant dweling Π^{vv} if the tenant leaves (an event occurring at rate q) as well as into Π^{ij} if the other dwelling is occupied by a type-j tenant. This new tenant arrives at rate η, is of type j with probability p_j, accepts the dwelling offer with probability $(1-\alpha_{ji})$, and is accepted by the landlord with probability $\bar{\beta}_{ji}$. The third line has a similar interpretation, for this time it is the first appartement that is vacant. The fourth line deals with the case of a double vacancy. Each term of the RHS of (4) describes the change in value that can happen to either appartment. They are symmetric and we do not need to take into account the prejudice parameter (α) since the whole building is initially vacant.

Dwelling landlords' strategies Dwelling landlords accept or reject applicants in a non cooperative way. They set the probability vectors β and $\bar{\beta}$ in a Nash equilibrium. 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 dwelling landlord is $\Pi_D : B \times B \to \mathbb{R}^9$ with typical element $\Pi_D^{kl}\left(\beta, \bar{\beta}\right) = \Pi^{kl}(\beta, \bar{\beta})$.

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

$$\beta_{bl} \in \underset{\tilde{\beta}_{bl} \in [0,1]}{\text{argmax}}\, \Pi^{bl}\left((\tilde{\beta}_{bl}, \beta_{b-l}), \bar{\beta}\right) \text{ for all } l = v, w, b, \tag{5}$$

where $(\tilde{\beta}_{bl}, \beta_{b-l})$ is the vector with all components of vector β except the l-th one.

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

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

A *symmetric Nash equilibrium* is a vector β^* such that for any $l = v, w, b$

$$\beta_{bl}^* \in \underset{\tilde{\beta}_{bl} \in [0,1]}{\text{argmax}}\, \Pi^{bl}\left((\tilde{\beta}_{bl}, \beta_{b-l}^*), \beta^*\right), \tag{7}$$

A *pure-strategy symmetric equilibrium* is a symmetric Nash equilibrium with $\beta_{bl}^* = 0$ or $\beta_{bl}^* = 1$ for all $l = v, w, b$ and B^* is the set of these strategies.

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 apparently do not need to compute coordinated 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. To

pursue the example, dwelling landlords have to set out what would be their optimal reaction should a black tenant be in the neighbor appartment.

Building landlord's strategies Building landlords maximize the value of the building rather than the value of each dwelling separately. Their strategy set is now the cartesian product $B \times B$. The profit function is $\Pi_B : B^2 \to \mathbb{R}^9$ with typical element $\Pi_B^{kl}\left(\beta, \bar{\beta}\right) = \Pi^{kl}(\beta, \bar{\beta}) + \Pi^{lk}(\bar{\beta}, \beta)$.

Since the externalities take place at the building level, building landlords are able to internalize them. Therefore, a *symmetric coordinated strategy* results from

$$\hat{\beta}_{bl} \in \underset{\tilde{\beta}_{bl} \in [0,1]}{\operatorname{argmax}} \Pi^{bl}\left((\tilde{\beta}_{bl}, \hat{\beta}_{b-l}), (\tilde{\beta}_{bl}, \hat{\beta}_{b-l}\right) \text{ for any } l = v, w, b. \tag{8}$$

Such a strategy must satisfy

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

A *pure-strategy symmetric coordinated strategy* satisfies $\hat{\beta}_{bl} = 0$ or $\hat{\beta}_{bl} = 1$ for all $l = w, b, v$. and $\hat{B}$ is the set of these strategies.

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

1.2 Theoretical results

We start with a simplified version of the 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 is interesting since the dynamic externality we refer to in the introduction vanishes. We are then able to isolate the impact of the static externality on both landlord types.

Proposition 1 EQUILIBRIUM AND COORDINATED STRATEGIES WITHOUT SEPARATION. *Assume* $\alpha > 0$, *and let us define*

$$\sigma_v = \eta p / (r + \eta p) \frac{r^2 + 3r\eta + 2\eta^2 + \alpha(r^2 + r\eta - 2p^2\eta^2)}{r^2 + 3r\eta + 2\eta^2 - \alpha(r^2 + (1+2p)r\eta + 2p^2\eta^2)\eta p/(r+\eta p)}.$$

Then,

(i) If $\sigma_v > 1$, *then* $B^* = \{(1,1,1)\}$ *and* $\hat{B} = \{(0,1,1)\}$;

(ii) If $\sigma_v \leq 1$, *then* $B^* = \hat{B} = \{(1,1,1)\}$.

Proof: see Online Appendix, Section 1.1

The main lesson of this Proposition is that building landlords discriminate more often than dwelling landlords who never discriminate. Dwelling landlords face a coordination problem, whereas building landlords do not. This phenomenon arises when the other dwelling is vacant.

It depends on whether σ_v is larger or lower than 1. When $\sigma_v > 1$, Black tenants are discriminated against by building landlords when the other dwelling is vacant but not when it is occupied by a White tenant. This latter tenant will not leave by assumption (since $q = 0$). Consequently, there is no cost of accepting a Black tenant when the other apartment is already filled in. On the opposite, when the other apartment is vacant, accepting a Black tenant today reduces the chances that the other dwelling will be rented by a White tenant tomorrow. Therefore the value of the other dwelling goes down. Unlike building landlords, dwelling landlords do not take this static externality into account because they do not own the other apartment.

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.

Proposition 2 COMPARING DWELLING AND BUILDING LANDLORDS STRATEGIES. *The following properties hold:*

(i)- With unprejudiced Whites ($\alpha = 0$), there is a unique Nash equilibrium, which coincides with the coordinated strategy and there is no discrimination, i.e., $\hat{B} = B^* = \{(1,1,1)\}$.

(ii)- With prejudiced Whites ($\alpha > 0$), if building landlords do not discriminate in all circumstances, then so do dwelling landlords, i.e., $(1,1,1) \in \hat{B}$ implies $(1,1,1) \in B^*$.

Proof: see see Online Appendix, Section 1.2

This proposition conveys two messages. First, the two types of landlords behave similarly when prejudices vanish. Second it highlights a significant case where dwelling landlords do not discriminate more than building landlords. 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.

1.3 Numerical simulations

The model is parameterized on a monthly basis. Table 1 presents the values of the different parameters. We then cover the entire set of reasonable values for all the parameters: R is normaized to one, 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.

Note that we do not weight the different cases. We implicitly consider that all parameter configurations have the same probability of occurrence.

Table 1: Parameter values

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

Notes: The first row 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 row describes the range of values taken by the counter i.

Nash equilibria Simulating the general model reveals a number of phenomena that the no-separation case cannot predict. Table 2 describes the equilibrium outcomes of the game played by dwelling landlords.

Table 2: Distribution of the symmetric Nash equilibria of the game played by dwelling landlords.

$(\beta_v^*, \beta_w^*, \beta_b^*)$	Nb observations	Proportion
$(0,0,1)$	8,334	1.30%
$(0,0,1),(0,1,1)$	5,223	0.82%
$(0,0,1),(0,1,1),(1,1,1)$	271	0.04%
$(0,1,1)$	6,212	0.97%
$(0,1,1),(1,1,1)$	8,317	1.30%
$(1,1,1)$	611,643	95.57%
Total	640,000	100%

Three pure-strategies occur at the Nash equilibria, $(1,1,1)$, $(0,1,1)$, $(0,0,1)$, that is, no discrimination at all, discrimination if the other apartment is vacant, and discrimination if the other apartment is vacant or filled in by a White tenant. Therefore, it is never an equilibrium best response to discriminate in case of occupancy of the other apartment by a Black tenant. There may be up to three equilibria at a time but such multiple equilibria only arise in 2% of the simulations. Still the dominant message is that discrimination remains very unlikely, only 5% of the cases.

Equilibrium vs coordinated strategies The strategies chosen by the building landlords are the same three ones emerging in equilibrium, i.e., no discrimination, discrimination in case of a vacancy or a vacancy and a White tenant in the other apartment. We rank these strategies from the least discriminatory to the most discriminatory one: $(1,1,1) \prec (0,1,1) \prec (0,0,1)$. To compare the equilibrium strategies with the coordinated ones, we assume that, in case of multiplicity of Nash equilibria, landlords coordinate on the most-discriminating equilibrium. This equilibrium is also the one associated to the highest payoffs for the two landlords.

The matrix displayed in Table 3 expresses that building landlords discriminate more than dwelling landlords.

Indeed, the matrix is upper triangular, which means that there are no cases where dwelling landlords discriminate more than building ones. The probability mass above the main diagonal

Table 3: Equilibrium and coordinated strategies: pure neighbor discrimination

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

Notes: Each column corresponds to a particular coordinated strategy $(\hat{\beta}_v, \hat{\beta}_w, \hat{\beta}_b)$, whereas each row corresponds to a particular equilibrium strategy $(\beta_v^*, \beta_w^*, \beta_b^*)$. 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.

is about 20% meaning that building landlords discriminate strictly more than dwelling landlords in 1 over 5 simulations.

We now examine in depth the role played by each parameter.

Role of the other parameters To highlight the role played by each parameter, we compute the percentage of simulations where discrimination occurs in equilibrium and in the coordinated 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. Figure 1 displays the results. On each plot, there are two curves. The curve with triangles is the proportion of cases where dwelling landlords discriminate whereas the curve with diamonds is the proportion of cases where building landlords discriminate. The former curve is always below the latter, which confirms the general result whereby building landlords discriminate more than dwelling landlords.

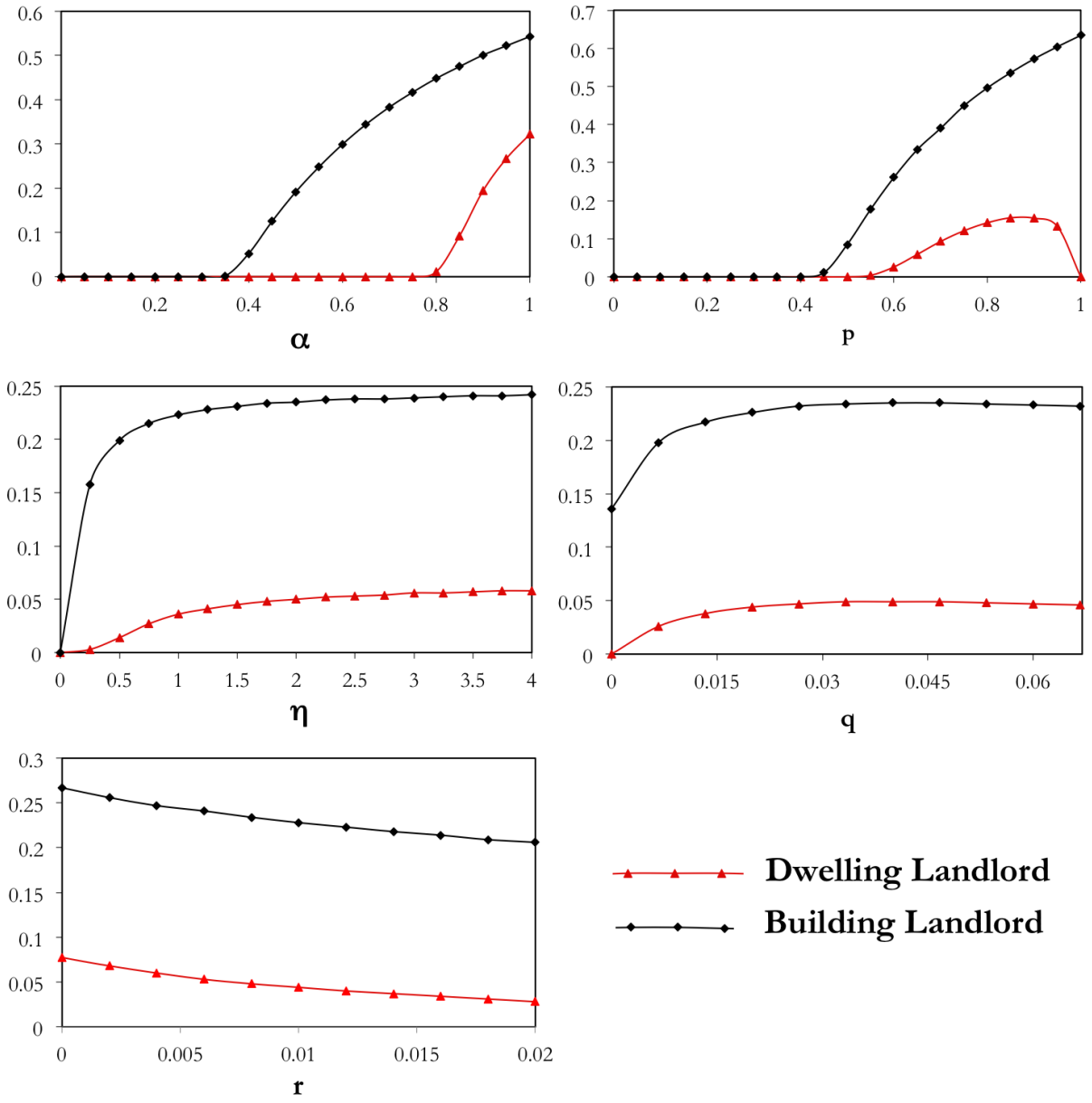
Three parameters have an unambiguous impact on the extent of discrimination: α, η, and r. The impact of α is straightforward. Increasing the proportion of prejudiced Whites leads both types of landlords to discriminate more often. There is a minimum value below which customer discrimination is never adopted. This threshold is around 35% for building landlords and around 75% for dwelling 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 η is equal to 0.

Lastly, the higher the discount rate, the less likely landlords are to discriminate. Adopting a discriminatory strategy means preferring to keep the dwelling vacant against the hope of a better match in the future. However, discrimination does not respond much to changes in discount rate.

As for α, the White proportion p increases the probability that building landlords adopt a discriminatory strategy. The minimum value below which no landlord discriminates is around 40% for building landlords and around 50% for dwelling landlords. These values around one

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. 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.

half reveal that when a minority stops to be a minority, it has much fewer chances to be discriminated against even if racial prejudices remain.

However, p has an non-monotonous impact on the behavior of dwelling 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.

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 building landlords practice neighbor discrimination.

The impact of the separation rate q is non-monotonous too. 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. 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 but landlords do not discriminate when q reaches unrealistic values.[5] 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.

1.4 From theory to the empirical strategy

In the absence of prejudiced Whites, Proposition 2 tells us that dwelling and building landlords behave similarly. Consequently, Black and White tenants are equally likely to have a building landlord. When there are prejudiced Whites, building landlords discriminate more than dwelling landlords according to our simulations. In this case, Black tenants are less likely to have a building landlord. This prediction leads to an eye-ball test of neighbor discrimination in the rental market.

Prediction 1 DETECTING NEIGHBOR DISCRIMINATION IN THE RENTAL MARKET *All else equal, if Black tenants are less likely to have a building landlord than White tenants, then there are prejudiced Whites in the rental market.*

This prediction can be confronted to survey data. The test strategy requires that the survey documents the ownership and occupancy status of each housing unit so we can identify whether a dwelling belongs to a building landlord or not. We now relax some assumptions of the basic model to assess the validity of the prediction and to address the roles played by potential confounding factors.

[5] 1.41 (the mean stay is 3 weeks) for dwelling landlords, against 8.02 for building landlords (the mean stay is half a week) .

White flight The first assumption that we relax is that tenants cannot or do not want to leave if a neighbor they do not like moves in. We switch to the opposite situation where tenants' prejudice is higher than their moving cost, and all prejudiced Whites are of that sort and always leave the building when a Black neighbor moves in. This feature adds endogenous separation to the model.[6] When a Black comes in, a prejudiced White gets out. For this to occur, three conditions must hold. First a Black applicant is willing to rent, which happens with probability $\eta(1-p)$; second in the other apartment there is a prejudiced White, which happens with probability α; third the landlord accepts the Black tenant, which arises with probability β_w. Then the building experiences the change $(wv) \to (vb)$ with probability $\eta(1-p)\alpha\beta_w$ and the same goes for $(vw) \to (bv)$. Note that at the building level, there is only one change: replacing a prejudiced white tenant with a black tenant. The only two value functions that are affected by this new framework are Π^{vw} and Π^{wv}, which are now defined by the following two equations with two new last terms:

$$\begin{aligned} r\Pi^{wv} &= R + q\left[\Pi^{vv} - \Pi^{wv}\right] \\ &+ \eta\left\{p\left[\Pi^{ww} - \Pi^{wv}\right] + (1-p)\beta_w\left\langle(1-\alpha)\left[\Pi^{wb} - \Pi^{wv}\right] + \alpha\left[\Pi^{vb} - \Pi^{wv}\right]\right\rangle\right\}, \end{aligned} \tag{10}$$

$$\begin{aligned} r\Pi^{vw} &= q\left[\Pi^{vv} - \Pi^{vw}\right] \\ &+ \eta\left\{p\left[\Pi^{ww} - \Pi^{vw}\right] + (1-p)\beta_w\left\langle(1-\alpha)\left[\Pi^{bw} - \Pi^{vw}\right] + \alpha\left[\Pi^{bv} - \Pi^{vw}\right]\right\rangle\right\} \end{aligned} \tag{11}$$

Accounting for endogenous separation means that accepting a White tenant may be less profitable than accepting a Black one. This arises for very high values of $(1-p)\alpha$, i.e., when the White majority is not that large and racial prejudice is very widespread. For simplicity, we do not elaborate further on this possibility and only focus on discrimination against Black applicants. We proceed to the same numerical simulations as previously. Table 4 shows that we recover the main prediction of the baseline model whereby building landlords discriminate more than dwelling landlords. The probability mass above the main diagonal is about 13%, against 20% in the baseline model, so even if the discrimination gap is reduced, Prediction 1 still holds (for further details see the online Appendix, Section 2.1).

Table 4: Equilibrium and coordinated strategies: pure neighbor discrimination with White flight

	$(1,1,1)$	$(0,1,1)$	$(0,0,1)$	Total
$(1,1,1)$	83.59%	5.82%	8.12%	97.53%
$(0,1,1)$	0	0	0.31%	0.31%
$(0,0,1)$	0	0	2.16%	2.16%
Total	83.59%	5.82%	10.61%	100%

Notes: See Table 3.

[6] Some difficulty arises in the treatment of this variant. The previous occupation history of the building may give information to the landlords regarding whether their current white tenant is prejudiced or not. Nonetheless, we still focus on the Markovian case and assume that landlords cannot observe the type of their White tenant.

Building size and colluding behavior A theoretical drawback of a framework with only two apartments in the building is that it makes it difficult to rule out the possibility of coordination in property management between the two dwelling landlords. If both landlords cooperate, their behavior can no longer be distinguished from that of a building landlord. Since coordinating implies some transaction costs, we can expect that not all dwelling landlords will coordinate. This 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. Clearly, if co-owners rent themselves the apartments, transactions costs would increase with the building size. We deduce that the frequency of coordination is expected to decrease with building size, which makes the prediction more likely with a large building than with a small building, unless all co-owners of a condominium choose the same property manager to rent their apartments.[7] When coming to data it will be important to control for whether the rent is collected by the landlord or by a property management firm. In the latter case, we can suspect a cooperative behavior among dwelling landlords.

Another issue is knowing whether the prediction itself becomes more likely when the number of apartments and then the number of (non cooperative) dwelling landlords increase in the building. It is important for our empirical application since using real data implies comparing landlords who own the entire buiding whatever the number n of apartments ($n \geq 2$), to other landlords who do not. In the online appendix (Section 2.2) we consider a variant of the model where buildings are made out of three apartments and prejudice cannot be diluted in the sense that one black tenant in the building is enough for prejudiced white applicants to refuse the proposed dwelling. Given that the state space is different, the comparison between building landlords is not completely straightforward, but remains unconclusive: the two types of building landlords behave quite similarly. All in all, even if the theory remains agnostic with regard to building size, it will be important to look at that dimension in the empirical work.

Endogenization of the proportion of black tenants The assumption that arrival rates for new tenants of either race are independent of landlord type may also be reconsidered. The random search hypothesis can be vindicated from the fact that ownership structure of the buildings is private knowlege. However, knowledge about denial can disseminate through networks and it might happen that, even if the members of the minority do not know the reason why they are specifically denied access to a given building, they avoid applying for that specific building. As a result of this directed search, the endogenous proportion of Black applicants would be lower in buildings with multiple landlords than in buildings with a unique landlord. As illustrated by Figure 1, the simulations show that building landlords discriminate more often when p increases. Accounting for directed search, therefore, may actually increase the discrimination gap between the two types of landlords. For the empirical strategy, it is therefore important to control for the way tenants have heard about the dwelling they currently occupy.

[7] In France, it is unfrequent that the condominium board will be in charge of property management. The co-owner is free to rent to whom he chooses without any restriction in a condominium see Article 8 of the Law of July 10, 1965. There might be restrictions if the tenant is operating a business.

Rents We have already argued in the introduction that the fixed rent assumption fits in the characteristics of the French housing market. Accordingly, we must check in the empirical investigation that the minority is not paying higher rents for similar apartments. We could have considered the extension where rents can be bargained between the tenant and the landlord or rents are posted by landlords and applicants take it or leave it. These extensions, although interesting from a purely theoretical viewpoint, receive no further elaboration, since statistical regressions presented in the next section conclude that minority tenants pay similar rents, regardless of landlord type.

Taste-based discrimination It is possible that some landlords share the prejudice of White tenants. The case of taste-based discrimination should be accomodated with the fact that we consider fixed rents. Instead of considering that the true renting profit is the same regarless of tenant type, we will now consider that the ratio of White rent to Black rent R_w/R_b is larger than one. Therefore landlords may discriminate against Black tenants for two reasons: because the neighbors are prejudiced, or because they are themselves prejudiced.

A new set of simulations shows that accounting for landlords' prejudice does not modify the key result whereby building landlords discriminate more than dwelling ones. We consider the same parameters as in Table 1. However, the rent ratio is now $R_w/R_b = 1.1$ so that accepting a Black tenant implies a utility loss equivalent to a 10% decrease in the rent. Table 5 shows the joint distribution of equilibrium and coordinated strategies. We adopt the following ranking of the different strategies, from the least discriminatory to the most discriminatory one: $(1,1,1) \prec (0,1,1) \prec (0,0,1) \prec (0,0,b)_{b\in(0,1)} \prec (0,0,0)$. The comparison with Table 5 makes it plain that the differential behavior between landlord types does not change with the rent ratio: the probability mass above the main diagonal is about 22% and thus is roughly constant. Then, in spite of the fact that discrimination has much increased, the relative discrimination power of building landlors versus dwelling landlords is unaltered (the online Appendix, section 2.1, provides additional details and results).

Table 5: Equilibrium and coordinated strategies: neighbor discrimination and a 10% discount for landlord discrimination

	$(1,1,1)$	$(0,1,1)$	$(0,0,1)$	$(0,0,b)$	$(0,0,0)$	Total
$(1,1,1)$	22.02%	3.52%	2.13%	0	0	27.67%
$(0,1,1)$	0	0	0.78%	0	0	0.78%
$(0,0,1)$	0	0	14.02%	0	10.41%	24.43%
$(0,0,b)$	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%

Notes: See Table 3.

Statistical discrimination 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 discussed in the previous extension devoted to taste-based discrimination. 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 L. 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:

$$r\Pi^{ij} = R_i + q\left[\Pi^{vj} + \Pi^{iv} - 2\Pi^{ij} - d_i L\right], \tag{12}$$

$$r\Pi^{iv} = R_i + q\left[\Pi^{vv} - \Pi^{iv} - d_i L\right] + \eta \sum\nolimits_j p_j \left(1 - \alpha_{ji}\right) \bar{\beta}_{ji} \left[\Pi^{ij} - \Pi^{iv}\right], \tag{13}$$

leaving the equations for $r\Pi^{vj}$ and $r\Pi^{vv}$ unchanged. The only novelty is due to the inclusion of the generic terms $d_i L$. Therefore, writing $\tilde{R}_i = R_i - d_i q L$ 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 here observationally equivalent.

2 Neighbor discrimination: test

Our model provides a sufficient condition for neighbor discrimination, namely there is neighbor discrimination only if discriminated persons are more likely to rent to a dwelling landlord than non-discriminated ones, other things equal. We now examine whether this condition is verified in the French rental market. Our dataset meets three requirements: (i) it clearly identifies a potentially discriminated group, (ii) it distinguishes between landlords who own the entire building from the others, (iii) it offers 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 the dataset, then show that tenants with African origin are less likely to rent from a landlord who owns the entire building, and finally discuss the robustness of this result.

2.1 Data

Our dataset pools together three waves (1996, 2002 and 2006) of the French National Housing Survey (*Enquête Nationale Logement*, henceforth ENL).[8] The ENL is a detailed cross-sectional survey on a nationally-representative sample of around 30,000 households, about 35,000 dwellings and 75,000 individuals. The purpose of the ENL is to get a representative sample of housing

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

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, we have precise information on location. We know in which municipality (36,000 municipalities) the dwelling is located and, unless the information is missing, we even know the census block (*ilot)*[9] (280,000 census blocks). We also consider coarser geographic partition such as departments[10] or MSAs.[11]

The partition of tenants We divide the sample into minority and majority tenants. For each individual, the dataset reports the current nationality, place of birth and whether they were French at birth. However 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.

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. 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 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 respondents were asked to say whether Algeria evocates a positive or a negative feeling, a clear majority (50% against 22%) have a strong 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 focus on a good candidate for discrimination, it can be thought that we approach it with the wrong concept, nationality. However, 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 a number of cases because some people born in the colonies were given French citizenship at birth. The increasing numbers 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

[9] This information is missing in about 30% of the sample.

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

[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*).

racism against second-generation immigrants.

We exclude from our sample all households whose respondents did not have a home of their 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. We seek to disentangle ethnic discrimination from the various difficulties experienced by recent migrants when coping with the codes of their new country. Therefore 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 A1 in Appendix B shows that Africans are over-represented both in the private rental market and in the market for apartments.[12] 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 A2 in Appendix A 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.

We also try to construct a placebo group composed of immigrants of "non-African origin" (both non-French, non-African citizens and people born outside of France and Africa and not French at birth). These individuals may be subject to the same cultural and language difficulties as all immigrants but less exposed to racial discrimination (see evidence in France-Stratégie (2016)). However, this group is very heterogenous (from Europeans to Turks and Chinese), therefore the corresponding results are not clear cut. We also try to isolate a sub-group of European immigrants among those of "non-African origin". However, this sub-group is very small: we only have 447 Europeans and 532 non-Africans non-Europeans against 1440 Africans.

The partition of landlords We also divide the sample of landlords into building and dwelling landlords. The sampling design is at the housing level and not at the building level. However, we know whether the owner of the housing unit is a firm or a household and whether the apartment is located in a building owned by a single landlord or not. This variable is informed by the respondents or, if they do not know, by their neighbors or by the caretaker of the building.[13] It does not allow us to identify the cases where the landlord owns part but not the entire building. However it gives an idea as to the scale of building ownership. This concerns about 40% of privately-rented apartments. This rate varies across regions (34% in Paris region versus 41% elsewhere). Table A3 in Appendix A shows that the two types of apartments differ in size and comfort. "Dwelling apartments" are more comfortable and smaller than "Building apartments". The latter are also cheaper and located in older and smaller buildings. Lastly, building landlords are not randomly allocated across France: they are fewer in densely populated areas and in areas

[12] Apartments will be 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.

[13] 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.

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. 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 early XXth century (about 500,000 households) as recently revisited by Piketty's work (Piketty, Postel-Vinay, and Rosenthal 2014, Piketty 2014). 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 ENL to follow this kind of owners. 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, corporations (specifically financial institutions, banks and insurance companies) left the French housing market at the end of the 1980s because of tighter regulations (*Loi Quillot* in 1982).

Whatever the legal status of the ownership (as shown in Table A3, 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 all landlords are assumed to be risk neutral in the model.

However, we can presume that building landlords are richer since they are descended from richer families than dwelling landlords. The dataset does not provide additional information about landlords. This raises the question as to whether the negative correlation observed in the empirical section between tenant's African origin and the probability for their landlord to be a building landlord might be reflecting a spurious correlation with unobserved landlords' characteristics correlated with prejudice.

We cannot directly address this issue. However, we can make use of another data source to mitigate this concern. We use data from the 1998 wave of the French Wealth Survey (Enquête Patrimoine). This survey is produced by the same institute as the ENL. Its sample design is similar (based on housing units) and it is almost similar in scope: in 1998, it samples 26,050 individuals in 10,207 households. We define as African households any household counting at least one person of African origin (non-French at birth and born in Africa, or holding African citizenship). Using this definition, African households make up for 3.6% of the population, a share very close to the one observed in the other dataset (3.4%), and for about 4.6% of the population of private tenants. Individuals are asked a series of questions regarding their real estate portfolio. 18% households own real estate property which is not their main residency. Each of these properties is separately documented. Therefore, we are able to reconstruct a dataset at the property level. Among these properties, 1,557 were rented out for at least one month during the year before the survey, and 1,418 were rented out for the entire year. After excluding isolated houses, and cases where the landlord declares a nonpositive rental income, we end up with a

sample of 771 privately-rented apartments.

While we miss the exact location of the units, we make use of information on their departement and the size of their city. There are 94 departments in continental France and city size is split in six categories. We define as "large" the landlords who own several apartments in the same location (departement $\times$ city size). Although we cannot rule out the possibility that those apartments are not located in the same building, nor that landlords do not actually own the entire buildings where those apartments are located, this definition makes up for a plausible approximation of what we define as building landlords: indeed, we end up with a share of 40% of privately-rented apartments owned by building landlords, to be compared with a share of 39% of privately-rented apartments owned by large landlords.

We document few observable differences between large and small landlords. Table 6 shows the results of t-tests comparings sample means between the two groups of landlords. We use all the relevant information about landlords we could find in the Wealth Survey.

Table 6: Differences between large and small landlords

	Small	Large	Diff. p-value
African (landlord)	0.017	0.016	89%
Inherited (dwelling)	0.831	0.802	38%
Owned for more than 5 years (dwelling)	0.726	0.842	<1%
Share owned by the household head (dwelling)	0.616	0.594	43%
In same location as landlord (dwelling)	0.363	0.439	7%
University degree (landlord)	0.546	0.487	17%
Household income (landlord)	23,734	25,697	19%
Age (landlord)	55	58	6%
Man (landlord)	0.818	0.847	41%
In a couple (landlord)	0.748	0.795	21%
Owns a real estate firm (landlord)	0.083	0.103	45%

Notes: (i) t-tests between comparing the characteristics of small landlords and large landlords (see text for definition) using sampling weights. (ii) Sample: all apartments in continental France rented out for the twelve past months by a landlord declaring positive rental income: 771 observations; (iii) "African": one of the members in the landlord household is an African immigrants; "Inherited": the dwelling was received through inheritance; "Share owned": share of the dwelling owned by the household head (most cases are: 50% and 100% but other values are observed in 15% of the observations); "In same location as landlord": the dwelling is located in the same location (see text for definition) as the landlord's main residence; "Household income" is total monthly labor income with transfers (in Francs), "University Degree", "Age", "Man" and "In a couple" describe the situation of the household head; "Owns a real estate firm": the household has shares in a "Société civile de placement immobilier (SCPI)'. SCPIs' are investment companies authorised to issue shares to institutions and the public, and set up with the exclusive purpose of buying and managing real estate property on behalf of the shareholders.
Source: Enquête Patrimoine 1998.

The only significant observable difference between large and small landlords is that large landlords have owned their dwelling for a little longer: 84% of the dwellings owned by large landlords have been in their possession for more than five years, against 73% for small landlords. However, this difference is mild and should not dramatically drive our results, which focus on households who already had a house of their own four years before the survey. Apart from this difference, the two groups are very similar. Neither is more likely to be African (1.7% vs 1.6%), to have inherited from the dwelling, to be in shared ownership of the dwelling, or

to own shares of a real estate firm. Large landlords are slightly more likely to live in the same location as the dwelling, but the difference is small and hardly significant. They are also slightly older (55 against 58 years old, p-value of 6%). All the other landlord characteristics (income, gender, marital status, diploma) are quite similar in both groups. Table A4 shows that these small differences observed between the two groups explain almost no variation in the probability for private tenants in apartments to be facing a large landlord. When we control for all the aforementioned landlord characteristics, the only significant coefficient is once again on the seniority of ownership.

2.2 Empirical tests

We start by discussing potential rent discrimination. Then we run two tests of our main prediction, the first one based on a regression framework, the second one on propensity score matching. We then examine the issue of spatial sorting. We end up with interactions between landlord and tenant.

2.2.1 Rent discrimination

Our basic theoretical assumption is that landlords do not use price discrimination because of legal restrictions[14]. Therefore building landlords in our model do not charge higher rents on African immigrants than dwelling landlords. Table B1 Appendix B shows that it is indeed the case in our dataset. It presents the regression results of the rent paid by tenants as a function of tenant's origin, landlord's type, and their interaction, plus a set of controls. Without any controls, African immigrants pay higher rents, but the effect disappears when location controls (departements, MSAs, municipalities) 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. Building landlords do offer lower rents to all tenants, but this is largely due to the type of apartments they rent.

We cannot rule out that African immigrants intrinsically prefer apartments owned by dwelling landlords. We can make use of another variable to mitigate this concern: in 2002 and 2006, respondents were asked to grade their dwelling conditions, on a scale from 1 to 10. If African immigrants really disliked apartments owned by building landlords, they should be more likely to report lower levels of satisfaction when they live in this type of apartment. However, as shown in Table B2 of Appendix B, the opposite property holds: they do report lower satisfaction levels in general, but, if anything, higher satisfaction levels when they live in apartments owned by building landlords (columns (1) to (3)). Note that, for the same specifications, apartments owned by building landlords are associated with lower levels of satisfaction for all tenants. Both patterns completely disappear when controlling for the observable characteristics of the dwelling (column (4)), which comforts our random search assumption regarding landlord type.

[14]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.

Therefore it is unlikely that there are fewer African immigrants in buildings owned by a unique landlord because they pay more expensive rents or they are less pleased with the apartments.

2.2.2 Test of the main prediction: regression

We 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 neighbor discrimination according to our prediction. 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. Therefore the coefficient of interest is biased downward.

Table 7 shows that the marginal effect of African origin is significantly negative in all specifications. Column (1) shows a small but significant 3% unconditional difference between African immigrants and French-born. Column (2) controls for tenant characteristics and the effect goes to 8%. 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 are over-represented in housing units owned by a building landlord. Columns (3) to (7) also control for location through a set of département fixed effects; the parameter of interest is reduced to 5%. Africans appear to be located in places where building landlords are less numerous. Moreover, our theoretical results are instructive here since they point out that the fewer the Africans, the higher the discrepancy in discriminating power between the two landlord types. Hence, if we control for location, the coefficient of interest should drop.

To fix the magnitude of neighbor discrimination, let us consider two possible interpretations. 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 fully 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.

Differential prejudice across landlord type is a potential confounder. Personal prejudice may play a greater role if landlords intend to coreside with their tenants. 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 results in column (4). However, columns (5) to (7) of Table 7 shows that this is not the case. There are comparatively fewer tenants of African origin when we restrict the sample to larger buildings, although the difference in the coefficients across building sizes is not statistically significant.

In the same vein, racial preferences might be correlated with the landlord wealth. However,

Table 7: Probability of having a building landlord

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
African immigrant	-0.0292**	-0.0818***	-0.0513***	-0.0539***	-0.0546***	-0.0448**	-0.0849***
	(0.0144)	(0.0147)	(0.0163)	(0.0172)	(0.0160)	(0.0194)	(0.0253)
non-African immigrant	-0.0133	-0.0509***	-0.0355**	-0.0417**	-0.0498***	-0.0407**	-0.0237
	(0.0164)	(0.0165)	(0.0176)	(0.0183)	(0.0169)	(0.0203)	(0.0318)
Individual characteristics		X	X	X	X	X	X
Location fixed effects			X	X	X	X	X
Apartment characteristics				X	X	X	X
Time dummies	X	X	X	X	X	X	X
Nb observations	11,139	11,139	11,136	11,052	8,819	3,808	1,700
Pseudo R-squared	0.0113	0.0298	0.0915	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) Individual and apartment characteristics: Those reported in Tables A2 and A3 (in Appendix A). (v) Location fixed effects: départements.

the fact that wealth leads to more xenophobic political attitude is not verified by electoral studies (Bélanger, Nadeau, Turgeon, Lewis-Beck, and Foucault 2014). Another possible story would be that both types of landlords would be equally prejudiced, but only building landlords with many apartments would have enough market power to discriminate at their will. We cannot eliminate this possibility, though such buildings with many apartments are overrepresented in large cities where market power is likely smaller for a single landlord.

Landlords' prejudice may be correlated with their legal status, i.e., firms may be less prejudiced than individuals. As already explained in section 2.1, this distinction between firms and households is not very instructive because most building landlords administratively registered as firms are actually made of households. Still, there may be different administrative requirements for landlords filing as firms, even when they are in fact a conglomerate of households. To account for the legal status of the landlord, we estimate a bivariate probit model of the joint probability of having a building landlord and a firm one, 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 B3 in Appendix B, considering the same set of controls as Table 7. 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 7.

Lastly, Table B4 in Appendix B compares the results for immigrants across origin with the same set of controls as Table 7. The pattern of the coefficient of interest for "Non-European and Non-African" immigrants is very similar to that for immigrants of African origin. On the contrary, European immigrants do not seem to be under-exposed to building landlords in line with the idea whereby they are very well accepted by the neighbors. However, the coefficient for Europeans is not precisely estimated because of the small size of the group and we cannot

say that the coefficient for Africans is different from that of Europeans.

2.2.3 Test of the main prediction: propensity score matching

The regression framework insufficiently addresses the issue of unobserved dwelling, building and neighborhood characteristics. Here we show the result of an alternative test based on propensity score matching estimation.

The main methodological problem is to deal with the dummy variables (time dummies and, more importantly, location fixed effects). Indeed, in all generality, households should only be compared within each category. However, stratified matching is not feasible here because of the large number of modalities and the small number of observations, especially for African tenants. We propose the following solution: we replace time dummies with a trend and departement fixed effects with a set of departement characteristics measured in the 1990 Census: total population, share of households living in public housing, share of household who are not homeowners, vacancy rate and share of furnished room (low-quality rentals called "meublés" largely targeted at immigrants). As shown in Table B5, the predictive power of this set of characteristics is almost as high as the set of département fixed effects.

We compute the average treatment effect of being of African origin over the sample of common support of observable characteristics. Because of the binary setting of propensity score matching, we drop the observations corresponding to non-African immigrant households. The estimation uses a kernel matching with a 10% bandwidth, with a logit estimation as the first stage, and standard errors are bootstrapped using 100 replications.

The results displayed in Table 8 consolidate our main empirical result. There are fewer African tenants with a building landlord than with a dwelling landlord. Although the coefficients of interest are less precisely estimated, their magnitude is fairly comparable with that estimated with the regression framework and all the previous comments apply as well.

Table 8: Probability of having a building landlord: propensity score matching estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average treatment effect	-0.029**	-0.113***	-0.052**	-0.037	-0.050**	-0.061*	-0.094*
	(0.013)	(0.018)	(0.022)	(0.023)	(0.023)	(0.037)	(0.049)
Individual characteristics		X	X	X	X	X	X
Location characteristics			X	X	X	X	X
Apartment characteristics				X	X	X	X
Trend	X	X	X	X	X	X	X
Nb non-immigrants on common support	8,710	8,710	8,710	8,669	6,284	2,955	1,325
Nb Africans on common support	1,440	1,440	1,440	1,417	1,198	577	278

Notes: (i) Average treatment effect of propensity score matching using a logit model in the first step. (ii) Standard errors in parentheses. For the Average treatment effects, standard errors are bootstrapped with 100 replications. 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, excluding non-African immigrants. (iv) Individual and apartment characteristics: Those reported in Tables A2 and A3 (in Appendix A). (v) Location characteristics: those reported in columns 2 and 3 of Table B5.

2.2.4 Neighborhood: 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 9, we consider finer spatial controls. In column (2), we distinguish between MSAs and départments. 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. In column (3) the more populated MSAs (Paris) is omitted from the sample, as a further robustness check.

Finally, we acknowledge the fact that spatial externalities may take place at a broader scale 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 (4)) and the census block (column (5)).[15] Those shares are computed from the 1990 Census in order to mitigate the reflection problem.

Table 9: Probability of having a building landlord: controlling for spatial sorting

	(1)	(2)	(3)	(4)	(5)
African immigrant	-0.0539***	-0.0391*	-0.0419^{o}	-0.0390**	-0.0626**
	(0.0172)	(0.0212)	(0.0274)	(0.0177)	(0.0255)
Non-African immigrant	-0.0417**	-0.0363*	0.0004	-0.0328*	-0.0550*
	(0.0183)	(0.0216)	(0.0288)	(0.0153)	(0.0240)
MSA Fixed effects		X			
Excluding Paris region			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	X
Nb observations	11,052	10,875	7,368	10,714	7,555
R-Squared	0.17	0.21	0.28	0.18	0.19

Notes: (i) Marginal effects of a Probit model reported. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10%, ^{o}: 13% (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 7.

[15] In this latter specification, the number of observation drops because of missing information on census block for about 30% of our sample.

The results are partially affected by these new specifications. In particular, the marginal effect of being African drops from 5 to 4% in columns (2) and (3). Without Paris, the result is only significant at the 13% threshold level which can be understood easily because 2/3 of Africans are dropped from our sample. The spatial allocation of African immigrants between different cities is partly correlated with the observation that they less often have building landlords. As shown in column (4), living in a municipality with a higher share of immigrants is negatively correlated with tenants' probability of having a building landlord. However, this is not the case at the neighborhood level (column (5)), where taste-based residential sorting is more likely to take place. In addition, regardless of the specification, the specificity of immigrants as a whole keeps standing out, except when Paris MSA is omitted for which the coefficient for Non-African vanishes.

The issue of residential sorting will be further addressed in Section 3, which provides a discussion on the potential impact of neighbor discrimination on the ethnic segmentation of the rental market.

2.2.5 Interactions between landlord and tenant

One may think to other confounding factors that have not been controlled for yet. These factors are related to the possible interactions between the landlord and the tenant. These interactions can take place in the search process itself or later on when the tenant occupies the apartment.

Intermediated search 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 (1) in Table B6 in Appendix B 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 affect the estimates.

Property management Property management may be different across landlord types. 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 a significantly lower 55% of tenants with a dwelling landlord. 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. However, as shown in column (2) of Table B6 in Appendix B controlling for this factor does not affect our result.

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

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. 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 B6 therefore controls for the default variable without any change on the marginal probability of African.

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 individual 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 (4) of Table B6, where we control for whether the tenant witnessed such property damage. Again, the marginal probability of African remains unchanged.

2.2.6 Quantitative implications for residential segregation

Overall, the micro effects we are able to detect amount to the under-representation of African immigrants in large-landlord buildings by between 3 and 8%. We can offer a back-of-the-envelope calculation of how much it explains the under representation of immigrants of African origin in the housing stock owned by building landlords. They own 39% of the private rental stock, but only 33% of Africans rent an apartment to a building landlord. If neighbor discrimination disappeared in the private rental sector, all else equal, this 33% would become something between

[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.

36% and 41%. Therefore, at least 50% of the differential between Africans and French born living in building-landlord housing stock is explained by our empirical model. We believe that it is likely to have large spatial consequences and to play a sizeable role in the segregation of ethnic minorities, as explained and illustrated in the next section.

3 Neighbor discrimination and segregation into public housing

In this section, we show that the probability of living 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.

This result matters for two reasons. First, it provides an indirect test of the existence of neighbor discrimination under the assumption that the conditional probability of living in public housing reflects a lack of access to the private housing market. Second, it is well-known that African immigrants are over-represented in public housing and our results suggest that neighbor discrimination in local private rental markets may account for 35% of the spatial component of this gap.

3.1 Elements of context

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). HLM applicants are strictly assigned to a set of dwellings based on their household characteristics and cannot pick housing characteristics (see (Algan, Hémet, and Laitin 2016) for evidence). We will make use of this feature and will therefore not control for housing characteristics in the regressions presented in this section.

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). One could argue that this situation reflects the specificity of African immigrants' housing demand. However, if HLMs were specifically chosen by Africans for cultural reasons, they should be enjoyed more by them than by other tenants, whereas our data seems to indicate that the opposite is actually true.[17]

We argue that the over-representation of African immigrants in public housing partly reflects neighbor discrimination in 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

[17] Table C1 in Appendix C shows that African HLM tenants are more likely by 16 points to declare that they would move out of their current dwelling if they could. Even after controlling for any observable characteristic of the household and the dwelling, this gap remains at 6 points.

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.

Unlike other forms of discrimination, the intensity of neighbor discrimination should increase with the market size owned by building landlords. This provides another test of neighbor discrimination, which complements the first one in a natural way. Section 3 in the online Appendix provides a more formal argument. It builds on the main lessons of the model in Section 1 to understand how neighbor discrimination affects the ethnic-specific proportions in HLM. This model as well as the previous reasoning lead to Prediction 2:

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

Prediction 2 is tested empirically using the same data as in Section 2.

3.2 Empirical strategy

We focus on the sample of tenants, indexed by i, in the public and private markets. Each tenant lives in département $d(i)$, which we regard as a local housing market. Each département is characterized by a fraction of building landlords $Share_d$. We examine the empirical impact of $Share_d$ on the difference in the net probability to live in public housing between French-born, 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).[18] In the second step, we regress the three sets of estimated ethnic-specific département fixed effects on $Share_d$ and a set of département control variables, X_d.

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

$$u_i^* = \beta_0 + \sum_{e=A,NA} \beta_1^e e_i + X_i\beta_2 + \phi^F_{d(i)} + \sum_{e=A,NA} \phi^e_{d(i)} \times e_i + \epsilon_i \tag{14}$$

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

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

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.

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 $e = F, A, NA$,

$$\hat{\phi}^{e}_{d} = \gamma^{e}_{0} + \gamma^{e}_{1} Share_d + X_d \gamma^{e}_{3} + \varepsilon^{e}_{d}, \tag{15}$$

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 (2016b) 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.[19]

3.3 Results

First step— Table C2 in Appendix C displays the estimation results of increasingly complete 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 immigrants (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.

[19] 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.

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-born or of non-African origin are close to zero and imprecisely estimated, whereas this impact for Africans is equal to 0.38 and is precisely estimated. The R-squareds confirm this difference since they are close to zero for French-born and non-African immigrants, and equal to 10% for African immigrants.

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 C2; (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).

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 the impact of the local share of building landlords are virtually unaffected by this set of controls, even though the R-squared 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.

Lastly, in columns (7) to (9), the regressions control 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 building 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 in the 1990 Census. The quality of the HLM supply is proxied by the age structure of the HLMs. We control for the share of HLMs that were built between 1960 and 1972.[20] The next two control variables, short-run and long-run vacancy rates in HLMs, are indicators of tightness in the public housing market. They combine supply-side and demand-side determinants: for example, if the vacancy rate is low, it may be because

[20]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.

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 vacancies 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.[21]

The other five controls, taken from the 1990 census, 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. Once again, the results are virtually unaffected by the inclusion of these controls, even though the R-squared significantly increases in each of the three regressions.

Table 10 offers an insight regarding the impact of neighbor discrimination in the private rental market on the segregation of ethnic minorities into public housing. According to column (3) in Table C2, the probability that African immigrants live in HLM is 9 percentage points larger than for the French-born. According to column (8) in Table 10, the bulk of this unexplained probability differential is due to building landlords who are more likely to discriminate against African immigrants. Indeed, multiplying the coefficient associated to the variable $SHARE$, 0.355, by the mean proportion of apartments owned by building landlords, 40%, gives about 14%. Therefore, it is even possible that African immigrants would less often live in public housing than non-immigrants, in the absence of neighbor discrimination. This finding is in line with the results displayed in Table C1 in Appendix C whereby African HLM tenants declare lower satisfaction levels than other HLM tenants. It is also in line with existing research showing that African public housing tenants end up in the lowest-quality neighborhoods (Schmutz 2015).

4 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

[21] These variables on vacancy and construction come from a survey called *Enquête Parc Locatif Social* (Survey 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.

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 neighbor 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 remain stuck in public housing. These persons cannot easily take 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 2016b). 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.

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A Descriptive statistics

Table A1: 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 A2: 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 A3: Characteristics of the dwelling by landlord type, population of interest

	Building landlord	Dwelling landlord	Significance of t-test
Number of rooms (logarithm)	0.96	0.83	$< 1\%$
Size in squared meters (logarithm)	4.06	3.96	$< 1\%$
Rent per square meter (2006 euro)	7.22	9.63	$< 1\%$
Balcony (share)	0.29	0.52	$< 1\%$
Private outdoor space (share)	0.09	0.04	$< 1\%$
Large bathtub (share)	0.57	0.69	$< 1\%$
Safety device (share)	0.31	0.41	$< 1\%$
Parking space (share)	0.28	0.37	$< 1\%$
Tenant suffers from cold (share)	0.18	0.16	3%
Tenant suffers from noise (share)	0.47	0.45	6%
Landlord is a firm (share)	0.27	0.06	$< 1\%$
Number of levels in the building	3.16	5.00	$< 1\%$
Number of apartments in the building	14.2	29.5	$< 1\%$
Building built between 1949 and 1974 (share)	0.25	0.39	$< 1\%$
Building built after 1974 (share)	0.19	0.30	$< 1\%$
Département population (1990 Census)	417,936	494,465	$< 1\%$
Public housing (1990 Census, dép. share)	0.15	0.14	85%
Homeowners (1990 Census, dép. share)	0.51	0.49	$< 1\%$
Large families (1990 Census, dép. share)	0.09	0.08	$< 1\%$
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.

Table A4: The probability of facing a large landlord as a function of landlord characteristics

	(1)	(2)	(3)	(4)
African household	-0.018	-0.010	-0.035	-0.052
	(0.259)	(0.254)	(0.245)	(0.239)
Inherited		-0.062	-0.064	-0.080
		(0.078)	(0.078)	(0.078)
Owned for more than 5 years		0.162***	0.159***	0.148***
		(0.057)	(0.056)	(0.055)
Share owned by the respondent		-0.001	-0.001	-0.000
		(0.001)	(0.001)	(0.001)
In same location as landlord			0.074	0.082
			(0.060)	(0.064)
University degree (respondent)				-0.072
				(0.052)
Household income				2.47
				(1.83)
Age (respondent)				0.001
				(0.003)
Man (respondent)				-0.009
				(0.149)
In a couple (respondent)				0.055
				(0.129)
Owns a real estate firm (respondent)				0.044
				(0.124)
Pseudo-R^2	0%	1.7%	2.1%	3.1%

Notes: (i) Marginal effects a probit models of the probability of facing a large landlord (see text for definition) using sampling weights. (ii) Sample: all apartments in continental France rented out for the twelve past months by a landlord declaring positive rental income: 771 observations; (iii) Covariates: see Table 6. For the sake of exposition, household income is expressed in millions of Francs.
Source: Enquête Patrimoine 1998.

B Additional results Section 2

Table B1: Determinants of the rent

	(1)	(2)	(3)	(4)
African immigrant	0.216***	-0.0209	-0.0170	-0.0220
	(0.0181)	(0.0134)	(0.0133)	(0.0138)
non-African immigrant	0.141***	-0.0172	-0.0157	-0.0320**
	(0.0214)	(0.0147)	(0.0146)	(0.0150)
Building landlord	-0.264***	-0.102***	-0.0905***	-0.0788***
	(0.0111)	(0.00797)	(0.00815)	(0.00885)
African × Building landlord	-0.00634	-0.0134	-0.0231	0.0141
	(0.0305)	(0.0200)	(0.0199)	(0.0209)
non-African × Building landlord	-0.0756**	0.00141	-0.0074	0.00192
	(0.0352)	(0.0231)	(0.0231)	(0.0244)
Individual characteristics		X	X	X
Apartment characteristics		X	X	X
Département fixed effects		X		
MSA fixed effects			X	
Département-year and Municipality fixed effects				X
Time dummies	X	X	X	X
Nb observations	11,138	11,055	11,055	11,055
R-squared	0.135	0.642	0.660	0.711

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 7, except rent. (iv) Sample: All tenants in privately-rented apartments who had a place of their own in France four years before the survey.

Table B2: Determinants of the declared satisfaction level

	(1)	(2)	(3)	(4)
African immigrant	-2.277***	-1.830***	-1.531***	-0.869***
	(0.0766)	(0.0798)	(0.0834)	(0.0769)
non-African immigrant	-1.248***	-0.977***	-0.697***	-0.365***
	(0.0944)	(0.0942)	(0.0966)	(0.0879)
Building landlord	-0.334***	-0.201***	-0.204***	-0.0585
	(0.0532)	(0.0527)	(0.0545)	(0.0514)
African × Building landlord	0.477***	0.329**	0.274**	0.169
	(0.132)	(0.130)	(0.130)	(0.117)
non-African × Building landlord	0.301*	0.249	0.127	0.0339
	(0.160)	(0.156)	(0.156)	(0.140)
Individual characteristics		X	X	X
Location fixed effects			X	X
Apartment characteristics				X
Time dummies	X	X	X	X
Nb observations	8,063	8,063	8,063	7,979
R-squared	0.144	0.186	0.213	0.372

Notes: (i) Ordinary-least-square regression of the grade (from 1 to 10) given to current living conditions. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Controls are the same as in Table 7. (iv) Sample: All tenants (ENL 2002 and 2006) in privately-rented apartments who had a place of their own in France four years before the survey.

Table B3: Probability of having a building landlord: controlling for the 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 (the two random variables are whether the landlord is a building landlord or not, and whether the landlord is registered as a firm or not), 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 7.

Table B4: Probability of having a building landlord: isolating the group of European immigrants

	(1)	(2)	(3)	(4)
African immigrant	-0.030**	-0.084***	-0.054***	-0.055***
	(0.014)	(0.015)	(0.016)	(0.017)
non-European non-African immigrant	-0.040*	-0.080***	-0.063***	-0.051***
	(0.022)	(0.022)	(0.023)	(0.025)
European immigrant	0.016	-0.019	-0.007	-0.033
	(0.023)	(0.023)	(0.024)	(0.024)
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	0.015	0.030	0.092	0.181

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 A2 and A3 (in Appendix A). (v) Location fixed effects: départements.

Table B5: First stage: probability for the tenant to be of African origin

	(1)	(2)	(3)
Total population (in 10^7)		-7.25***	-8.89***
		(1.99)	(1.96)
Share of public housing		3.36	-0.91
		(2.14)	(1.99)
Share of non-homeowners		10.36***	14.58***
		(2.42)	(2.23)
Vacancy rate		-4.44*	-10.35***
		(2.65)	(2.49)
Share of furnished rooms		7.84	12.05
		(8.47)	(8.38)
Departement fixed effects	X		
Trend	X	X	X
Nb observations	9,094	10,150	9,094
Pseudo-R^2	0.19	0.18	0.16

Notes: (i) Logit model of the probability for the tenant to be of African origin. (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, excluding non-African immigrants..

Table B6: Probability of having a building landlord: controlling for taste-based discrimination, statistical discrimination and networks

	(1)	(2)	(3)	(4)	(5)
African immigrant	-0.062**	-0.058***	-0.055***	-0.052***	-0.061**
	(0.025)	(0.017)	(0.017)	(0.017)	(0.025)
non-African immigrant	-0.054*	-0.039**	-0.042**	-0.040**	-0.054*
	(0.029)	(0.018)	(0.018)	(0.018)	(0.029)
Friends or relatives	0.180***				0.163***
	(0.016)				(0.016)
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)
Controls	X	X	X	X	X
Nb observations	5,417	11,034	11,052	11,034	5,417
pseudo R-squared	0.211	0.187	0.181	0.181	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 (2) to (4): All tenants in privately-rented apartments who had a place of their own in France four years before the survey; columns (1) and (5): Restricted to those who have recently moved in. (v) Controls: Those considered in column (4) of Table 7.

C Additional results Section 3

Table C1: African HLM tenants would leave their current dwelling if they could

	(1)	(2)	(3)	(4)
African immigrants	0.160***	0.125***	0.120***	0.0610***
	(0.0125)	(0.0138)	(0.0143)	(0.0145)
non-African immigrants	0.0140	0.0329*	0.0317*	0.00487
	(0.0159)	(0.0169)	(0.0172)	(0.0174)
Individual characteristics		X	X	X
Location fixed effects			X	X
Apartment characteristics				X
Time dummies	X	X	X	X
Nb observations	15,290	15,290	15,290	15,254
Pseudo R-squared	0.0156	0.101	0.109	0.161

Notes: (i) Marginal effects of a Probit model reported. Probability that respondents answer they would move out of their current dwelling if they could. (ii) Standard errors in parentheses. Significance: ***: 1%, **: 5%, *: 10% (iii) Sample: All tenants in HLM who had a place of their own in France four years before the survey. (iv) Controls: those reported in Table 7.

Table C2: 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

ONLINE APPENDIX

A Proofs of Propositions

We provide the proofs of generalized version of Propositions 1 and 2 stated in Combes et al. when the landlord have prejudice, that is, $R_b/R_w \geq 1$. The difference $R_w - R_b$ is Becker's taste for discrimination.

Proposition 3 EQUILIBRIUM AND EFFICIENT STRATEGIES WITHOUT SEPARATION. *Consider the following thresholds* $\sigma_b = \eta(1-\alpha)p/[r+\eta(1-\alpha)p]$, $\sigma_w = \eta p/(r+\eta p)$,

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

1. *Assume* $\alpha = 0$.
   Then, $\hat{B} = B^* = \{(1,1,1)\}$ *when* $R_b/R_w \geq \sigma_w$, *and* $\hat{B} = B^* = \{(0,0,0)\}$ *when* $R_b/R_w < \sigma_w$.

2. *Assume* $\alpha > 0$
   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 $R_b/R_w \geq \sigma_{2v}$, *then* $B^* = \hat{B} = \{(1,1,1)\}$.

Proposition 1 in Combes and al corresponds to the case where $R_b/R_w = 1$ and $\sigma_{2v} = \sigma_v$. This gives only two possibilities described by parts (iv) and (v), which correspond to parts (i) and (ii) in their Proposition 1.

Proposition 4 COMPARING BUILDING AND DWELLING 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 building 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 building landlords—that is, for all $j = v, w, b$, $(0,0,0) \in B^*$ *implies* $(0,0,0) \in \hat{B}$.

Proposition 2 in Combes et al. corresponds to the case where $R_b/R_w = 1$. Therefore $R_b/R_w > \eta p/(r+q+\eta p)$ and $\hat{B} = B^* = \{(1,1,1)\}$, which gives their part (i). Their part (ii) is the same as here.

A.1 Proof of Proposition 1

Proof of Proposition 1.1

The result can be easily inferred from the limit properties of system (1)-(4) when $\alpha \to 0$. Note that this case is not examined in Combes et al. because in the absence of landlord discrimination, we have $R_b/R_w = 1 > \sigma_w$.

Proof of Proposition 1.2

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

$$r\Pi^{kl} = R_k, \tag{16}$$

$$\begin{aligned} r\Pi^{vb} &= \eta \frac{(1-p)\,\beta_b R_b + p\,(1-\alpha)\,R_w}{r + \eta\left[(1-p)\,\beta_b + p\,(1-\alpha)\right]} && (17)\\ r\Pi^{vw} &= \eta \frac{(1-p)\,\beta_w R_b + pR_w}{r + \eta\left[(1-p)\,\beta_w + p\right]} && (18)\\ r\Pi^{vv} &= \eta \frac{X_b R_b + X_w R_w}{\left\{r + \eta\left[(1-p)\,\beta_b + p\,(1-\alpha)\right]\right\}\left\{r + 2\eta\left[(1-p)\,\beta_v + p\right]\right\}} && (19) \end{aligned}$$

where:

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

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:

$$\Pi^{bb} - \Pi^{vb} = \Pi^{bb} - \Pi^{vb} - \left(\Pi^{bv} - \Pi^{bb}\right) = \frac{rR_b - (1-\alpha)\,p\eta\,(R_w - R_b)}{r\left[r + \eta\left((1-p)\,\beta_b + p\,(1-\alpha)\right)\right]}. \tag{20}$$

This implies:

$$\Pi^{bb} - \Pi^{vb} < 0 \Leftrightarrow \Pi^{bb} - \Pi^{vb} < \Pi^{bv} - \Pi^{bb} \Longleftrightarrow R_b/R_w < \sigma_b = \frac{\eta\,(1-\alpha)\,p}{r + \eta\,(1-\alpha)\,p}. \tag{21}$$

We also have:

$$\Pi^{bw} - \Pi^{vw} = \Pi^{bw} - \Pi^{vw} - \left(\Pi^{wv} - \Pi^{wb}\right) = \frac{rR_b - p\eta\,(R_w - R_b)}{r\left[r + \eta\left((1-p)\,\beta_w + p\right)\right]}. \tag{22}$$

This yields:

$$\Pi^{bw} - \Pi^{vw} < 0 \Leftrightarrow \Pi^{bw} - \Pi^{vw} < \Pi^{wv} - \Pi^{wb} \Longleftrightarrow R_b/R_w < \sigma_w = \frac{\eta p}{r + \eta p}. \tag{23}$$

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:

$$\Pi^{bv} - \Pi^{vv} = \frac{(r + p\eta)\, R_b - p\eta R_w}{r(r + p\eta)}. \tag{24}$$

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:

$$\begin{aligned} \Pi^{bv} - \Pi^{vv} \quad = \quad & \frac{(r + p\eta)\,(r + \eta + p\eta)\,(r + (1-\alpha)\,p\eta)}{r\,(r + 2\eta)\,(r + p\eta)\,(r + (1-\alpha)\,p\eta)} R_b \\ & - \frac{p\eta\left[r^2 + r\eta\,(1 - \alpha + 2p) + \eta^2\,(1-\alpha)\,p\,(1+p)\right]}{r\,(r + 2\eta)\,(r + p\eta)\,(r + (1-\alpha)\,p\eta)} R_w. \end{aligned} \tag{25}$$

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

$$\Pi^{bv} - \Pi^{vv} = \frac{(r + p\eta)\, R_b - p\eta R_w}{r(r + p\eta)}. \tag{26}$$

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.

A.2 Proof of Proposition 2

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

$$\arg\max_{\beta \in B} \Pi_2(\beta, \beta) = \arg\max_{\beta \in B} \Pi_1(\beta, .) = \arg\max_{\beta \in B} \Pi(\beta, .). \tag{27}$$

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

$$r\tilde{\Pi}^i = R_i + q(\tilde{\Pi}^v - \tilde{\Pi}^i), \tag{28}$$

$$r\tilde{\Pi}^v = \eta p(\tilde{\Pi}^w - \tilde{\Pi}^v) + \eta(1-p)\beta_b(\tilde{\Pi}^b - \tilde{\Pi}^v). \tag{29}$$

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:

$$\Pi^{jv} - \Pi^{jb} = \alpha p \eta [(q + r)R_w + \eta(1-p)(R_w - R_b)]N^j/D \tag{30}$$

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

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

Moreover

$$\Pi^{vv} - \Pi^{vb} = \frac{\alpha p (2q+r) \eta R_w}{(q+r)(q+r+p\eta)(2q+r+(1-\alpha)p\eta)} \geq 0. \tag{32}$$

B Extension of the model of Section 2

We assess the theoretical robustness of our test strategy by looking at two extensions, White flight and heterogenity in building size.

B.1 Numerical Simulations: White flight

White flight means that prejudiced White tenants immediately quit the dwelling when the neighbor is Black. The model is parameterized as in Combes et al., Table 1, but we allow for prejudiced landlords. There are three situations: unprejudiced landlords with $R_w = R_b = R$ (the baseline case presented in Combes et al.), a 10% discount with $R_w = 1.1R_b$ (a case discussed in Combes et al., section 2.4) and a 20% discount with $R_w = 1.2R_b$. We obtain two main results. First, as in the model without White flight, building landlords discriminate more often than dwelling ones. Second, the two models generates outcomes that are quantitatively very similar.

Table 2 describes the distribution of equilibrium outcomes of the game played by dwelling landlords, while Table 1 describes the distribution of the coordinated strategies set by building landlords. Both tables allow for a comparison between the baseline model (no White flight) and the alternative model (White flight). In the case of the game played by dwelling landlords, the two distributions look fairly similar, although the possibility of White flight seems to act as a mild deterrent against discrimination. The likelihood of discrimination in all possible states stays the same: if no black applicant is ever accepted, the issue of White flight becomes irrelevant. In the case of building landlords, this phenomenon is even more striking: discrimination becomes less likely under White flight because accepting a Black applicant when the other apartement is occupied (free-riding on the other tenant's lack of mobility) is no longer a viable option in most cases.

Table 1: Comparison of the distributions of the coordinated strategies by building landlords

	No white flight		White flight	
$(\hat{\beta}_b, \hat{\beta}_v, \hat{\beta}_w)$	Nb observations	Proportion	Nb observations	Proportion
$(0,0,0)$	853,914	44.47%	853,914	44.47%
$(0,0,1)$	240,621	12.53%	240,621	12.53%
$(0,1,1)$	111,153	5.79%	42,264	2.20%
$(1,1,1)$	714,312	37.20%	783,201	40.79%
Total	1,920,000	100%	1,920,000	100%

As in the baseline model, in order to compare the equilibrium strategies with the coordinated ones, we assume conservatively that landlords coordinate on the most-discriminating equilibrium. Table 3 tabulates the distribution of strategies adopted by each type of landlord. For the sake of comparison, the corresponding proportions obtained in the baseline model are in parentheses. As in the baseline model, the matrix is upper triangular, which means that there are no cases where dwelling landlords discriminate more than building ones. The probability mass above the main diagonal is about 17%, against 21% in the baseline model. Building land-

Table 2: Comparison of the distributions of the symmetric Nash equilibria of the game played by dwelling landlords.

	No white flight		White flight	
$(\beta_v^*, \beta_w^*, \beta_b^*)$	Nb observations	Proportion	Nb observations	Proportion
$(0,0,0)$	642,868	33.48%	642,868	33.48%
$(0,0,b)_{b\in(0,1)}$	88,707	4.62%	78,215	4.07%
$(0,0,1)$	251,456	13.10%	158,019	8.23%
$(0,0,1),(1,1,1)$	1,230	0.06%	95,311	4.96%
$(0,0,1),(1,0,1)$	6,304	0.33%	3	0.00%
$(0,0,1),(1,0,1),(1,1,1)$	1,020	0.05%	12,953	0.67%
$(0,0,1),(0,1,1)$	6,271	0.33%	6,381	0.33%
$(0,0,1),(0,1,1),(1,1,1)$	9,002	0.47%	8,248	0.43%
$(0,0,1),(1,0,1),(0,1,1),(1,1,1)$	5,632	0.29%	0	0
$(0,1,1)$	6,497	0.34%	948	0.05%
$(0,1,1),(1,1,1)$	15,497	0.81%	1,221	0.06%
$(1,1,1)$	885,516	46.12%	915,833	47.70%
Total	1,920,000	100%	1,920,000	100%

Table 3: Equilibrium and coordinated strategies: comparison of the baseline and the white flight models

	$(1,1,1)$	$(0,1,1)$	$(0,0,1)$	$(0,0,0)$	Total
$(1,1,1)$	**40.79%**	**2.20%**	**4.17%**	**0.54%**	**47.70%**
	(37.20%)	(5.79%)	(3.13%)	(0)	(46.12%)
$(0,1,1)$	0	0	**0.1%**	**0.01%**	**0.11%**
	0	0	(1.15%)	(0)	(1.15%)
$(0,0,1)$	0	0	**8.26%**	**6.37%**	**14.63%**
	0	0	(8.26%)	(6.37%)	(14.63%)
$(0,0,b)$	0	0	0	**4.07%**	**4.07%**
	0	0	0	(4.62%)	(4.62%)
$(0,0,0)$	0	0	0	**33.48%**	**33.48%**
	0	0	0	(33.48%)	(33.48%)
Total	**40.79%**	**2.20%**	**12.44%**	**44.47%**	**100%**
	(37.20%)	(5.79%)	(12.53%)	(44.47%)	(100%)

Notes: Each column corresponds to a particular coordinated strategy $(\hat{\beta}_v, \hat{\beta}_w, \hat{\beta}_b)$, whereas each row corresponds to a particular equilibrium strategy $\left(\beta_v^*, \beta_w^*, \beta_b^*\right)$. 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.

lords, therefore, discriminate strictly more than dwelling landlords in 17% of simulations. The difference comes from the fact that the non-discriminatory strategy for both types of landlord happens in 3.5% of additional cases.

B.2 Heterogeneity in building size

We discuss here the impact of the building size on the coordinated strategy. We show that, contrary to the intuition, building landlords of larger buildings may not always discriminate more.

We consider a model where buildings are made out of three apartments and prejudice cannot be diluted in the sense that one black tenant in the building is enough for prejudiced white applicants to refuse the proposed dwelling. The value functions for two-dwelling building landlords are defined in Combes et al. as the sum $\Pi^{jl}+\Pi^{lj}$ and we allow for neighbor discrimination. For three-dwelling building landlords, in order to save on the number of equations, we directly model the values of the buildings. There are ten possible building compositions. The building value functions are therefore defined as follows:

$$
\begin{aligned}
r\Pi^{vvv} &= 3\eta\left\{p[\Pi^{vvw}-\Pi^{vvv}]+(1-p)\beta_{vv}[\Pi^{vvb}-\Pi^{vvv}]\right\}, && (33)\\
r\Pi^{vvb} &= R_b+q[\Pi^{vvv}-\Pi^{vvb}]+2\eta\left\{p(1-\alpha)[\Pi^{vbw}-\Pi^{vvb}]+(1-p)\beta_{vb}[\Pi^{vbb}-\Pi^{vvb}]\right\}, && (34)\\
r\Pi^{vvw} &= R_w+q[\Pi^{vvv}-\Pi^{vvw}]+2\eta\left\{(p[\Pi^{vww}-\Pi^{vvw}]+(1-p)\beta_{vw}[\Pi^{vbw}-\Pi^{vvw}]\right\}, && (35)\\
r\Pi^{vbb} &= 2R_b+2q[\Pi^{vvb}-\Pi^{vbb}]+\eta\left\{p(1-\alpha)[\Pi^{bbw}-\Pi^{vbb}]+(1-p)\beta_{bb}[\Pi^{bbb}-\Pi^{vbb}]\right\}, && (36)\\
r\Pi^{vbw} &= R_b+R_w+q[\Pi^{vvb}+\Pi^{vvw}-2\Pi^{vbw}] && (37)\\
&\qquad \eta\left\{p(1-\alpha)[\Pi^{bww}-\Pi^{vbw}]+(1-p)\beta_{bw}[\Pi^{bbw}-\Pi^{vbw}]\right\} && (38)\\
,r\Pi^{vww} &= 2R_w+2q[\Pi^{vvw}-\Pi^{vww}]+\eta\left\{(p[\Pi^{www}-\Pi^{vww}]+(1-p)\beta_{ww}[\Pi^{bww}-\Pi^{vww}]\right\},\\
r\Pi^{www} &= 3R_w+3q[\Pi^{vww}-\Pi^{www}], && (39)\\
r\Pi^{www} &= 3R_w+3q[\Pi^{vww}-\Pi^{www}], && (40)\\
r\Pi^{bbb} &= 3R_b+3q[\Pi^{vbb}-\Pi^{bbb}], && (41)\\
r\Pi^{bww} &= 2R_w+R_b+q[2\Pi^{vbw}+\Pi^{vww}-3\Pi^{bww}], && (42)\\
r\Pi^{bbw} &= R_w+2R_b+q[2\Pi^{vbw}+\Pi^{vbb}-3\Pi^{bbw}] && (43)
\end{aligned}
$$

where β_{jl} denotes the probability of accepting a black applicant when the other two apartments are of type-(j,l).

We simulate the model using the same parameterization as in Section A.1. Table 4 displays the discriminatory strategies adopted by the two types of building landlords. Given that the state space is different, the comparison is not completely straightforward, but the general picture is that all the positive-profit strategies are located around the "diagonal", which shows that the two types of building landlords behave somewhat similarly. However, there are a few cases where three-dwelling building landlords unambiguously discriminate less than two-dwelling building landlords. For instance, in 0.12% of the simulations, three-dwelling building landlords

do not discriminate at all, while two-dwelling building landlords discriminate against Black applicants when their other apartment is vacant.

Table 4: Coordinated strategies: comparison of building landlords of two- and three-dwelling buildings

	$(1,1,1)$	$(0,1,1)$	$(0,0,1)$	$(0,0,0)$	Total
$(1,1,1,1,1,1)$	34.41%	0.12%	0	0	34.52%
$(0,1,1,1,1,1)$	1.39%	0.003%	0	0	1.40%
$(0,1,0,1,1,1)$	1.40%	2.21%	0	0	3.61%
$(1,0,1,1,1,1)$	0	0.05%	0	0	0.05%
$(0,0,1,0,1,1)$	0	3.41%	8.28%	0	11.70%
$(0,0,0,0,1,1)$	0	0	0.24%	0	0.24%
$(0,0,1,0,0,1)$	0	0	1.53%	0.25%	1.79%
$(0,0,0,0,0,1)$	0	0	2.47%	2.03%	4.50%
$(0,0,0,0,0,0)$	0	0	0	42.19%	42.19%
Total	37.20%	5.79%	12.53%	44.47%	100%

Notes: Each column corresponds to a particular coordinated strategy $(\hat{\beta}_v, \hat{\beta}_w, \hat{\beta}_b)$ for two-dwelling building landlords, whereas each row corresponds to a particular coordinated strategy $(\hat{\beta}_{vv}, \hat{\beta}_{vw}, \hat{\beta}_{vb}, \hat{\beta}_{ww}, \hat{\beta}_{bw}, \hat{\beta}_{bb})$ for three-dwelling building landlords. The number in each cell corresponds to the percentage of our simulations that engender this particular configuration.

C Theoretical extension for Section 3

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 2, x_b depends on the probability of meeting a building landlord. We have

$$x_b = (1-\gamma)\left[Share \times \beta_2 + (1-Share) \times \beta_1\right], \tag{44}$$

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 appli-

cants, 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:

$$rU_e^{HLM} = \max\left\{0, -c + \mu x_i \left[U_e^{PR} - U_e^{HLM}\right]\right\}, \tag{45}$$

$$rU_e^{PR} = a + q\left[U_e^{HLM} - U_e^{PR}\right]. \tag{46}$$

Solving for (45) and (46), 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 rent in the private sector. In steady state,

$$HLM_e = \frac{q}{q + \mu x_e \Psi(\theta_e)}. \tag{47}$$

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

$$\begin{aligned} \frac{d\Delta_{b,w}}{dShare} &= \frac{dHLM_b}{dx_b} \times \frac{dx_b}{dShare} \\ &= (HLM_b)^2 \frac{\mu\Psi(\theta_b)}{q}\left[1 + \varepsilon(\theta_b)\right](1-\gamma)(\beta_1 - \beta_2) \geq 0, \end{aligned} \tag{48}$$

where $\varepsilon(t) \equiv t \times \Psi'(t)/\Psi(t)$ is the elasticity of the participation rate to the search activity.

Therefore this effect is positive if and only if building landlords discriminate more than dwelling landlords. This phenomenon only arises when there is neighbor discrimination. This reasoning leads to the additional test of neighbor discrimination that we run throughout Section 3.