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City Structure, Job Search, and Labor Discrimination. Theory and Policy Implications

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Abstract

We consider a search-matching model in which black workers are discriminated against and the job arrival rates of all workers depend on social networks as well as distance to jobs. Location choices are driven by the racial preferences of households (both blacks and whites) consciously choosing to trade off proximity to neighbors of similar racial backgrounds for proximity to jobs. Because of coordination failures in the location choices, multiple urban equilibria emerge. There is a *Spatial-Mismatch Equilibrium* in which blacks reside far away from jobs and experience high unemployment rates and a *Spatial-Match Equilibrium* in which blacks are closer to jobs and experience lower unemployment rates. Under some reasonable condition, we demonstrate that all workers are better off in the Spatial-Match Equilibrium. We then consider two policies: affirmative action, and employment subsidies to the firms which hire black workers. We show that the optimal policy requires imposing larger quotas or subsidies in cities in which black workers reside far away from jobs than in cities in which they live closer to jobs.

JEL Classification: J15, J41, R14.

Keywords: Spatial mismatch, racial preferences, social networks, Affirmative Action, employment subsidies.

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1 Introduction

Most (American and European) cities exhibit stark and persisting socioeconomic disparities across neighborhoods and racial groups. In the US in particular, segregated black workers residing in inner cities often face lower wages and higher unemployment probabilities than other workers residing elsewhere in the city.

Even though the link between urban segregation and the labor market outcomes of ethnic minorities has been extensively debated and studied by social scientists (see, among others, Kain, 1968; Massey and Denton, 1988; Holzer, 1991; Wilson, 1996; Cutler and Glaeser, 1997; Topa, 2001), we still do not have a clear understanding of this link. It may be because two seemingly unrelated issues are at stake: the location choices of workers in cities and their consequences in the labor market. The objective of the present paper is to further investigate this link by proposing a new mechanism based on racial preferences, labor discrimination, job search and social networks.

Indeed, we consider a search-matching model in which black workers are discriminated against and in which the job arrival rates of all workers depend on social networks as well as distance to jobs. Our main focus is the impact of ethnic preferences and location on labor market outcomes.[1] Location choices are driven by the racial preferences of households (both blacks and whites) consciously choosing to trade off proximity to neighbors of similar racial backgrounds for proximity to jobs.

To be more precise, we consider three different groups: whites, conformist blacks who abide by the ghetto's norm and thus wish to live among blacks, and status-seeker blacks who abide by the norm of the white majority and thus wish to live close to whites. As stated above, the spatial separation between racial groups does not result from housing discrimination but is caused by the voluntary choices of individuals who wish to interact exclusively with other individuals of their own community. Given the residential structure of the city, there are two main factors that determine job acquisition: labor discrimination and the amount of information workers can gather about jobs through (local) social networks and (local) formal sources of information.

We show that multiple equilibria emerge depending on which equilibrium individuals coordinate their residential choices. In the *Spatial-Mismatch Equilibrium*, blacks reside far away from jobs, experience high unemployment rates and have poor social networks. In the *Spatial-Match Equilibrium*, blacks are close to jobs and experience low unemployment rates whereas whites, who locate further away from jobs, can still face a low unemploy-

[1]In fact, few theoretical models have investigated this link. Akerlof (1997) discusses informally a model that has these features while Akerlof and Kranton (2002) propose a theory in which a student's primary motivation is his or her identity and the quality of a school depends on how students fit in a school's social setting. Battu et al. (2003) investigate the tension between identity and access to good jobs. Finally, Austen-Smith and Fryer (2003) model peer pressures in education by putting forward the tension faced by individuals between signalling their type to the outside labor market and signalling their type to their peers: signals that induce high wages can be signals that induce peer rejection. One of their main results is to show that the more individuals discount the future, the more acute peer pressure becomes and the more homogemous groups are (in terms of education).

ment rate because they are not discriminated against. We demonstrate that under some reasonable condition, workers are better off in the *Spatial-Match Equilibrium* than in the *Spatial-Mismatch Equilibrium*, confirming various empirical studies that show that spatial mismatch is very harmful to blacks (see Ihlanfeldt and Sjoquist, 1998, for a detailed survey).

We also show that access to jobs does not matter very much for whites (because they are not discriminated against) and not so much for status-seeker blacks (because of their local interactions with whites) but does matter very much for conformist blacks. We are also able to highlight the fact that social networks strongly depend on location and physical distance to jobs, which implies that social networks differ across locations and groups.

We finally analyze two different policies: affirmative action, and employment subsidies to the firms which hire black workers. We show that the impact of both policies depends on city-structure. In particular, we show that *the optimal policy requires imposing higher quotas in cities in which black workers reside far away from jobs than in cities in which they live closer to jobs*.

The remainder of the paper is organized as follows. The model is introduced in the next section. In section 3, we determine the different urban land-use equilibria and the associated labor-market outcomes. In section 4, we compare the two equilibria and discuss some important implications of our model. We also propose a set of numerical simulations which illustrates the workings of the model. We then analyze the two above-mentioned policies in section 5. Finally, section 6 concludes.

2 The model

Let us consider a continuum of equally productive workers (blacks and whites)[2] uniformly distributed along a linear and closed city. All land is owned by absentee landlords and all firms are exogenously located in the Business District (BD hereafter). The BD is a unique employment center located at one end of the linear city. In a centralized city, it corresponds to the Central Business District, whereas in a completely decentralized city, it represents suburban employment. We assume that firms only resort to two types of recruitment methods: by word of mouth, or by posting "want ads" in local newspapers. This assumption will have important consequences on the amount of locally available information about jobs in each residential district (see subsection 2.2 below). Workers are risk neutral, optimally decide their place of residence between the BD and the other end of the city, and all consume the same amount of land (normalized to 1 for simplicity). Without loss of generality, the density of residential land parcels is taken to be unity, so that there are exactly x units of housing within a distance x from the BD. As mentioned in our introduction and discussed in detail below, there are three groups: two types of blacks respectively denoted by BS (status-seeker blacks) and BC (conformist blacks), and whites denoted by W. The sizes of these population groups are respectively denoted by $\overline{N}_{BS}$, $\overline{N}_{BC}$ and $\overline{N}_{W}$, with

[2] In this paper, we do not focus on differences in education between blacks and whites. On the contrary, we want to compare their labor market outcomes for a given level of human capital.

$\overline{N}_{BS} + \overline{N}_{BC} + \overline{N}_W \equiv 1$, so that the second end of the city is at a distance equal to 1 from the BD. We assume that $\overline{N}_W > \overline{N}_B$, which is the case of most cities.

2.1 Racial preferences and utilities

In our model, racial preferences play a fundamental role because the desire—or reluctance—to interact with other racial groups can influence the relative location of each community in the city. The present subsection discusses our way of modeling such preferences.

As stated in the introduction, residential segregation occurs because individuals prefer to interact exclusively with other individuals of their own community. This assumption may seem provocative but has both theoretical and empirical foundations. From a theoretical point of view, Loury (1999) observes that 'even a mild desire for people to live near members of their own race can lead to a strikingly severe degree of segregation in the aggregate'. This is indeed a well know result in the so-called *preference models* in the urban literature (also see the theoretical and empirical studies of Schelling, 1971, Galster, 1990, 2000). In a recent empirical study, Ihlanfeldt and Scafidi (2002) find evidence that racial preferences are a large, if not the main factor that explains housing segregation in Atlanta, Boston, Detroit and Los Angeles. They show that the preferences of blacks and whites for the racial composition of their neighborhoods account for respectively 65% and 9% of housing segregation in those cities. As the authors observe, this is in accordance with the controversial observation that 'segregation is partly—and for most middle-class Afro-Americans, largely—a voluntary phenomenon' (Patterson, 1997).[3]

To model this behavior, we assume that there exist costs or benefits associated with living near and interacting with individuals of a different race. The idea is not new in the literature on ghettos (see for instance Cutler and Glaeser, 1997, who present a stylized model in which blacks incur a cost to move into areas where whites are a majority, and whites bear a similar cost to move into mostly black areas). We adopt a fairly similar way of modeling racial preferences. In our model, the further an individual locates from another race group, the fewer contacts the individual is likely to establish with members of that race group. This means that individuals from a given community who seek interracial contacts will value living close to the other community, whereas individuals who prefer to interact exclusively with members of their own group will shun such locations. Thus, depending on their tastes for interracial social interactions, individuals may benefit or suffer from a group-specific externality increasing or decreasing with the distance to the physical frontier between races.

In order to keep the model tractable, we assume that groups always form spatially homogenous communities. In other words, we only focus on equilibria in which all the members

[3]To explain why individuals have such racial preferences is beyond the scope of the present paper. It should be noted however that both majority and minority groups may have reasons to segregate themselves. In particular, it is believed that minority groups may wish to share a common culture with their neighbors or to interact in their own language (Akerlof, 1997, Akerlof and Kranton, 2000), that they may be prejudiced against whites or may have expectations of unfavorable treatment by whites in white neighborhoods (Ihlanfeldt and Scafidi, 2002) and that clustering together might enable them to mobilize common resources (Yinger, 1985), improving their access to ethnic goods such as food, education or religious service.

of a given community live together and do not mix with members of other communities (this is in accordance with real-world cities; see e.g. Table 1 in Borjas, 1998). This is because the aim of this paper is not to explain why segregation occurs (or why only homogenous communities emerge in equilibrium)[4] but rather to analyze the consequences of urban segregation on labor market outcomes. In this context, what only matters for a white (black) worker in terms of racial preferences is the residential location of the closest black (white) individual.

We will now express the utility functions of workers. To do that, let us consider an individual located in x. If this individual is white, we denote by $b_B(x)$ the location of the closest black worker from x. If this individual is a conformist black or a status-seeker black, we denote by $b_W(x)$ the location of the closest white from x. Since communities are assumed to be homogenous, observe that: (i) by definition, the location of the closest black (white) individual is the location of the closest border between communities; (ii) both $b_B(x)$ and $b_W(x)$ are step functions such that generically $b_B'(x) = 0$ and $b_W'(x) = 0$ wherever these functions are defined and differentiable. This is because two close neighbors share the same closest neighborhood border. The respective utility functions for a white, a status-seeker black, and a conformist black worker of employment status $j = U, E$, and location x, are then given by:

$$V_{Wj}(x) = y_j - t\,x - R(x) + e_W\ |x - b_B(x)| \tag{1}$$

$$V_{BSj}(x) = y_j - t\,x - R(x) + e_{BS}\ |x - b_W(x)| \tag{2}$$

$$V_{BCj}(x) = y_j - t\,x - R(x) + e_{BC}\ |x - b_W(x)| \tag{3}$$

where y_j is the exogenous income of a worker with employment status j (y_E and y_U are respectively the wage of the employed and the unemployment benefit, with $y_E > y_U > 0$), t is the commuting cost per unit of distance, $R(x)$ is the land rent at a distance x from the BD and e_i measures racial preferences.

The following comments are in order. First, we have assumed that, irrespective of race, all workers are paid the same wage. This is because all workers have the same education level and are equally productive. Second, we have assumed that the unemployed and the employed bear the same commuting cost per unit of distance. This assumption can be justified by considering that, when unemployed, workers still have to go to the BD in order to shop. Even though this assumption is not essential to our model, it simplifies the analysis. Third, in our formulation, the racial externality incurred by a worker of one community is expressed through the distance to the other community. Therefore, as discussed above, *racial preferences are captured through the fact that individuals may want to live far from or close to the other community so as to interact or avoid contact with members of the other group.* We assume that all whites want to live far away from blacks and that some blacks (labeled "conformist blacks") want to live far away from whites. In our framework, this requires $e_W > 0$ and $e_{BC} > 0$. For these two types of workers, it is easy to see that when the distance to the other community increases, utility increases, reflecting the disutility

[4] The endogenous formation of segregation has been analyzed in the urban economics literature by, among others, Courant and Yinger (1977), Yinger (1976) and surveyed by Fujita (1989, ch.7) and Kanemoto (1980).

of interracial contacts with neighbors. This is the case for some blacks because they may not *trust* people from other communities, such as whites, especially when they have been historically discriminated against. In a similar way, whites may not *trust* blacks because of some traumatic experiences such as crime or fear of crime (see Alesina and La Ferrara, 2001, for an interesting study on trust and racial mixing). To the contrary, we assume that there is another group of blacks (labeled "status-seeker blacks") who would like to live close to whites, implying $e_{BS} < 0$. It is then easy to see that, for status-seeker blacks, utility increases with proximity to the boundary between communities, reflecting the benefit of living close to the other community.

These differences in behavior among blacks have sociological justifications: it has been observed that when a community is or has been socially excluded from a dominant group, some will identify with the dominant culture whereas others may reject it, even if it involves low economic returns for the latter subgroup (Akerlof and Kranton, 2000).[5] To summarize, in our model, some black workers are "status-seekers" ($e_{BS} < 0$) abiding by the white group's norm and trying to develop social contacts with whites, whereas others are "conformists" willing to maintain a group culture (like e.g. black nationalism), which implies social distance between themselves and whites ($e_{BC} > 0$). In the urban space, the former are willing to live close to whites ($e_{BS} < 0$) whereas the latter are less sensitive to the issue of integration and value residing far away from the white community ($e_{BC} > 0$).

2.2 Job search, social networks and arrival rates

In the following, we use the subscript $i = B, W$ for blacks and whites, and among blacks, we use the subscript $k = C, S$ to distinguish conformists from status-seekers. Consequently, we shall use the double subscript ik with $ik = W, BC, BS$ to refer to each one of our three groups.

Let us start by presenting the stocks in the labor market. There are $\overline{d}$ jobs in the economy. The total labor force is normalized to 1 and each firm only hires one worker. This implies that:

$$\overline{d} = E + Z \tag{4}$$

$$1 = E + U \tag{5}$$

where E, U and Z are respectively the total number of employed workers, unemployed workers, and vacancies in the economy (since each firm only hires one worker, E is also the total number of filled jobs).

[5] Empirical studies confirm such a behavioral split between blacks. For instance, Bledsoe et al. (1995) show that inner-city blacks and those living in predominantly black neighborhoods show stronger racial solidarity towards blacks as a whole than black suburbanites and black residents of racially-mixed neighborhoods. In a similar perspective, Cutler and Glaeser (1997) observe that it is skilled minorities who actually come into contact with whites, whereas unskilled minorities are left behind in segregated areas. This suggests that the different inclinations could be attributable, for instance, to differences in skills, maybe because skilled individuals may benefit more from integration than unskilled individuals.

As this will become clear below, there is discrimination in the labor market since some firms will only hire white workers (type $W-$firms) while others will only hire black workers (type $B-$firms).[6] As a result, the labor markets for blacks and for whites are separate (or segmented) because, for example, blacks and whites do not apply to the same type of jobs even if they have the same level of education. Time is continuous and workers live forever. A vacancy of type $i = B, W$ can be filled according to a random Poisson process. Similarly, unemployed workers of type $i = B, W$ can find a job also according to a random Poisson process. In aggregate, these processes imply that there is a number of contacts (or matches) per unit of time between the two sides of the market that are determined by a race-specific standard matching function as follows:

$$M_i \equiv M(\overline{\theta}_i U_i, Z_i) \qquad i = B, W \tag{6}$$

where U_i and Z_i are respectively the total number of unemployed workers and vacancies of type $i = B, W$ in the economy, and $U_B = U_{BC} + U_{BS}$. Each unemployed worker of type $ik = W, BC, BS$ gathers information about jobs at a rate θ_{ik} (which will be determined below). Accordingly,

$$\overline{\theta}_W = \theta_W \text{ and } \overline{\theta}_B = \frac{\theta_{BC} U_{BC} + \theta_{BS} U_{BS}}{U_{BC} + U_{BS}} \tag{7}$$

is a group-specific index of aggregate information about economic opportunities. As usual (Pissarides, 2000), $M(.)$ is assumed to be increasing in both its arguments, concave and to exhibit constant returns to scale.

As a result, the rate at which the vacancies of firms of type $i = B, W$ are filled is given by:

$$\frac{M(\overline{\theta}_i U_i, Z_i)}{Z_i} = M\left(\frac{1}{\Omega_i}, 1\right) \equiv q(\Omega_i)$$

where $\Omega_i = Z_i/(\overline{\theta}_i U_i)$ is a measure of labor market i's tightness, in units of information intensity or search efficiency. Similarly, the group-specific job-arrival rate for workers of type $ik = W, BC, BS$ is given by:

$$\theta_{ik} \frac{M(\overline{\theta}_i U_i, Z_i)}{\overline{\theta}_i U_i} = \theta_{ik} M(1, \Omega_i) \equiv \theta_{ik} \Omega_i q(\Omega_i)$$

For workers of type $ik = W, BS, BC$, finding a job results from the interplay of two factors: the rate at which they gather information (which is group-specific and given by θ_{ik}) and the search externalities (which are race-specific and captured by Ω_i). Even though, as we will see below, θ_{ik} is not chosen optimally and is group- and not individual-specific, it can be interpreted as the search effort or the search efficiency in gathering information. Thus, for a given labor-market tightness Ω_i, the higher θ_{ik}, the better information about jobs and the shorter the time spent unemployed for individuals of the group ik.

[6] As we will see, the endogenous distribution of firms will be skewed towards the employment of white workers.

By using the standard properties of the matching function, it is easy to see that:

$$\frac{\partial q(\Omega_i)}{\partial \Omega_i} < 0 \text{ and } \frac{\partial\left[\Omega_i q(\Omega_i)\right]}{\partial \Omega_i} > 0$$

since a tighter labor market (i.e. more vacancies) increases the job-arrival rate of workers but decreases the rate at which vacancies are filled. Those properties account for the search externalities common to all matching models (Pissarides, 2000).

In contrast to the standard job-matching model where space is absent (Mortensen and Pissarides, 1999, Pissarides, 2000), θ_{ik} *establishes a link between labor and land markets* since it is a function of workers' location and thus of city-structure.[7] Let us be more explicit about θ_{ik}. It is equal to:[8]

$$\theta_{ik} = \mu + \lambda\, s_{ik} - \beta\, \overline{x}_{ik} \qquad ik = W, BS, BC \tag{8}$$

where $\mu > 0$ is the common information about jobs available to anyone (independently of race or space), s_{ik} denotes the (endogenous) local social network of a worker of type ik, and $\overline{x}_{ik}$ is the (endogenous) average distance to the employment center for workers of type ik. λ and β are positive parameters that measure the respective impacts of social networks and distance to jobs on θ_{ik}.

As stated above, θ_{ik} is the rate at which workers gather information about jobs. Formula (8) assumes that a given level of information is available to anyone in the city and that this level of information may be altered locally, through social networks or formal sources of information. Indeed, information about jobs is mainly obtained locally, through employed friends or local newspapers. In other words, besides the common knowledge factor, there are two ways of learning about jobs: either employed workers hear about a job and transmit this information to all their residential unemployed neighbors, or the unemployed directly read about job opportunities in the newspapers published in their area of residence. It should be clear that *none of these channels involve commuting to the BD* since, in our framework, it is information that reaches the neighborhood and workers only commute to the BD in order to work and shop. This is why the information-acquisition rate θ_{ik} is group-specific and the job-arrival rate is the same for all unemployed workers within a given group ik (what matters is the neighborhood of residence and not the individual's particular location within that neighborhood).

Let us now present in detail the two channels through which information about jobs can be gathered. *The first channel operates via social networks which are built upon local connections.* The local connections that individuals from a given group ik can use to find a job are measured by s_{ik}, which we assume to be a positive function of that group's employment rate $1 - u_{ik}$ (or equivalently a negative function of the unemployment rate u_{ik}). In other

[7] Wasmer and Zenou (2002, 2004), both with and without relocation costs, also have a model that links job search to space. This is done through search intensity, which is negatively related to distance to jobs. The present model has the same flavor since location plays an important role in determining θ_{ik}. As we will see below, an extra link between search and space is provided by social networks.

[8] Here also the assumption that each community lives in a racially homogenous neighborhood is important to derive θ_{ik}.

words, when the unemployment rate is high among a particular group, individuals of that group have few connections that can refer them to jobs and their social network is poor (Calvo-Armengol, 2004, Calvo-Armengol and Jackson, 2004, Calvo-Armengol and Zenou, 2004, Montgomery, 1991, Mortensen and Vishwanath, 1994, Topa, 2001).[9]

As far as whites are concerned, individuals only use (local) connections with other whites so that their social network is simply defined by:

$$s_W = 1 - u_W \tag{9}$$

For blacks, since we have two groups ($k = C$ or $k = S$), there are two cases depending on their respective residential location in the city. If blacks from group k reside far away from whites, then they only benefit from their own connections to jobs, which implies that:

$$s_{Bk} = 1 - u_{Bk} \tag{10}$$

If, to the contrary, blacks from group k reside in the same neighborhood as whites (or, more accurately in our model, in an adjacent neighborhood) then they benefit from their own connections to jobs and also from part of the social network of whites (because of the local interactions between the two neighboring groups). Observe that, even if black and white labor markets are segmented, employed whites can still transmit information about job opportunities to unemployed blacks since, being employed, they have access to a wider range of information than the unemployed. For example, imagine that blacks are mostly plumbers and whites mostly electricians, then, employed whites can see help-wanted signs for plumbers or hear about these types of jobs and report them to their black unemployed neighbors.

Thus, the social network of blacks from group ik depends on their own employment rate but also on that of their white neighbors, so that we have:

$$s_{Bk} = \alpha(1 - u_W) + (1 - \alpha)(1 - u_{Bk}) \tag{11}$$

with $0 < \alpha < 1$. This local externality causes the employment rate in the black neighborhood to be positively affected by the employment rate in the adjacent white area. However, depending on the value of α, blacks can benefit more or less from the connections whites have with jobs. If for example α is close to 1, then blacks benefit almost entirely from the social network of their white neighbors, so that they have access to a local social network which is almost as good as that of whites. To the contrary, a very low α indicates that, because of racial prejudices, there are very few contacts between blacks and whites living in adjacent neighborhoods, so that the social network spillover between the two groups is very limited. The existence of such externalities across neighborhoods is empirically verified. For instance, using Census Tract data for Chicago in 1980 and 1990, Topa (2001) finds a

[9] Resorting to word of mouth and newspaper ads are two major job-search methods that are used by young males (see Holzer, 1987, 1988). Word of mouth, in particular, seems to be of crucial importance: almost 70 percent of the jobs obtained by white workers and almost 60 percent of those obtained by black workers are found by checking with relatives or friends or through direct application without referral (Holzer, 1987).

significantly positive amount of social interactions across neighboring tracts, especially for areas with a high proportion of less educated workers and/or minorities.[10]

The second way workers can learn about jobs involves local formal sources of information. What we have in mind here is the amount of information conveyed by ads in local newspapers. Obviously, this type of information is available to all workers residing in the same neighborhood since they can all buy the same local newspaper. *Since employers tend to post more ads in newspapers that cover areas adjacent to their firms, we assume that the quantity of information available in each district decreases with the district's distance to the BD.* This is why, in (8), we have considered that the job acquisition rate of type-i workers negatively depends on $\overline{x}_{ik}$, the workers' average distance to the BD—which should be considered as a measure of the district's distance to firms—. As a matter of fact, several empirical studies on job search confirm that distance to jobs deteriorates the information one has on job opportunities and that job accessibility is crucial to get a job (see for example Rogers, 1997, Ihlanfeldt, 1997, Turner, 1997, Stoll, 1999). In our model, as far as firms are concerned, they only use local recruitment methods (such as local newspapers or relying on word-of-mouth communication), which further emphasizes the adverse effect of physical distance to jobs.

To sum up, the rate θ_{ik} at which information about jobs reaches workers strongly depends on the availability of information in each district. In our formulation, workers of a specific group obtain information about jobs through their social networks (measured by the number of employed workers in their community) but also through the quantity of formal information about jobs which reaches their neighborhood (measured by their district's distance to the BD).

2.3 Unemployment and labor discrimination

Workers As stated above, changes in the employment status of a worker of type $ik = W, BS, BC$ are governed by a Poisson process in which $\theta_{ik}\Omega_i q(\Omega_i)$ is the (group-specific) job acquisition rate and δ is the exogenous job separation rate.[11] Therefore, the expected duration of employment is given by $1/\delta$ for all workers whereas the expected durations of unemployment differ across groups and amount to $1/\left[\theta_{ik}\Omega_i q(\Omega_i)\right]$ for workers of type ik. It then follows that a worker of type ik spends a fraction $\theta_{ik}\Omega_i q(\Omega_i)/\left[\theta_{ik}\Omega_i q(\Omega_i)+\delta\right]$ of his lifetime employed and a fraction $\delta/\left[\theta_{ik}\Omega_i q(\Omega_i)+\delta\right]$ of his lifetime unemployed.

At the steady state, flows into and out of unemployment must be equal. Therefore, for

[10] In the present paper, network effects are assumed to be local since agents are only affected by contacts within their own community as well as in the adjacent community. One may argue that in sociology networks are only partially local. Assuming for example that s_i depends more smoothly on distance from other groups would not change the qualitative nature of the results, since, as we will see below, conformist blacks would still reside further away from whites than status-seeker blacks so that the social network of the latter would still be of better quality than that of the former.

[11] The higher $\theta_{ik}\Omega_i q(\Omega_i)$ (respectively δ), the shorter the expected period of time before a job is found (respectively destroyed). For instance, if $\theta_{ik}\Omega_i q(\Omega_i)$ tends towards infinity, then the unemployed workers of type ik never have to wait before establishing a contact with a firm and getting a job. If δ tends to zero then the duration of employment tends to infinity.

whites, we have:

$$u_W = \frac{\delta}{\theta_W \Omega_W q(\Omega_W) + \delta} \tag{12}$$

whereas for status-seeker and conformist blacks, we respectively obtain:

$$u_{BS} = \frac{\delta}{\theta_{BS} \Omega_B q(\Omega_B) + \delta} \tag{13}$$

$$u_{BC} = \frac{\delta}{\theta_{BC} \Omega_B q(\Omega_B) + \delta} \tag{14}$$

where u_{ik} denotes the unemployment rate of workers of type $ik = W, BS, BC$. Observe from (12), (13) and (14), that the steady-state unemployment and employment rates correspond to the respective fractions of time a worker remains unemployed and employed over his infinite lifetime. Equations (12), (13) and (14) can also be interpreted as the probabilities a type-ik worker will be unemployed or employed at the steady state.

We are now able to calculate the expected utilities of each group. To do that, we assume perfect capital markets with a zero interest rate.[12] With perfect capital markets, workers are able to smooth their disposable income over time so that at any moment in time, the disposable income of a type-ik worker is equal to his average income over the job cycle. Therefore, the expected utility of a worker of type $ik = W, BS, BC$ residing in x is given by:

$$EV_{ik} = (1 - u_{ik}) V_{iE}(x) + u_i V_{iU}(x)$$

where V_{iE} and V_{iU} are given by (1), (2) or (3), and u_{ik} is determined by (12), (13) or (14).

Observe that in order to write this expected utility, we have implicitly assumed that, because workers are able to smooth their income over time, *a worker's residential location remains fixed as he enters and leaves unemployment.* This is indeed more realistic than assuming that changes in employment status involve changes in residential location.

Firms To model discrimination, we use a model *à la* Becker (1957). In our framework, firms have to decide whether they want to hire black or white workers. Without loss of generality, we assume that each firm can hire only one worker. There exists a continuum of employers (or firms) whose mass is normalized to $\overline{d} > 0$ and whose taste for discrimination d is uniformly distributed on $[0, \overline{d}]$ (i.e. there is one firm at each point in the interval $[0, \overline{d}]$). When working in a firm, each worker, black or white, has the same productivity $p > 0$ and receives

[12] When there is a zero interest rate, workers have no intrinsic preference for the present so that they only care about the fraction of time they spend employed and unemployed. Therefore, the expected utilities are not state dependent. For example, since a worker ik spends a fraction $\theta_{ik}\Omega_i q(\Omega_i) / [\theta_{ik}\Omega_i q(\Omega_i) + \delta]$ of his lifetime employed and a fraction $\delta / [\theta_{ik}\Omega_i q(\Omega_i) + \delta]$ unemployed, his average income is equal to

$$\frac{\theta_{ik}\Omega_i q(\Omega_i)}{\theta_{ik}\Omega_i q(\Omega_i) + \delta} y_E + \frac{\delta}{\theta_{ik}\Omega_i q(\Omega_i) + \delta} y_U$$

the same wage y_E.[13] Employers are more or less prejudiced against blacks (depending on the value of their taste for discrimination d). In our framework, the parameter d corresponds to the psychological cost of hiring and working with a black person, and will enter in the profit function as a cost associated with the hiring of a black worker. It measures the intensity of the employer's racial preferences. In this context, the subjective cost of hiring a black worker takes into account both wage and psychological costs and is given by $y_E + d$. This is why, even though black and white workers have the same productivities, an employer will decide whether to hire a black or a white worker by comparing their respective subjective costs. This means that, in equilibrium, there exists a threshold $\widetilde{d}$ such that all firms with prejudice $d \in \left[0, \widetilde{d}\right]$ only hire black workers, whereas all firms with prejudice $d \in \left]\widetilde{d}, \overline{d}\right]$ only hire white workers. In other words, only firms with high prejudices discriminate against blacks, whereas firms with low prejudices prefer to hire blacks.

In this context, the instantaneous profit function for a firm of type d hiring a black worker is given by:

$$\Pi_B(d) = p - y_E - d$$

whereas for a firm hiring a white worker, it is equal to:

$$\Pi_W = p - y_E$$

where $p > y_E$ is workers' productivity. Of course, if the model were static and there were no turnover, then a black worker would never be hired.

Let us now determine the expected profit for discriminating and non-discriminating firms. We have a Poisson process on the firm's side in which $q(\Omega_i)$ is the (group-specific) job-contact rate and δ is the exogenous job-separation rate. At the steady state, flows into and out of vacancies are equal. Therefore, the vacancy rate for discriminating firms is equal to:[14]

$$z_W = \frac{\delta}{q(\Omega_W) + \delta} \tag{15}$$

whereas for non-discriminating firms, we have:

$$z_B = \frac{\delta}{q(\Omega_B) + \delta} \tag{16}$$

With zero interest rate and assuming that the cost of holding a vacant job is γ, we have:

$$E\Pi_W = (1 - z_W)(p - y_E) - z_W\,\gamma$$

$$E\Pi_B(d) = (1 - z_B)(p - y_E - d) - z_B\,\gamma$$

[13] There is a legislation that prevents employers to discriminate between blacks and whites in terms of wages. Because we focus on low-skill workers, y_E can be interpreted as a minimum wage.

[14] In our formulation, there is no free entry and the total number of firms/jobs is fixed and equal to $\overline{d}$.

where $E\Pi_W$ and $E\Pi_B$ respectively stand for the steady-state expected profit of a discriminating firm (which hires only white workers) and the expected profit of a non-discriminating firm (which hires only black workers).

We are now able to calculate $\widetilde{d}$ the threshold above which firms choose to hire only white workers. It is such that

$$E\Pi_W = E\Pi_B(\widetilde{d})$$

which, using the equations above, yields:

$$\widetilde{d} = \left(\frac{z_W - z_B}{1 - z_B}\right)(p - y_E + \gamma) \tag{17}$$

It can easily be seen from (17) that $\widetilde{d} > 0$ whenever $z_W > z_B$, which is equivalent to $\Omega_W > \Omega_B$, i.e. when the labor market of whites is tighter than that of blacks. Indeed, since all workers obtain the same wage, in order for any prejudiced firm to be willing to hire a black worker, it has to be that the expected duration of a vacancy is shorter on the black labor market than on the white labor market, i.e. that $q(\Omega_W) < q(\Omega_B)$.

Finally, observe that the total number of vacancies in discriminating and non-discriminating firms are respectively equal to:

$$Z_W = z_W\left(\overline{d} - \widetilde{d}\right) \text{ and } Z_B = z_B\,\widetilde{d}$$

3 The different equilibria

In equilibrium, all workers of the same type reach the same utility level: v_W, v_{BS} and v_{BC} for whites, status-seeker blacks, and conformist blacks respectively. Therefore, the bid rent of a white worker residing at a distance x from the BD is equal to:[15]

$$\Psi_W(x, v_W) = \frac{\theta_W \Omega_W q(\Omega_W)}{\theta_W \Omega_W q(\Omega_W) + \delta}(y_E - y_U) + y_U - t\,x + e_W\,|x - b_B(x)| - v_W \tag{18}$$

whereas those of status-seeker and conformist blacks are respectively given by:

$$\Psi_{BS}(x, v_{BS}) = \frac{\theta_{BS} \Omega_B q(\Omega_B)}{\theta_{BS} \Omega_B q(\Omega_B) + \delta}(y_E - y_U) + y_U - t\,x + e_{BS}\,|x - b_W(x)| - v_{BS} \tag{19}$$

and

$$\Psi_{BC}(x, v_{BC}) = \frac{\theta_{BC} \Omega_B q(\Omega_B)}{\theta_{BC} \Omega_B q(\Omega_B) + \delta}(y_E - y_U) + y_U - t\,x + e_{BC}\,|x - b_W(x)| - v_{BC} \tag{20}$$

In equilibrium, absentee landlords allocate land to the highest bids. Since we assume that groups always form spatially homogenous communities and since bid rents are all linear

[15] The bid rent is a standard concept in urban economics. It indicates the maximum land rent that a worker located at a distance x from the BD is ready to pay in order to achieve utility level v.

in x (recall that generically $b'_B(x) = 0$ and $b'_W(x) = 0$), it is then easy to verify that six different equilibrium land-use configurations can arise depending on the relative ranking of whites (W), status-seeker blacks (BS) and conformist blacks (BC) in the city. However, we show that under a reasonable assumption, only two equilibria can be sustained: Equilibrium 1, in which, moving outward from the BD, we have the location of the following groups: W, BS, BC (see Figure 1a) and Equilibrium 2, in which, starting from the BD, we have: BC, BS, W (see Figure 2). We will refer to Equilibrium 1 as the *Spatial-Mismatch Equilibrium* since, in that equilibrium, blacks reside far away from jobs.[16] To the contrary, Equilibrium 2 corresponds to a situation in which blacks reside close to jobs and that we will call the *Spatial-Match Equilibrium*.

Proposition 1 *Assume that*[17]

$$e_{BC} < |e_{BS}| < e_W \tag{21}$$

Then, we have multiple equilibria in which either the Spatial-Mismatch Equilibrium (Equilibrium 1) or the Spatial-Match Equilibrium (Equilibrium 2) occur.

Proof. See the Appendix.

The following comments are in order. First, observe that assuming $e_{BC} < |e_{BS}| < e_W$ means that whites are more eager to isolate themselves from blacks than status-seeker blacks to have contacts with whites ($e_W > |e_{BS}|$), while status-seeker blacks are more eager to have contacts with whites than conformist blacks to isolate themselves from whites ($|e_{BS}| > e_{BC}$). This is in accordance with the findings of Cutler, Glaeser and Vigdor (1999) who find that whites are more likely to oppose living in a majority-black neighborhood than blacks in either a majority-black or white neighborhood. The reasons why only Equilibrium 1 and Equilibrium 2 can be sustained under assumption (21) are quite easy to understand. The assumption that $e_{BC} < |e_{BS}|$ is used to rule out the two urban configurations in which whites locate in between status-seeker blacks and conformist blacks, so that status-seeker blacks and conformist blacks must locate on the same side of whites. Moreover, the two other urban configurations in which conformist blacks locate in between whites and status-seeker blacks can never be sustained since the two black groups would always prefer to switch locations (since $e_{BC} > 0$ and $e_{BS} < 0$). It follows, using $e_W > |e_{BS}|$, that status-seeker blacks must always locate in between whites and conformist blacks, so that only Equilibrium 1 and Equilibrium 2 can exist.

Second, in both equilibria, whites never locate close to conformist black families. In other words, status-seeker blacks form a *buffer zone* between conformist blacks and white families.

[16] The spatial mismatch hypothesis, first formulated by Kain (1968), states that, residing in urban segregated areas distant from and poorly connected to major centers of employment growth, black workers face strong geographic barriers to finding and keeping well-paid jobs. See the surveys by Holzer (1991), Kain (1992), Ihlanfeldt and Sjoquist (1998) and Gobillon et al. (2003).

[17] We also assume that $|e_{BS}| < t < e_W$. These are just technical conditions that are not necessary to obtain the results of Proposition 1 (see Appendix 1). The first condition ($t < e_W$) ensures that the bid rent of whites is increasing in Equilibrium 2 and the second condition ($|e_{BS}| < t$) guarantees that the bid rents of all blacks are decreasing in both equilibria, as observed in most US cities.

Interestingly, it has been shown that the black middle class in the United States is also more likely to live in neighborhoods that border poor black neighborhoods, thereby creating such a buffer zone between the black poor and white non-poor (see for instance Jargowsky and Bane, 1991, Massey and Denton, 1993, and Pattillo-McCoy, 1999, ch.2).

Third, recall that we have focused on spatially homogenous communities. Relaxing this assumption would lead to more equilibria than those stated in Proposition 1 since communities would be able to form subgroups in the urban space. Nevertheless, recall that the focus of our model is to explain the adverse effect of distance to jobs on labor market outcomes rather than to explain the endogenous formation of spatially homogenous neighborhoods.[18] Thus, since status-seeker and conformist blacks always live in adjacent areas, there exists only one border between racial communities for each equilibrium. This implies that $b_B^m(x)$ and $b_W^m(x)$ are independent of x and equal to a constant b^m (where b^m denotes the unique border location in Equilibrium $m = 1, 2$). We have $b^1 = \overline{N}_W$ while $b^2 = \overline{N}_B \equiv \overline{N}_{BC} + \overline{N}_{BS}$.

Fourth, let us now discuss the existence of multiple equilibria. Assumption (21) guarantees that $e_W > |e_{BS}|$ which makes both Equilibria 1 and 2 sustainable (otherwise status-seeker blacks would always outbid whites for their locations and the urban configuration would not be sustainable). The reason we have multiple equilibria is because *the driving force behind the location of communities is racial preferences* since commuting costs do not discriminate between blacks and whites (the commuting cost per unit of distance is the same for both races). Therefore, multiple equilibria emerge since what matters is only the desire of workers to live or not to live with other individuals of their communities. This is because distance to jobs equally affects the location decision of each community and thus does not favor any of the two urban configurations. In this context, which equilibrium will prevail only depends on the coordination of workers.

Finally, note that in both Equilibria 1 and 2, it is status-seeker blacks who reside close to whites and thus benefit from the social network of whites in addition to their own connections to jobs. To the contrary, conformist blacks live far away from whites and only benefit from their own social network. This implies that (10) and (11) can now be rewritten as:

$$s_{BC} = 1 - u_{BC} \tag{22}$$

$$s_{BS} = \alpha(1 - u_W) + (1 - \alpha)(1 - u_{BS}) \tag{23}$$

We are now able to determine the information acquisition rate of each community. Using (9), (10), (11), (22) and (23), we can rewrite (8) for Equilibrium $m = 1, 2$ as:

$$\theta_W^m = \mu + \lambda(1 - u_W^m) - \beta\,\overline{x}_W^m \tag{24}$$

$$\theta_{BS}^m = \mu + \lambda\,[\alpha(1 - u_W^m) + (1 - \alpha)(1 - u_{BS}^m)] - \beta\,\overline{x}_{BS}^m \tag{25}$$

$$\theta_{BC}^m = \mu + \lambda(1 - u_{BC}^m) - \beta\,\overline{x}_{BC}^m \tag{26}$$

[18]The racial homogeneity of neighborhoods is a well documented phenomenon in US cities. In 1979, for example, the average black lived in a neighborhood that was 63.6% black, even though blacks formed only 14.9% of the population (Borjas, 1998). In the 1990 census, the figures were similar (Cutler, Glaeser and Vigdor, 1999).

Observe that λ measures the marginal impact on the information-gathering rate of a social-network improvement (following a rise in local employment rate(s)) whereas β measures the marginal impact on the information-gathering rate of an increase in the distance to the BD (which results in a loss of formal information about jobs). We impose the following condition to guarantee that θ_i^m is always positive:

$$\mu \geqslant \beta \tag{27}$$

3.1 The Spatial-Mismatch Equilibrium

The slopes of the different bid rents are given in the Appendix by (64), (65) and (66) and the resulting urban equilibrium is represented by Figure 1a. In this urban configuration, whites live close to the BD whereas status-seeker blacks and conformist blacks live further away. Whites are attracted to the BD for two reasons: to save on commuting costs and to be as far as possible from the border distance $b^1 \equiv \overline{N}_W$ with blacks. Therefore, the equilibrium land rent decreases from the BD to $\overline{N}_W$ in order for white workers to obtain the same utility level v_W whatever their location between 0 and $\overline{N}_W$. Status-seeker blacks are also attracted to the BD to be close to jobs and close to whites so that the equilibrium land rent also decreases between $\overline{N}_W$ and $\overline{N}_W + \overline{N}_{BS}$. For conformist blacks, there are in fact two opposite forces: on the one hand, they would like to be close to the BD in order to save on commuting costs; on the other hand, they would like to be as far as possible from whites and thus from the BD. Since $t > e_{BC}$, the former effect dominates the latter and land rent also decreases between $\overline{N}_W + \overline{N}_{BS}$ and 1.

Because blacks differ in their racial preferences, those among blacks who value most interacting with other blacks will prefer to reside relatively further away from the white community. This is why, in equilibrium, when whites reside close to the employment center, conformist blacks locate far away from jobs. We refer to Equilibrium 1 as a *Spatial-Mismatch Equilibrium* since blacks are far away from jobs and, as we will see, they experience high unemployment rates.

$[Insert\ Figure\ 1a\ here]$

We are now able to give a formal definition of the market equilibrium (i.e. an equilibrium in both land and labor markets).[19]

Definition 1 *A Spatial-Mismatch Equilibrium is a 9-uple* $(v_W^{1*}, v_{BS}^{1*}, v_{BC}^{1*}, u_W^{1*}, u_{BS}^{1*}, u_{BC}^{1*}, z_W^{1*}, z_B^{1*}, \widetilde{d}^{1*})$ *such that:*

$$\Psi_W(\overline{N}_W, v_W^{1*}) = \Psi_{BS}(\overline{N}_W, v_{BS}^{1*}) \tag{28}$$

$$\Psi_{BS}(\overline{N}_W + \overline{N}_{BS}, v_{BS}^{1*}) = \Psi_{BC}(\overline{N}_W + \overline{N}_{BS}, v_{BC}^{1*}) \tag{29}$$

[19]The population constraints are trivially defined since the density of individuals is one everywhere in the city.

$$\Psi_{BC}(1, v_{BC}^{1*}) = 0 \tag{30}$$

$$u_W^{1*} = \frac{\delta}{\theta_W^{1*}\Omega_W^{1*}q(\Omega_W^{1*}) + \delta} \tag{31}$$

$$u_{BS}^{1*} = \frac{\delta}{\theta_{BS}^{*1}\,\Omega_B^{*1}q(\Omega_B^{*1}) + \delta} \tag{32}$$

$$u_{BC}^{1*} = \frac{\delta}{\theta_{BC}^{1*}\,\Omega_B^{*1}q(\Omega_B^{*1}) + \delta} \tag{33}$$

$$z_W^{1*} = \frac{\delta}{q(\Omega_W^{*1}) + \delta} \tag{34}$$

$$z_B^{1*} = \frac{\delta}{q(\Omega_B^{*1}) + \delta} \tag{35}$$

$$\widetilde{d}^{1*} = \left(\frac{z_W^{1*} - z_B^{1*}}{1 - z_B^{1*}}\right)(p - y_E + \gamma) \tag{36}$$

where θ_W^{1*}*,* θ_{BS}^{1*}*,* θ_{BC}^{1*} *are respectively given by (24), (25) and (26),* $\Omega_i^{1*} = Z_i^{1*}/(\overline{\theta}_i^{1*} N_i u_i^{1*})$*,* $i = B, W$*,* $Z_W^{1*} = z_W^{1*}\left(\overline{d} - \widetilde{d}^{1*}\right)$*,* $Z_B^{1*} = z_B^{1*}\widetilde{d}^{1*}$ *and* $\overline{\theta}_i^{1*}$*,* $i = B, W$*, are defined by (7).*

Equations (28)-(30) reflect the equilibrium conditions in the land market (see Figure 1a) and equations (31)-(36) express the equilibrium conditions in the labor market. Equation (28) states that, in the land market, at the border $\overline{N}_W$ between whites and status-seeker blacks, bid rents must be equal. Equation (29) says that at the border $\overline{N}_W + \overline{N}_{BS}$ between status-seeker blacks and conformist blacks, bid rents must also be equal. Equation (30) means that, at the other end of the city (in $x = 1$), the bid rent of the most peripheral conformist black worker must be equal to the agricultural land rent (normalized to 0 for simplicity). Equations (31)-(33) express the unemployment rate for each type of workers in which the θs are defined by (24), (25) and (26). Equations (34) and (35) express the vacancy rates of the firms which employ white workers and of those which employ black workers. Finally, equation (36) gives the number of firms that hire black workers.

Observe that the Spatial-Mismatch Equilibrium is typical of many decentralized US cities where most jobs are created in the suburbs and where blacks reside close to the city center. Figure 1b illustrates this case by flipping the city so that our BD corresponds to a suburban business district that concentrates all jobs.

[*Insert Figure* 1*b here*]

Since workers are uniformly distributed in the urban space, it should be clear that:

$$\overline{x}_W^{1*} = \frac{\overline{N}_W}{2} \tag{37}$$

$$\overline{x}_{BS}^{1*} = \overline{N}_W + \frac{\overline{N}_{BS}}{2} \tag{38}$$

$$\overline{x}_{BC}^{1*} = 1 - \frac{\overline{N}_{BC}}{2} \tag{39}$$

Solving equations (28)-(30) and using (37)-(39) yields the following equilibrium utilities:

$$v_W^{1*} = (1 - u_W^{1*})(y_E - y_U) + y_U - t + e_{BS}\,\overline{N}_{BS} + e_{BC}\,\overline{N}_{BC} \tag{40}$$

$$v_{BS}^{1*} = (1 - u_{BS}^{1*})(y_E - y_U) + y_U - t + e_{BS}\,\overline{N}_{BS} + e_{BC}\,\overline{N}_{BC} \tag{41}$$

$$v_{BC}^{1*} = (1 - u_{BC}^{1*})(y_E - y_U) + y_U - t + e_{BC}\,(1 - \overline{N}_W) \tag{42}$$

It is now interesting to compare the different unemployment rates and utility levels. We have:

Proposition 2 *In the Spatial-Mismatch Equilibrium (Figure 1a) with discrimination, i.e. when* $\widetilde{d}^{1*}/\overline{d} < N_B$*,*

(*i*) *Communities that live closer to jobs have lower unemployment rates:*

$$u_W^{1*} < u_{BS}^{1*} < u_{BC}^{1*}$$

In particular, whites live close to jobs, have the lowest unemployment rate and experience the shortest unemployment spells.

(*ii*) *Blacks who value most interacting with other blacks (conformist blacks) live further away from jobs, have a higher unemployment rate, experience longer unemployment spells than status-seeker blacks.*

Proof. See the Appendix.

Observe that we define a discriminating equilibrium whenever $\widetilde{d}^{*}/\overline{d} < N_B$, that is when the fraction of jobs available to black workers is lower that the fraction of black individuals in the economy. Of course, $\widetilde{d}^{*}/\overline{d} < N_B$ is equivalent to $\left(\overline{d} - \widetilde{d}^{*}\right)/\overline{d} > N_W$. In this equilibrium, it is clear that whites and conformist blacks are respectively the most and the less favored group. Indeed, whites have a very good access to jobs (because they are closest to jobs), are not discriminated against, and benefit from a good social network. To the contrary, conformist blacks have a very bad access to jobs, have a poor social network (in particular because they reside far away from whites), and are discriminated against. Therefore, in this equilibrium, the place where conformist blacks live can be viewed as a ghetto: unemployment is rampant and peer pressure (to conform to the ghetto's norm and accept adverse racial preferences) has negative effects on those who are sensitive to it. These results are partly based on the fact that information about jobs can only be acquired locally, either through social networks (employed friends), or via formal sources of information (local newspapers).

In this respect, conformist blacks are totally isolated from jobs, both physically and through their local contacts, and have very little information on job opportunities in the BD. The situation is different for status-seeker blacks who do not live in the ghetto but seek contacts with whites. They are less isolated from jobs, both physically and because they have contacts with whites.

3.2 The Spatial-Match Equilibrium

In this urban configuration, the slopes of bid rents are given in the Appendix by (67), (68) and (69) and the resulting urban equilibrium is described by Figure 2. Conformist blacks live close to the BD, whereas status-seeker blacks and whites live further away. We refer to Equilibrium 2 as a *Spatial-Match Equilibrium* since blacks now reside close to jobs and, as we will see, both blacks and whites experience relatively low unemployment rates.

[*Insert Figure* 2 *here*]

We have:

Definition 2 *A Spatial-Match Equilibrium is a 9-uple* $(v_{BC}^{2*}, v_{BS}^{2*}, v_W^{2*}, u_{BC}^{2*}, u_{BS}^{2*}, u_W^{2*}, z_W^{2*}, z_B^{2*}, \widetilde{d}^{2*})$ *such that:*

$$\Psi_{BC}(\overline{N}_{BC}, v_{BC}^{2*}) = \Psi_{BS}(\overline{N}_{BC}, v_{BS}^{2*}) \tag{43}$$

$$\Psi_{BS}(\overline{N}_{BC} + \overline{N}_{BS}, v_{BS}^{2*}) = 0 \tag{44}$$

$$\Psi_W(\overline{N}_{BC} + \overline{N}_{BS}, v_W^{2*}) = 0 \tag{45}$$

$$u_W^{2*} = \frac{\delta}{\theta_W^{2*}\Omega_W^{2*}q(\Omega_W^{2*}) + \delta} \tag{46}$$

$$u_{BS}^{2*} = \frac{\delta}{\theta_{BS}^{2*}\Omega_B^{2*}q(\Omega_B^{2*}) + \delta} \tag{47}$$

$$u_{BC}^{2*} = \frac{\delta}{\theta_{BC}^{2*}\Omega_B^{2*}q(\Omega_B^{2*}) + \delta} \tag{48}$$

$$z_W^{2*} = \frac{\delta}{q(\Omega_W^{2*}) + \delta} \tag{49}$$

$$z_B^{2*} = \frac{\delta}{q(\Omega_B^{2*}) + \delta} \tag{50}$$

$$\widetilde{d}^{2*} = \left(\frac{z_W^{2*} - z_B^{2*}}{1 - z_B^{2*}}\right)(p - y_E + \gamma) \tag{51}$$

where θ_W^{2*}, θ_{BS}^{2*}, θ_{BC}^{2*} *are respectively given by (24), (25) and (26),* $\Omega_i^{2*} = Z_i^{2*}/(\overline{\theta}_i^{2*} N_i u_i^{2*})$, $i = B, W$, $Z_W^{2*} = z_W^{2*}\left(\overline{d} - \widetilde{d}^{2*}\right)$, $Z_B^{2*} = z_B^{2*}\widetilde{d}^{2*}$ *and* $\overline{\theta}_i^{2*}$, $i = B, W$, *are defined by (7).*

The interpretation of these equations are similar to that of (28)-(36) in the case of Equilibrium 1 (see the previous subsection). Since workers are uniformly distributed in the urban space, we have:

$$\overline{x}_{BC}^{2*} = \frac{\overline{N}_{BC}}{2} \tag{52}$$

$$\overline{x}_{BS}^{2*} = \overline{N}_{BC} + \frac{\overline{N}_{BS}}{2} \tag{53}$$

$$\overline{x}_{W}^{2*} = \left(1 - \frac{\overline{N}_{W}}{2}\right) \tag{54}$$

Solving the land market conditions (43)-(45) and using (52)-(54), we come up with the following equilibrium utilities:

$$v_{BC}^{2*} = (1 - u_{BC}^{2*})(y_E - y_U) + y_U - t\overline{N}_B + (e_{BC} - e_{BS})\overline{N}_{BS} \tag{55}$$

$$v_{BS}^{2*} = v_{BS}^{2*} = (1 - u_{BS}^{2*})(y_E - y_U) + y_U - t\,\overline{N}_B \tag{56}$$

$$v_{W}^{2*} = (1 - u_{W}^{2*})(y_E - y_U) + y_U - t\overline{N}_B \tag{57}$$

We then obtain the following result:

Proposition 3 *In the Spatial-Match Equilibrium (Figure 2) with discrimination, i.e.* $\widetilde{d}^{2*}/\overline{d} < N_B$*, unemployment rates cannot be ranked. However,*

- (i) *If* $e_W\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC} > t(1 + \overline{N}_{BS})$*, then whites living far away from jobs pay on average higher land rents than blacks residing at the vicinity of the BD.*
- (ii) *Even though status-seeker blacks are further away from jobs than conformist blacks, they can have a lower unemployment rate than conformist blacks because they reside close to whites and therefore benefit from their social network.*
- (iii) *Even though whites are the furthest away from jobs, they can experience the lowest unemployment rate when they are sufficiently favored by employers (because of racial discrimination against blacks).*

Proof. See the Appendix.

First, condition (i) guarantees that the average land rent paid by whites is strictly greater than the land rent paid by blacks close to the BD. This condition is obviously satisfied whenever there is a sufficiently large number of whites, which is the case of most US cities. As we will see in the next section, this equilibrium aims to describe cities such as Philadelphia in which blacks residing close to the city center pay low land rents whereas whites living in the suburbs face expensive land values. Moreover, it is easy to see that, in this equilibrium, whites are ready to pay a very high land rent in order to separate themselves from blacks. This may be one of the explanations of high land prices in American residential suburbs. Finally, one of the main results in this proposition is to show that access to jobs is more crucial to blacks than to whites (which is in accordance with the spatial-mismatch literature). Indeed, an equilibrium in which whites are the furthest away from jobs can still have that whites have the lowest unemployment rate in the city (if discrimination is sufficiently high). Because of their advantage in terms of labor-market discrimination, whites can easily find a job even if they reside far away from jobs. In other words, for *high levels of labor discrimination, whites may benefit from a much better social network than blacks, even if they are physically isolated from jobs.* To the contrary *the social networks of blacks are strongly connected to their physical distance to jobs.* However, if there are strong social network spillovers across adjacent neighborhoods, then, *for status-seeker blacks, proximity to the white community may be even more crucial than proximity to jobs.*

4 City structure and labor-market outcomes

4.1 Comparison between the two equilibria

Since our model leads to multiple equilibria (Proposition 1), it is quite natural to compare the utilities of agents between the different urban configurations. This involves comparing gains and losses associated with variations in permanent income, transportation costs, and land consumption. Even though analytical comparisons do not enable us to systematically rank these two equilibria, it is quite easy to show that, under a plausible condition on parameters, all workers are better off in Equilibrium 2 than in Equilibrium 1. We have indeed:

Proposition 4 *If*

$$t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS} > y_E - y_U \tag{58}$$

then all workers are better off in the Spatial-Match Equilibrium than in the Spatial-Mismatch Equilibrium.

Proof. See the Appendix.

Proposition 4 states that if blacks are sufficiently keen on interacting with whites, i.e. if status-seekers are very eager to have contacts with whites (e_{BS} sufficiently negative) and conformists are not too conformist (e_{BC} small enough), then workers are better off in the Spatial-Match Equilibrium (Equilibrium 2) than in the Spatial-Mismatch Equilibrium (Equilibrium 1).

The intuition runs as follows. In our model, racial preferences (as well as transport costs) are completely capitalized in land rents. Comparing the two equilibria, condition (58) guarantees that reductions in land rents more than compensate possible losses in permanent income or that increases in land rents do not completely offset possible gains in permanent income. Conformist blacks are better off in the Spatial-Match Equilibrium (Equilibrium 2) because they are much less unemployed than in the Spatial-Mismatch Equilibrium (Equilibrium 1) and because, even if they reside closer to jobs, the increase in land rent is quite limited. Whites are better off even though their unemployment rate is higher because, residing far away from jobs, they now face lower land rents. The same intuition applies to status-seeker blacks.

Observe that in Proposition 4, we only compare the utilities of workers. If one compares the total surplus which includes the utility of absentee landlords and the profit of firms, then one cannot rank the two equilibria analytically. However, in the numerical simulations proposed below (and in many others that we do not display), the total surplus is greater in the *Spatial-Match Equilibrium* than in the *Spatial-Mismatch Equilibrium*.

4.2 How realistic are these urban equilibria?

Let us now describe in more detail our two equilibria and show that they exhibit some common features with US cities. The first equilibrium, *the Spatial-Mismatch Equilibrium* corresponds to a situation in which blacks reside far away from jobs and whites close to jobs whereas in the second equilibrium, *the Spatial-Match Equilibrium*, we have the reverse pattern.

Raphael and Stoll (2002, Table 1) have categorized all Metropolitan Statistical Areas (MSAs) in the US according to the severity of their spatial mismatch. The authors measure the spatial imbalance between jobs and residential locations using an index of dissimilarity. The Duncan and Duncan dissimilarity index is generally used to measure the extent of housing segregation between members of different racial and ethnic groups within a given metropolitan area (see e.g. Glaeser and Vigdor, 2001). Raphael and Stoll adapt this measure in order describe the imbalance between the residential locations of population groups and the general employment distribution. In the present context, the dissimilarity index thus ranges from 0 to 100, with higher values indicating a greater geographic mismatch between populations and jobs within a given metropolitan area. For instance, a dissimilarity index of 50 for blacks means that 50 percent of all blacks residing in the metropolitan area would have had to relocate to different neighborhoods within the metropolitan area in order to be spatially distributed in perfect proportion with jobs.

The following two tables illustrate our two equilibria using the spatial-mismatch indices calculated by Raphael and Stoll.[20]

[*Insert Tables* 1*a* and 1*b here*]

Our comments are in order. First, the two types of cities –with spatial-mismatch and spatial-match features– do coexist in the United States, even though the size of the population is larger for the first type of cities. In particular, there are many MSAs with more than 100,000 inhabitants in which whites reside further away from jobs than blacks. This can be seen by comparing the white/job and black/job dissimilarity indices. Second, as

[20] These tables are calculated for the total number of jobs in each MSA/PMSA. One may argue that blacks tend to occupy low-skill jobs so that the proposed measure is imperfect. In fact, if one calculates the same tables for retail employment only (which consists of mainly low-skill jobs), the picture is roughly the same as with all jobs.

predicted by our model, the average unemployment rate of blacks in cities where they are further away from jobs (Table 1a) is higher than in cities where blacks are closer to jobs (Table 1b) whereas the unemployment rate of whites does not seem to be much affected by disconnection to jobs. Third, the racial composition of a city's does not seem to affect the spatial mismatch index: there are cities with large and small proportions of blacks and large and small values of the spatial-mismatch index for blacks. Finally, spatial mismatch can be very intense for blacks but not for whites (In Table 1a, the spatial-mismatch index of blacks is between 52 and 71 whereas the spatial-mismatch index of whites never exceeds 44 in both tables).

Of course, these tables do not constitute in any way a test of our theoretical model. They just illustrate some of our results. In fact, what would come closest to a test of our model is the study by Weinberg (2000) which exploited cross-metropolitan area variations in black residential centralization to estimate the effect of job access on black employment. Weinberg found that increasing by 100% black centralization (i.e. increasing spatial mismatch in many US cities) would increase the gap in the white-black employment rates by 12%, whereas increasing job centralization by 10% (i.e. decreasing spatial-mismatch in many US cities) would decrease the gap in the white-black employment rates by 22.2%. These results indicate that city structure does indeed have an impact on the unemployment rates on black workers. In this context, the existence of different city structures might be key to understand the low labor-market outcomes of African Americans.

4.3 Numerical simulations

We will now proceed to some basic simulations that illustrate the workings of the model. The surplus in Equilibrium $m = 1, 2$ is defined as:

$$S^{m*} = \overline{N}_W v_W^{m*} + \overline{N}_{BS} v_{BS}^{m*} + \overline{N}_{BC} v_{BC}^{m*} + TLR^{m*} + TP^{m*} \tag{59}$$

where $TLR^{m*} \equiv \int_0^1 R^k(x)dx$ is the total land rent in Equilibrium m (i.e. the sum of all land rents paid to absentee landlords) and TP^{m*} denotes the aggregate profit of all firms. It is easy to see that both wages and land rents are pure transfers that cancel out in the surplus calculation.

We use a Cobb-Douglas form for the matching function (as standardly used in most empirical analyses and numerical simulation; see Petrongolo and Pissarides, 2001). We have:

$$M_i^m = \kappa \left(\overline{\theta}_i^{*m} U_i^{*m}\right)^\eta (Z_i^{*m})^{1-\eta} \qquad i = B, W,\, m = 1, 2$$

where $\kappa > 0$ is a scale or an efficiency parameter. Using this specific matching function implies that the vacancy-filling rates (on the white and the black labor-markets respectively) and the job-acquisition rates (of whites, conformist blacks, and status-seeker blacks respectively) are given by:

$$\kappa(\Omega_i^{m*})^{-\eta} \text{ and } \kappa\theta_{ik}(\Omega_i^{m*})^{1-\eta}$$

Let us consider a city (Base Case) that consists of 80% whites ($\overline{N}_W = 0.8$), 10% status-seeker blacks ($\overline{N}_{BS} = 0.1$), and 10% conformist blacks ($\overline{N}_{BC} = 0.1$). In this economy, the exogenous job destruction rate stands at .07. If we interpret a time period of unit length to be one year, this means that 7% of all jobs are destroyed every year or, equivalently, that the average employment spell is approximately 14 years. As for job acquisition, it is influenced by the publicly available information about jobs with $\mu = 30$. Since the scale parameter κ is equal to .5, this means that, if both space and social networks did not matter (i.e. if we had $\beta = \lambda = 0$), and if there were exactly one vacancy for each unemployed worker, then unemployed workers would be expected to wait $4\frac{1}{2}$ months before getting a job. However, the job contact rate is also positively influenced by social networks with $\lambda = 10$. This means that, if space did not affect job search (i.e. if $\beta = 0$), and if there were exactly one vacancy for each unemployed worker, then individuals belonging to a group that is for example 5% unemployed, would only have to wait $3\frac{3}{4}$ months on average before finding a job. In fact, the job contact rate is also influenced by residential location in the city, with a marginal deterioration in information about jobs of $\beta = 30$. This means that the unemployment spell of individuals from the above-mentioned group located in a neighborhood at an average distance equal to 1 from the job center, would be of $7\frac{3}{4}$ months. In other words, for individuals of this socially well-endowed group—which exhibits a low unemployment rate—, spatial frictions double the unemployment spell. Moreover, we assume that $\alpha = .9$ so that the social network spillovers from whites towards status-seeker blacks are very strong: status-seeker blacks resort 9 times out of 10 to their white neighbors when informally looking for a job. Finally, the ratio y_E/y_U amounts to 5, the price of the product p is 15 and the transport cost t per unit of distance stands at .5. Racial preferences are equal to 2, $-.2$ and .1 for whites, status-seeker blacks, and conformist blacks respectively. It is easily checked that these parameters satisfy conditions (21) and (27), and that $e_W > t$ and $t > |e_{BS}|$ (see our note along with Proposition 1).

Table 2a presents our results. We calibrate our simulations to obtain unemployment rates that are consistent with Tables 1a and 1b. The unemployment rate of whites varies little across equilibria and is always the lowest of all groups, even when they live the furthest away from jobs (3.3% in the Spatial-Mismatch Equilibrium—Equilibrium 1—, and 4.7% in the Spatial-Match Equilibrium—Equilibrium 2—). In Equilibrium 1, as expected, conformist blacks are more unemployed than status-seeker blacks (18.1% versus 13.2%). In Equilibrium 2, status-seeker blacks live further away from jobs than conformist blacks but experience only a slightly higher unemployment rate (8.8% vs 8.2%). This is because in this equilibrium status-seeker blacks strongly benefit from the social network spillover of whites, which in Equilibrium 2 nearly compensates for their comparatively more distant location from jobs.

Comparing the two equilibria, it can be seen that in both cases, we have $\widetilde{d}^k/\overline{d} < (\overline{N}_{BC} + \overline{N}_{BS})/\overline{N} = 20\%$, which means that, in both equilibria, the equilibrium proportion of occupied and vacant jobs offered to blacks is lower than the proportion of blacks in the city. As we have seen, this indicates *de facto discrimination*. Discrimination is nevertheless lower in the Spatial-Match Equilibrium than in the Spatial-Mismatch Equilibrium: in Equilibrium 1, only 17.7% of firms hire blacks, whereas this proportion rises to 19.2%

in Equilibrium 2. The intuition runs as follows. Other things else being equal, comparing across equilibria, when blacks are far away from jobs, their information-acquisition rate is much lower (especially for conformist backs) than when they reside closer to jobs. This is consistent with Ihlanfeldt (1997) who has shown that Atlanta's inner-city residents are less able to identify the location of suburban employment centers than suburbanites and thus, have less information on those jobs. This effect is so strong that in all our simulations blacks have a higher labor-market tightness when they are far away from jobs (and thus face less search congestion externalities). However, their information-acquisition rate is so much lower in Equilibrium 1 than in Equilibrium 2 that their job-acquisition rate is always lower when they reside far away from jobs in spite of the higher labor-market tightness. As for the firms which employ blacks, the higher labor-maket tightness when blacks reside far away from jobs means that they face higher search congestion externalities. This is consistent with Turner (1997) who has shown that, in Detroit's suburbs, firms which resort to local recruitment methods have very few inner-city black applicants. As a result firms are less willing to hire blacks. Blacks are therefore more discriminated against in Equilibrium 1 than in Equilibrium 2.

In this context, observe that, for blacks, Equilibrium 2 is preferable to Equilibrium 1 to the extent that they are both closer to jobs and less discriminated against. Thus, both black groups are much less unemployed in the Spatial-Match Equilibrium (their unemployment rates are in the range of 8%) than in the Spatial-Mismatch Equilibrium (where their unemployment rates are in the range of 13% to 18%), which confirms the theoretical results obtained in the previous section. In other words, *proximity to jobs is crucial for minorities to the extent that it ameliorates their frequency of contacts with jobs and is also likely to decrease the intensity of racial discrimination in the city.*[21]

As we have seen, a closer look at the labor market shows that, in both equilibria, labor-market tightness is higher for whites than for blacks. For instance in Equilibrium 1, labor-market tightness is approximately five times greater for whites than for blacks. In other words, there is much more search congestion for a black unemployed worker than for a white unemployed worker. In conjunction with the role played by location (through distance to jobs and social segregation), this explains that the different groups experience very different unemployment spells: in Equilibrium 1, it takes on average less than 6 months for an unemployed white worker to find a job, 26 months for a status seeker black, and 37 months for a conformist black. Conversely, "black" firms have an advantage over "white" firms in their search for a worker: a vacancy is filled on the white labor market on average only after 6 weeks whereas it takes $3\frac{3}{4}$ months to fill a vacancy on the white labor market. As discussed before this explains why some firms may be willing to hire black workers in spite of their strictly positive taste for racial discrimination. Comparing unemployment spells in Equilibrium 1 and 2, it can easily be seen that in Equilibrium 2, the unemployment spell of whites is only $2\frac{1}{2}$ months longer than in Equilibrium 1, whereas it is $9\frac{1}{2}$ months shorter for status-seeker blacks and $22\frac{1}{2}$ shorter for conformist blacks. These results confirms that spatial mismatch

[21] Although we cannot prove analytically that $\widetilde{d}^2/\overline{d} > \widetilde{d}^1/\overline{d}$, all our silmulations suggest that this result holds.

has a significant adverse effect on the job-search efficiency of black job-seekers whereas it has little impact on the white majority. *It is because they are discriminated against that spatial proximity becomes key for ethnic minorities in terms of access to the labor market.*

Finally, observe that all workers are better off, that the aggregate profit of firms is higher, and that the total surplus (taking into account the surplus of absentee landlords) is higher in the Spatial-Match Equilibrium than in the Spatial-Mismatch Equilibrium.

[*Insert Table 2a here*]

Let us now simulate a few variations from the Base Case, which will give us a better intuition of how the model behaves (see Table 2b where figures refer to Equilibrium 1, and figures in round brackets refer to Equilibrium 2). In the first column of Table 2b, we recapitulate our results from the Base Case. In the second column, we simulate a situation in which physical distance to jobs does not deteriorate information about employment opportunities ($\beta = 0$). In this context, the only effect of space is through land rents and city structure, so that space does not have any effect on labor-market outcomes (observe that, consequently, unemployment rates, job acquisition rates and wages are identical in the two urban configurations).

Comparing this new simulation with the Base Case, it can be seen that in Equilibrium 1, the unemployment rate of each group is lower when $\beta = 0$ than in the Base Case. This is because discrimination is less intense (the proportion of discriminating firms $\widetilde{d}^1/\overline{d}$ increases from 17.7% in the Base Case to 18.1% when β becomes null) and because all workers are now "freed" from the harmful effect of space on job-search efficiency. The changes in Equilibrium 2 tell a different story. Indeed, in Equilibrium 2, discrimination is *more intense* when $\beta = 0$ than in the Base Case ($\widetilde{d}^2/\overline{d}$ decreases from 19.2% in the Base Case to 18.1% when $\beta = 0$). Whites thus benefit both from the intensification of discrimination against blacks and the removal of the negative spatial externalities. For blacks, the intensification of discrimination more than offsets the removal of the spatial externality so that their unemployment rates increase in comparison with the Base Case. Observe that whites and conformist blacks are better off in the Spatial-Mismatch Equilibrium (Equilibrium 1) when $\beta = 0$ than in the Base Case. In the Spatial-Match Equilibrium (Equilibrium 2), only whites are better-off when $\beta = 0$. Not surprisingly, since vacancy durations are reduced in both equilibria, the aggregate profit of firms increases in both equilibria.[22]

In the third column, we neutralize the beneficial effect of social networks. Contrary to setting $\beta = 0$ which decreased discrimination in Equilibrium 1 and increased discrimination in Equilibrium 2, setting $\lambda = 0$ increases discrimination in the Spatial-Mismatch Equilibrium (since $\widetilde{d}^1/\overline{d}$ decreases from 17.7% to 16.2%) and decreases discrimination in the Spatial-Match Equilibrium (since $\widetilde{d}^2/\overline{d}$ increases from 19.2% to 19.9%). This suggests that *social networks are crucial in the Spatial-Mismatch Equilibrium not only because they may attenuate the harmful effect of distance to jobs (which is the main device through which blacks may gather*

[22]Observe that in all our tables, the agregate profit of each type of firms should not be compared across columns since the proportion of firms of each type varies with $\widetilde{d}$.

information about job opportunities) but also because social networks seem to be associated with a lower endogenous intensity of discrimination against blacks when the latter reside far away from jobs. In Equilibrium 1, setting $\lambda = 0$ dramatically increases the unemployment rates of blacks. It also decreases the unemployment rate of whites: the intensification of discrimination against blacks means that whites are now even more favored by employers. In Equilibrium 2 however, the attenuation of discrimination more than offsets the harmful effect associated with the neutralization of social networks: the unemployment rates of blacks are significantly reduced (from 8.8% to 6.1% for status-seeker blacks, and from 8.2% to 5.5% for conformist blacks). In both equilibria however, the total profit of firms and the total surplus decrease.

The fourth column presents our simulation with $\alpha = 0$, i.e. when there are *no* inter-group social-network externalities. In this case, it can be seen that the unemployment rate of status-seeker blacks significantly increases in Equilibrium 1 (from 13.2% to 13.8%) but rises only slightly in Equilibrium 2 (from 8.8% to 8.9%), which suggests that *social networks are once again crucial to blacks when they reside far away from jobs.*

[*Insert Table* 2*b here*]

5 Policy implications

We would now like to consider two different policies that can improve the situation of blacks as well as increase social welfare (as defined by (59)) in the economy.

5.1 Affirmative Action

Let us start by considering an affirmative-action policy that consists in giving a preferential treatment to minority groups, for example by imposing minimum hiring quotas to firms. In particular, we would like to assess the efficiency of such a policy and determine whether different quotas should be imposed depending on the structure of the city.

In the present model, an affirmative-action policy consists in imposing a quota $0 < \phi < 1$ to all firms that do not choose to hire blacks voluntarily, i.e. the discriminating firms. Since each firm only employs one worker at a time, imposing a quota means that a discriminating firm has to fill a vacancy with a black worker ϕ percent of the time and with a white worker $1 - \phi$ percent of the time. To put it short, a "white firm" must turn into a "black firm" ϕ percent of the time. As a result, a non-discriminating firm has an expected profit of $E\Pi_B^A(d) = E\Pi_B(d)$ while a discriminating firm now has an expected profit of $E\Pi_W^A(d) = \phi\, E\Pi_B(d) + (1-\phi)\, E\Pi_W$ (with $d \in \left[\widetilde{d}^A, \overline{d}\right]$).[23] In fact, it is easy to see that there exists a

[23] In the rest of the paper, the superscript A stands for affirmative action. When there is no ambiguity, we omit the superscript $m = 1, 2$ that defines each equilibrium. We continue to call "white firms" firms which d is above $\widetilde{d}^A$ even though they now operate on both white and black labor markets.

unique threshold $\widetilde{d}^A$ such that:

$$E\Pi_B^A(\widetilde{d}^A) = E\Pi_W^A(\widetilde{d}^A)$$

Solving this equation leads to:

$$\widetilde{d}^A = \left(\frac{z_W^A - z_B^A}{1 - z_B^A}\right)(p - y_E + \gamma) \tag{60}$$

The expression of $\widetilde{d}^A$ is thus the same as without any policy. In fact, the main change that an affirmative-action policy introduces is that the total number of vacancies on the labor market of blacks is now given by:

$$Z_B^A = \widetilde{d}^A z_B^A + \phi\left(\overline{d} - \widetilde{d}^A\right) z_B^A \tag{61}$$

while the total number of vacancies on the "white" labor market is:

$$Z_W^A = (1 - \phi)\left(\overline{d} - \widetilde{d}^A\right) z_W^A \tag{62}$$

Observe that z_B^A is now the vacancy rate of all firms employing blacks, i.e. of "black firms" strictly speaking as well as of "white firms" when they hire a black worker. Inspection of (61) and (62) reveals that, all things else being equal (i.e. if $\widetilde{d}^A$, z_B^A and z_W^A were constant), an affirmative-action policy should increase the labor-market tightness of blacks but decreases that of whites.[24] It should thus also increase the vacancy duration of firms which hire blacks and decrease that of firms which hire whites.

Another important change in the model is that our measure of *effective discrimination* (the proportion of occupied jobs or vacancies on the "black" labor market) is now given by:

$$\frac{\widehat{d}^A}{\overline{d}} = \frac{\widetilde{d}^A + \phi\left(\overline{d} - \widetilde{d}^A\right)}{\overline{d}} \tag{63}$$

In this context, our prediction, is that an affirmative action policy should reduce effective labor-market discrimination by increasing the value of $\widehat{d}^A/\overline{d}$.

To check these different intuitions, we now run some numerical simulations using the same parameter values as in the previous section. Table 3a presents the effects of an affirmative-action policy for different values of ϕ on labor-market outcomes in the two urban configurations. The first column recapitulates the Base Case, which can be obtained under a particular affirmative-action policy with $\phi = 0$. The second and third column presents our results for a quota of 5% and one of 15%. In both city-structures, it is clear that quotas significantly reduce the unemployment rates of blacks, while only raising slightly that of whites.

[24] The tightness of labor market $i = B, W$ under an affirmative-action policy is $\Omega_i^A = Z_i^A / \left(\overline{\theta}_i^A N_i u_i^A\right)$, where Z_i^A are now defined by (61) and (62) and $\overline{\theta}_i^A$ and u_i^A are still given by (7) and (12)-(14) respectively, with the new value of labor-market tightness.

In Equilibrium 1, for $\phi = 15\%$ for instance, the unemployment rate of status-seeker blacks (respectively of conformist blacks) decreases from 13.2% to 9.4% (respectively from 18.1% to 12.4%). The unemployment rate of whites only rises from 3.3% to 4.2%. Consequently, the equilibrium utility of whites decreases while those of blacks increase. As predicted, an affirmative-action policy also reduces (respectively increases) the labor-market tightness, the vacancy rate, and the vacancy duration on the white labor market (respectively on the black labor market). Table 3a also enables us to check that while $\widetilde{d}^A/\overline{d}$ the proportion of strictly speaking black firms decreases, $\widehat{d}^A/\overline{d}$ the effective proportion of black jobs and black vacancies always increases. For instance, in the Base Case, in Equilibrium 1, the proportion of black jobs and black vacancies only amounts to 17.7%. Under an affirmative-action policy with $\phi = 15\%$, the same figure rises to 18.8%. Finally, and not surprisingly, since firms are constrained by the quota, total profit decreases with ϕ. As for the total surplus, for both equilibria, it turns out to be increasing for low values of ϕ and decreasing for higher values. This indicates that the welfare effects of such policies is not monotonic.

[*Insert Table* 3*a here*]

We would now like to deepen our analysis by answering the three following questions for each city $m = 1, 2$:

(i) Since $\widetilde{d}^A$ decreases with ϕ, what is the value of ϕ (denoted by $\overline{\phi}$) that would make $\widetilde{d}^A = 0$, i.e. the value that would make all firms perceive the quota as an active constraint?[25]

(ii) Since $\widehat{d}^A$ increases with ϕ, what is the value of ϕ (denoted by $\widehat{\phi}$) that would ensure that $\widehat{d}^A/\overline{d} = \overline{N}_B/\overline{N} = 20\%$, i.e. the value that would suppress discrimination by equating the proportion of firms effectively employing blacks or searching for a black worker and the proportion of blacks in the city?[26]

(iii) What is the optimal ϕ (denoted by ϕ^o) that maximizes the total surplus (59) in the city?

Table 3b presents our results in the two urban configurations when ϕ takes the three values just defined above (i.e. $\overline{\phi}$, $\widehat{\phi}$ and ϕ^o). There are obviously stark differences between the different city-structures. Indeed, the optimal quota ϕ^o is quite high (nearly 10%) in the urban configuration in which blacks are far away from jobs and quite low (just above 1%) in the urban configuration in which they are close to jobs. This difference is also reflected in the value of $\widehat{\phi}$ since one has to impose a 20% black quota in order to suppress discrimination in the first equilibrium, but only a 12.7% quota in the second equilibrium. Indeed, we have seen in the previous section that blacks are more discriminated against when they live far away from jobs. Therefore, when an affirmative-action policy is implemented in order

[25] Observe that, by definition, we then have $\overline{\phi}^m = \widehat{d}^A/\overline{d}$. This is because whenever $\phi \geq \overline{\phi}^m$ (and in the present case $\phi = \overline{\phi}^m$) there are no "black firms" so that the proportion of black jobs and black vacancies is exactly determined by the quota imposed onto "white firms". Also observe that when $\phi = \overline{\phi}$, we must have $z_W^{m,A} = z_B^{m,A}$, which is equivalent to $\Omega_W^{m,A} = \Omega_B^{m,A}$.

[26] Removing discrimination means that the demand side of the labor-market will not treat blacks and whites differently. It does not mean that blacks and whites will have the same unemployment rates (since they occupy different locations in the city).

to eliminate discrimination or to maximize the total welfare, it is thus natural that the quota has to be higher in the Spatial-Mismatch Equilibrium so as to compensate for this discrepancy between the two equilibria. This suggests that *affirmative-action policies have different impacts depending on city-structure and are more justified in cities where blacks reside far away from jobs.*

[*Insert Table 3b here*]

5.2 Employment subsidies

We now consider another policy in which the (local) government gives a subsidy σ to all firms that accept to hire a black worker. This policy is financed with a lump-sum tax T on all profits. This implies that firms' profits can now be written as follows:[27]

$$E\Pi_W^S = \left(1 - z_W^S\right)(p - y_E) - z_W^S\,\gamma - T$$

$$E\Pi_B^S(d) = \left(1 - z_B^S\right)(p - y_E - d + \sigma) - z_B^S\,\gamma - T$$

and the government's budget constraint is given by:

$$\overline{d}\,T = \widetilde{d}^S\sigma \Leftrightarrow T = \frac{\widetilde{d}^S}{\overline{d}}\sigma$$

Equating $E\Pi_W^S$ and $E\Pi_B^S(d)$ gives the value of $\widetilde{d}$ under an employment-subsidy policy. We now have:

$$\widetilde{d}^S = \left(\frac{z_W^S - z_B^S}{1 - z_B^S}\right)(p - y_E + \gamma) + \sigma$$

Comparing with (17), it can be easily seen that an employment subsidy increases the proportion of firms employing blacks. However, contrary to the previous policy, observe that $\widetilde{d}^S$ always increases with σ. Also observe that this policy implies a redistribution from firms which employ whites towards firms which employ blacks.

Table 4a presents the effect of employment subsidies for two different values of σ. Clearly, as with the previous policy, the unemployment rates of blacks decrease with σ while the unemployment rate of whites increases. Total welfare increases then decreases with σ. The mechanism at stake is however quite different from the previous policy since firms that are subsidized now *freely chose* whether it is more profitable for them to hire a black worker or not.

In comparison with the Base Case, observe that in both equilibria, black workers are less discriminated against when black employment is subsidized. However, because the location of each group differs across equilibria, the impact of σ on both welfare and unemployment is also quite distinct in each city.

[27] The superscript S stands for employment subsidy. When there is no ambiguity, we omit the superscript $m = 1, 2$ that defines each equilibrium.

[*Insert Table* 4*a here*]

Let us further investigate this issue by calculating the subsidy $\widehat{\sigma}$ which neutralizes discrimination and the subsidy σ^o which maximizes the total surplus, subject to the (local) government budget constraint. Table 4b presents our results. As σ increases, it is easy to see that Ω_W^m always decreases while Ω_B^m always increases.[28] Indeed, since the number of firms which hire black workers increases, the number of firms which hire white workers decreases, and thus it becomes easier for blacks and more difficult for whites to find a job. The second interesting result is that the optimal subsidy (and thus the taxation) is higher (three times higher in our simulations) in a city where blacks are far away from jobs than in a city where blacks are closer to jobs. Indeed, as stated above, the main problem for isolated blacks in Equilibrium 1 is that their job-acquisition rate is indeed *very low*. So even when there are many unemployed black workers as in Equilibrium 1 (which should imply that the vacancy-filling rate of black firms should be quite high), firms are in fact *seldom contacted by black workers* (which explains why the duration of a black vacancy is higher in the Spatial-Mismatch Equilibrium than in the Spatial-Match Equilibrium). For this reason, we have $\widetilde{d}^1/\overline{d} < \widetilde{d}^2/\overline{d}$. As a result, in order to reduce discrimination or in order to maximize total welfare, *a more intense employment-subsidy policy is required in the city where blacks are further away from jobs.*

[*Insert Table* 4*b here*]

5.3 Affirmative Action versus employment subsidies

We have seen that both policies imply that they should be more intense in cities in which the spatial mismatch (i.e. the distance between black workers and jobs) is more severe.[29]

If we go back to Tables 1a and 1b which characterize different MSAs according to the severity of the spatial mismatch for both blacks and whites, we see that the Equilibrium-1 type of cities (Spatial-Mismatch Equilibrium) corresponds to big MSAs such as New York, Los Angeles or Chicago whereas the Equilibrium-2 type of cities (Spatial-Match Equilibrium) consists of MSAs of a smaller population size such as Salt-Lake City or Eugene-Springfield. Our policy results from the previous sections suggest that it would be preferable to implement an affirmative-action policy or an employment-subsidy policy in the MSAs listed in Table 1a

[28] These effects are large. For example, in Equilibrium 1, when σ increases from 0 to .357, Ω_W^1 is more than halved (from .022 to .009) while Ω_B^1 is multiplied by 7 (from .004 to .030). In Equilibrium 2, we observe similar effects but of a slightly smaller amplitude.

[29] As we have seen from Table 2, when space does not matter (i.e. when $\beta = 0$), the labor-market outcomes are identical in the two equilibria. This means that each policy (affirmative action, or employment subsidies) would have the same impact in both equilibria. Whenever space matters (i.e. whenever $\beta > 0$), there is a discrepancy between the two equilibria since blacks workers have more difficulties to obtain information about jobs in Equilibrium 1. In this case, both policies should be more intense in the city in which blacks are far away from jobs than in the city in which blacks are close to jobs.

rather than in those listed in Table 1b. Even if we did not show it explicitly, our results also suggest that between the MSAs of Table 1b, it would preferable to implement the two above-mentioned policies in Detroit or New York rather than in Baltimore or Atlanta because the mismatch between blacks and jobs is higher in the former cities than in the latter. This is quite interesting because the debate on affirmative action has been carried out at the state level in the United States but not at the MSA level. This is at odds with our analysis, which, for example, would recommend to implement an affirmative action policy in Houston but not in Sherman-Denison, even though both MSAs are located in Texas.

Another important issue that we would like to address is which policy should be preferred. There are two aspects that need to be considered. First, it appears in our simulations that, for both equilibria, the optimal employment-subsidy policy leads to a higher surplus than the optimal affirmative-action policy. This is because the mechanisms are quite different. An affirmative-action policy imposes a *hiring constraint* on the firms which employ whites whereas employment subsidies let firms *freely choose* whom they want to hire. In other words, with affirmative action, a policy maker forces firms which are not willing to hire black workers to hire them, even if these firms would be better off hiring white workers. With an employment-subsidy policy, some firms that were not willing to hire blacks do hire them now because it becomes profitable to do so. Accordingly, the first policy reduces $\widetilde{d^m}/\overline{d}$ but increases $\widehat{d^m}/\overline{d}$ whereas the second policy directly increases $\widetilde{d^m}/\overline{d}$.

This leads to our second aspect, which is more political. In choosing between the two policies, one has to trade off a policy that has a *purely psychological cost* and which is in general not popular among white firms and white workers (affirmative action) with a policy that has a *monetary cost* (employment subsidies). Also, the structure of the city does play an important role when comparing these two policies. If one implements an optimal policy which maximizes the total welfare (Tables 3b and 4b), then, in Equilibrium 1, the trade off is between the psychological cost of imposing a quota of nearly 10% black workers in each "white" firm, or a taxation corresponding to .7% of the aggregate profit. In Equilibrium 2, the optimal taxation is still relatively high (.3%) whereas the optimal quota is much lower (1.3%). As a result, it may be that a policy maker may prefer an employment-subsidy policy in Equilibrium 1 and an affirmative-action policy in Equilibrium 2. One may argue however that this comparison is not completely correct since the two optimal policies lead to different surpluses. This is why in the last column of Table 4b (AA equivalent), we present, for both equilibria, the impact of an employment subsidy that would lead to the same aggregate surplus that can be obtained with the optimal quota. In this case, Table 4b indicates that the trade off is now between setting a quota of 9.9% in Equilibrium 1 (respectively 1.3% in Equilibrium 2) and taxing .09% of the aggregate profit (respectively .004% in Equilibrium 2). These figures imply that, in a utilitarian context, *an employment-subsidy policy could be preferred in both equilibria.* Observe however that when the two policies are such that they yield the same welfare, employment subsidies slightly favor firms and white workers at the expense of black workers. It is easy to understand why since employment subsidies can be viewed as a redistribution towards freely operating firms whereas quotas are perceived as a constraint that hinders firms.

6 Concluding remarks

This paper has emphasized the role of labor discrimination, access to jobs, and social networks in explaining the high unemployment rates among urban black workers in cities. Indeed, we believe that these are three crucial factors that have a significant impact on employment by affecting their frequency of contact with employers and their probability of transforming this contact into a job match. In our model, workers endogenously chose their location by trading off commuting costs and racial preferences, leading to multiple equilibria.

An important lesson to be derived from this model is that urban segregation can be a voluntary phenomenon even if it implies very adverse outcomes on the labor market. If some blacks value social interactions within their own group and, because of that, are ready to segregate themselves by residing far away from jobs, then they will experience longer unemployment spells and higher unemployment rates. This is amplified by their poor social networks and the fact that blacks are discriminated against in the labor market. This makes them more dependent on proximity to jobs than whites. In this context, being close to jobs is indeed the main way minorities can gather information about jobs, whereas this is not the case for whites. Moreover, social networks are localized, so that blacks living far away from whites know fewer employed people who can refer them to jobs. In other terms, blacks who reside in segregated black ghettos do not benefit from local interactions with whites who have better social networks, which all the more reduces their chances to find a job.

The last and certainly the most important message of our model is in terms of policy implications. We have shown that, depending on the city-structure, affirmative action and employment subsidy policies can have very different impacts on unemployment rates and welfare. In particular, in cities where black workers reside far away from jobs, the optimal policy is to impose higher quotas or employment subsidies than in cities where they live closer to jobs.

References

[1] Akerlof, G. (1997), "Social distance and social decisions", *Econometrica*, 65, 1005-1027.

[2] Akerlof, G. and Kranton, R. (2000), "Economics and identity", *Quarterly Journal of Economics*, 115, 715-753.

[3] Akerlof, G.A. and R.E. Kranton (2002), "Identity and schooling: Some lessons for the economics of education", *Journal of Economic Literature*, 40, 1167-1201.

[4] Austen-Smith, D. and R.J. Fryer, Jr. (2003), "The economics of acting white", mimeo.

[5] Alesina, A. and E. La Ferrara (2001), "Who trusts others?", *Journal of Public Economics*, 85, 207-234.

[6] Battu, H., M. Mwale and Y. Zenou (2003), "Do oppositional identities reduce employment for ethnic minorities?", mimeo.

[7] Becker, G.S. (1957), *The Economics of Discrimination*, Chicago: Chicago University Press.

[8] Bledsoe, T., Welch, S., Sigelman, L. and M. Combs (1995), "Residential context and racial solidarity among African Americans", *American Journal of Political Science*, 39, 434-458.

[9] Borjas, G. J. (1998), "To ghetto or not to ghetto: Ethnicity and residential segregation", *Journal of Urban Economics*, 44, 228-253.

[10] Calvó-Armengol, A. (2004), "Job contact networks", *Journal of Economic Theory*, 115, 191-206.

[11] Calvó-Armengol, A. and M. O. Jackson (2004), "Social networks in determining employment: Patterns, dynamics, and inequality," *American Economic Review*, forthcoming.

[12] Calvo-Armengol, A. and Y. Zenou (2004), "Job matching, social network and word-of-mouth communication", mimeo.

[13] Courant, P.N. and J. Yinger (1977), "On models of racial prejudices and urban residential structure", *Journal of Urban Economics*, 4, 272-291.

[14] Cutler, D. M. and E. L. Glaeser (1997), "Are ghettos good or bad?", *Quarterly Journal of Economics*, 112, 827-872.

[15] Cutler, D., Glaeser, E.L. and J.L. Vigdor (1999), "The rise and decline of the American gheto", *Journal of Political Economy*, 107, 455-506.

[16] Fujita, M. (1989), *Urban Economic Theory*, Cambridge: Cambridge University Press.

[17] Galster, G. (1990), "White flight from racially integrated neighborhoods in the 1970s: the Cleveland experience", *Urban Studies*, 27, 385-399.

[18] Galster, G. (2000), "Identifying neighborhood thresholds: An empirical exploration", *Housing Policy Debate*, 11, 701-732.

[19] Glaeser, E.L. and J.L. Vigdor (2001), "Racial segregation in the 2000 Census: Promising news", Washington, DC: The Brookings Institution.

[20] Gobillon, L., Selod, H. and Y. Zenou (2003), "Spatial mismatch: From the hypothesis to the theories", CEPR Discussion Paper series 3740.

[21] Holzer H. J. (1991), "The spatial mismatch hypothesis: What has the evidence shown?", *Urban Studies*, 28, 105-122.

[22] Holzer, H. (1987), "Informal job search and black youth unemployment", *American Economic Review*, 77, 446-452.

[23] Holzer, H. (1988), "Search method used by unemployed youth", *Journal of Labor Economics*, 6, 1-20.

[24] Holzer, H. and J. Reaser (2000), "Black applicants, black employees, and urban labor market policy", *Journal of Urban Economics*, 48, 365-387.

[25] Ihlanfeldt, K. and B. Scafidi (2002), "Black self-segregation as a cause of housing segregation. Evidence from the multi-city study of urban inequality", *Journal of Urban Economics*, 51, 366-390.

[26] Ihlanfeldt, K. (1997), "Information on the spatial distribution of job opportunities within Metropolitan Areas", *Journal of Urban Economics*, 41, 218-242.

[27] Ihlanfeldt, K.R. and D.L. Sjoquist (1998), "The spatial mismatch hypothesis: a review of recent studies and their implications for welfare reform", *Housing Policy Debate*, 9, 849-892.

[28] Jargowsky, P. and M-J. Bane (1991), "Ghetto poverty in the United States, 1970-1980", in *The Urban Underclass*, C. Jencks and P. Peterson (Eds.), Washington DC: The Brookings Institution.

[29] Kain, J.F. (1968), "Housing segregation, negro employment, and Metropolitan decentralization", *Quarterly Journal of Economics*, 82, 175-197.

[30] Kain J. F. (1992), "The spatial mismatch hypothesis: Three decades later", *Housing Policy Debate,* 3, 371-460.

[31] Kanemoto, Y. (1980), *Theories of Urban Externalities*, Amsterdam: North Holland.

[32] Loury, G. C. (1999) "Social exclusion and ethnic groups: The challenge to economics", paper presented at the Annual World Bank Conference on Development Economics, Washington, D.C.

[33] Massey, D.S. and N.A. Denton (1988), "Suburbanization and segregation in U.S. Metropolitan Areas", *American Journal of Sociology,* 94, 592-626.

[34] Massey, D.S. and N.A. Denton (1993), *American Apartheid: Segregation and the Making of the Underclass*, Cambridge, MA: Harvard University Press.

[35] Montgomery, J. (1991), "Social networks and labor-market outcomes: Toward an economic analysis", *American Economic Review*, 81, 1408-1418.

[36] Mortensen, D.T. and T. Vishwanath (1994), "Personal contacts and earnings. It is who you know!", *Labour Economics*, 1, 187-201.

[37] Mortensen, D.T. and C.A. Pissarides (1999), "New developments in models of search in the labor market", in *Handbook of Labor Economics*, D. Card and O. Ashenfelter (Eds.), Amsterdam: Elsevier Science, ch.39, pp. 2567-2627.

[38] Patterson, O. (1997) *The Ordeal of Integration: Progress and Resentment in America's "Racial" Crisis*. New York: Civitas/Counterpoint.

[39] Pattillo-McCoy, M. (1999), *Black Picket Fences: Privilege and Peril Among the Black Middle Class*, Chicago: The University of Chicago Press.

[40] Petrongolo, B. and C.A. Pissarides (2001), "Looking into the black box: A survey of the matching function," *Journal of Economic Literature*, 39, 390-431.

[41] Pissarides, C.A. (2000), *Equilibrium Unemployment Theory*, 2nd edition, Cambridge: MIT Press.

[42] Raphael, S. and M.A. Stoll (2002), "Modest progress: The narrowing spatial mismatch between blacks and jobs in the 1990s", Washington, DC: The Brookings Institution.

[43] Rogers C. (1997), "Job search and unemployment duration: implications for the spatial mismatch hypothesis", *Journal of Urban Economics*, 42, 109-132.

[44] Schelling, T. (1971), "Dynamic models of segregation", *Journal of Mathematical Sociology*, 1, 143-186.

[45] Stoll, M. (1999), "Spatial hob search, spatial mismatch, and the employment and wages of racial and ethnic groups in Los Angeles", *Journal of Urban Economics*, 46, 129-155.

[46] Topa, G. (2001), "Social interactions, local spillovers and unemployment", *Review of Economic Studies*, 68, 261-295.

[47] Turner, S. (1997), "Barriers to a better break: Employers discrimination and spatial mismatch in Metropolitan Detroit", *Journal of Urban Affairs*, 19, 123-141.

[48] Wasmer, E. and Y. Zenou (2002), "Does city structure affect job search and welfare?" *Journal of Urban Economics*, 51, 515-541.

[49] Wasmer, E. and Y. Zenou (2004), "Equilibrium search unemployment with explicit spatial frictions", mimeo.

[50] Weinberg, B.A. (2000), "Black residential centralization and the spatial mismatch hypothesis", *Journal of Urban Economics*, 48, 110-134.

[51] Wilson, W. (1996), *When Work Disappears: The World of the New Urban Poor,* New York: Alfred A. Knopf.

[52] Yinger, J. (1976), "Racial prejudice and racial residential segregation in an urban model", *Journal of Urban Economics*, 3, 383-396.

[53] Yinger, J. (1995), *Closed Doors, Opportunities Lost: The Continuing Cost of Housing Discrimination*, New York: Russel Sage Foundation.

APPENDIX

Proof of Proposition 1:

Since groups are assumed to form spatially homogenous communities and since bid-rent functions are linear (recall that generically $b'_B(x) = 0$ and $b'_W(x) = 0$), there are only six possible urban configurations depending on the relative locations of the three groups: W (Whites), BS (Status-Seeker Blacks), BC (Conformist Blacks) within the urban space.

- Equilibrium 1, in which, moving outward from the BD, we have the location of the following groups: W, BS, BC;
- Equilibrium 2: BC, BS, W;
- Equilibrium 3: BS, W, BC;
- Equilibrium 4: BC, W, BS;
- Equilibrium 5: W, BC, BS;
- Equilibrium 6: BS, BC, W.

Observe that all these configurations exhibit only one border between black and white communities, except for configurations 3 and 4 which exhibit two such borders.

The aim of this proof is twofold. First, we show that under (21), only equilibria 1 and 2 can exist. Then, we show that we always have multiple equilibria in which either Equilibrium 1 or 2 can occur.

Let us first show that under (21), only equilibria 1 and 2 can exist. Two observations can be made:

First, throughout this proof, we assume that $e_W > t$, $e_{BC} < t$ and $|e_{BS}| < t$. These are just technical conditions that are not necessary for the proof but allows us to have plausible economic results.

Second, to determine an equilibrium configuration with heterogeneous workers, it is necessary to rank bid rents in order of relative steepness (see Fujita, 1989). Since bid rents are always linear with respect to x (see (18), (19) and (20)), the ranking of bid rents is thus straightforward.

(a) Equilibrium 3

Comparing the bid rents of conformist and status-seeker blacks, it is easy to verify that for Equilibrium 3 to be sustained, it must be that $e_{BC} > |e_{BS}|$. This obviously contradicts (21) and thus Equilibrium 3 is ruled out.

(b) Equilibrium 4

Similarly, it is easy to verify that for Equilibrium 4 to be sustained, it must also be that $e_{BC} > |e_{BS}|$. This obviously contradicts (21) and thus Equilibrium 3 is also ruled out.

(c) Equilibrium 5

It is easy to verify that for Equilibrium 5 to be sustained, it must be that $e_{BC} < e_{BS}$. This is by definition impossible since $e_{BC} > 0$ and $e_{BS} < 0$.

(d) Equilibrium 6

It is also easy to verify that for Equilibrium 5 to be sustained, it must be that $e_{BC} < e_{BS}$. As previously, this is by definition impossible since $e_{BC} > 0$ and $e_{BS} < 0$.

So far, we have shown that under assumption (21), equilibria 3, 4, 5 and 6 cannot exist. Therefore, if an equilibrium exists, it is either Equilibrium 1 or Equilibrium 2. For each of these two equilibria, we will first show that all bid rents are decreasing before stating the conditions under which the equilibrium can be sustained. Then we will prove the second part of the proposition, i.e. that we have multiple equilibria.

(e) Equilibrium 1

Using (18), (19) and (20), we have:

$$\frac{\partial \Psi_W(x, v_W^1)}{\partial x} = -e_W - t < 0 \tag{64}$$

$$\frac{\partial \Psi_{BS}(x, v_{BS}^1)}{\partial x} = e_{BS} - t < 0 \tag{65}$$

$$\frac{\partial \Psi_{BC}(x, v_{BC}^1)}{\partial x} = e_{BC} - t < 0 \tag{66}$$

In this equilibrium, all bid rents are decreasing. Now, for Equilibrium 1 to exist, it must be that:

$$\frac{\partial \Psi_W(x, v_W^1)}{\partial x} < \frac{\partial \Psi_{BS}(x, v_{BS}^1)}{\partial x} < \frac{\partial \Psi_{BC}(x, v_{BC}^1)}{\partial x}$$

This is always true under assumption (21).

(f) Equilibrium 2

Using (18), (19) and (20),we have:

$$\frac{\partial \Psi_{BC}(x, v_{BC}^2)}{\partial x} = -e_{BC} - t < 0 \tag{67}$$

$$\frac{\partial \Psi_{BS}(x, v_{BC}^2)}{\partial x} = -e_{BS} - t < 0 \tag{68}$$

$$\frac{\partial \Psi_W(x, v_W^2)}{\partial x} = e_W - t > 0 \tag{69}$$

In this equilibrium, both bid rents of blacks are decreasing but the bid rent of whites is increasing. For Equilibrium 2 to hold, we must have:

$$\frac{\partial \Psi_{BC}(x, v_{BC}^2)}{\partial x} < \frac{\partial \Psi_{BS}(x, v_{BS}^2)}{\partial x} < \frac{\partial \Psi_W(x, v_W^2)}{\partial x}$$

This is again always true under assumption (21).This implies that, under assumption (21) both equilibria prevail.

Proof of Proposition 2

(i) Let us proceed in two steps:

Let us first compare whites and conformist blacks and show that their respective unemployment rates and their respective rates of arrival of information about jobs are always ranked in reverse order. Observe that we focus on discriminating equilibria in which $\widetilde{d}^{1*} > 0$. This implies that $z_W^{1*} > z_B^{1*}$, which using (34) and (35), is equivalent to $q(\Omega_W^{*1}) < q(\Omega_B^{*1})$, that is

$$\Omega_W^{*1} > \Omega_B^{*1} \tag{70}$$

Now, since $\Omega_i^{1*} q\left(\Omega_i^{1*}\right)$ is increasing in Ω_i^{1*}, (70) implies that

$$\Omega_W^{1*} q\left(\Omega_W^{1*}\right) > \Omega_B^{1*} q\left(\Omega_B^{1*}\right) \tag{71}$$

Assume that $\theta_W^{1*} > \theta_{BS}^{1*}$. Using (71), this implies that

$$\theta_W^{1*} \Omega_W^{1*} q\left(\Omega_W^{1*}\right) > \theta_{BS}^{1*} \Omega_B^{1*} q\left(\Omega_B^{1*}\right)$$

Inspection of (46) and (47), implies that $u_W^{1*} < u_{BS}^{1*}$.

Reciprocally, assume that $u_W^{1*} < u_{BS}^{1*}$ then, since $\overline{x}_W^{1*} < \overline{x}_{BS}^{1*}$, it is easy to see from (24) and (25) that $\theta_W^{1*} > \theta_{BS}^{1*}$ is satisfied.

We have thus shown that if $\theta_W^{1*} > \theta_{BS}^{1*}$, then $u_W^{1*} < u_{BS}^{1*}$ and if $u_W^{1*} < u_{BS}^{1*}$, then $\theta_W^{1*} > \theta_{BS}^{1*}$. This means that $\theta_W^{1*} > \theta_{BS}^{1*} \Longleftrightarrow u_W^{1*} < u_{BS}^{1*}$.

Let us show that $\theta_W^{1*} > \theta_{BS}^{1*}$. Using (24) and (25), and (37) and (38), this is equivalent to:

$$\beta\left(\frac{\overline{N}_W + \overline{N}_{BS}}{2}\right) > \lambda\left(1-\alpha\right)\left(u_W^1 - u_{BS}^1\right)$$

Let us take the upper bound of $u_W^1 - u_{BS}^1$, which is 1. This inequality can be written as:

$$\beta\left(\overline{N}_W + \overline{N}_{BS}\right) > 2\lambda\left(1-\alpha\right)$$

Thus if $\overline{N}_W$ is sufficiently large, this is always true. As a result, $\theta_W^{1*} > \theta_{BS}^{1*}$, which is equivalent to $u_W^{1*} < u_{BS}^{1*}$.

Let us now compare conformist blacks and status-seeker blacks. Since both groups have the same match rate $(\Omega_B^{1*} q\left(\Omega_B^{1*}\right))$ and since conformist blacks live further away from jobs

($\overline{x}_{BC}^{1*} > \overline{x}_{BS}^{1*}$) and status-seeker blacks benefit from the positive social network externality of whites (who have a lower unemployment rate), then it must necessarily hold that status-seeker blacks are simultaneously less unemployed than conformist blacks ($u_{BS}^{1*} < u_{BC}^{1*}$) and that information about jobs reach them them at a higher rate ($\theta_{BC}^{1*} > \theta_{BS}^{1*}$).

It follows that $u_W^{1*} < u_{BS}^{1*} < u_{BC}^{1*}$.

(*ii*) We have shown in (*i*) that conformist blacks experience the highest unemployment rate in the city.

Proof of Proposition 3

Unemployment rates cannot be ranked because distance to jobs, social networks and the discrimination parameter may act as opposite forces in (8). Indeed, whites have an advantage in terms of their match rate but now live the furthest away from jobs ($\overline{x}_W^{2*} > \overline{x}_{BS}^{2*} > \overline{x}_{BC}^{2*}$). Similarly, status-seeker blacks are further from jobs than conformist blacks ($\overline{x}_{BS}^{2*} > \overline{x}_{BC}^{2*}$) but may benefit from the social network of whites to the extent that it compensates for their adverse locations.

(*i*) Using the slopes of the bid rents, it is straightforward to verify that

$$R^2(1) > R^2(0) \Leftrightarrow e_W\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC} > t$$

and that

$$[R^2(1) + R^2(\overline{N}_{BS} + \overline{N}_{BC})]/2 > [R^2(0) + R^2(\overline{N}_{BC})]/2$$
$$\Leftrightarrow e_W\overline{N}_W - 2e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC} > t(1 + \overline{N}_{BS}).$$

Clearly, $e_W\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC} > t(1 + \overline{N}_{BS})$ implies both of these conditions.

(*ii*) The result is immediate by comparing θ_W^{2*}, θ_{BS}^{2*} and θ_{BC}^{2*}.

(*iii*) The result is immediate by comparing θ_W^{2*}, θ_{BS}^{2*} and θ_{BC}^{2*}.

Proof of Proposition 4

We want to show that all workers are better off in Equilibrium 2 than in Equilibrium 1. Using (40)-(42) and (55)-(57), we easily obtain:

$$v_W^{2*} - v_W^{1*} = (u_W^{1*} - u_W^{2*})(y_E - y_U) + t\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC}$$

$$v_{BC}^{2*} - v_{BC}^{1*} = (u_{BC}^{1*} - u_{BC}^{2*})(y_E - y_U) + t\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC}$$

$$v_{BS}^{2*} - v_{BS}^{1*} = (u_{BS}^{1*} - u_{BS}^{2*})(y_E - y_U) + t\overline{N}_W - e_{BS}\overline{N}_{BS} - e_{BC}\overline{N}_{BC}$$

Since unemployment rates are always between 0 and 1, the difference in unemployment rates is always between -1 and 1. In particular, we have that:

$$\begin{aligned} u_W^{1*} - u_W^{2*} &> -1 \\ u_{BC}^{1*} - u_{BC}^{2*} &> -1 \\ u_{BS}^{1*} - u_{BS}^{2*} &> -1 \end{aligned}$$

and thus

$$\begin{aligned}
(u_W^{1*} - u_W^{2*})(y_E - y_U) &> -(y_E - y_U) \\
(u_{BC}^{1*} - u_{BC}^{2*})(y_E - y_U) &> -(y_E - y_U) \\
(u_{BS}^{1*} - u_{BS}^{2*})(y_E - y_U) &> -(y_E - y_U)
\end{aligned}$$

Therefore, using (58), we have:

$$\begin{aligned}
(u_W^{1*} - u_W^{2*})(y_E - y_U) &> -(y_E - y_U) > -(t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS}) \\
(u_{BC}^{1*} - u_{BC}^{2*})(y_E - y_U) &> -(y_E - y_U) > -(t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS}) \\
(u_{BS}^{1*} - u_{BS}^{2*})(y_E - y_U) &> -(y_E - y_U) > -(t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS})
\end{aligned}$$

which implies that

$$\begin{aligned}
t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS} + (u_W^{1*} - u_W^{2*})(y_E - y_U) &> 0 \\
t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS} + (u_{BC}^{1*} - u_{BC}^{2*})(y_E - y_U) &> 0 \\
t\overline{N}_W - e_{BC}\overline{N}_{BC} - e_{BS}\overline{N}_{BS} + (u_{BS}^{1*} - u_{BS}^{2*})(y_E - y_U) &> 0
\end{aligned}$$

and thus

$$\begin{aligned}
v_W^{2*} - v_W^{1*} &> 0 \\
v_{BC}^{2*} - v_{BC}^{1*} &> 0 \\
v_{BS}^{2*} - v_{BS}^{1*} &> 0
\end{aligned}$$

Figure 1a: The Spatial-Mismatch Equilibrium:

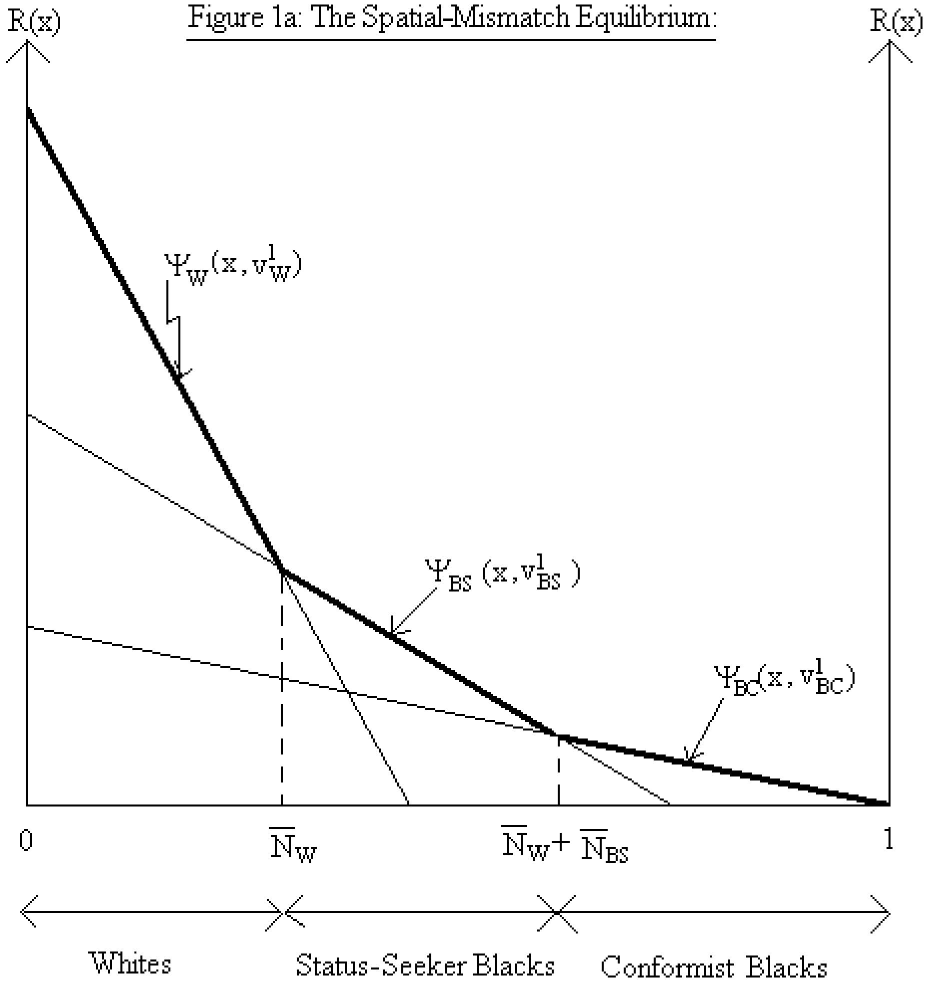

Figure 1b : The Spatial-Mismatch Equilibrium

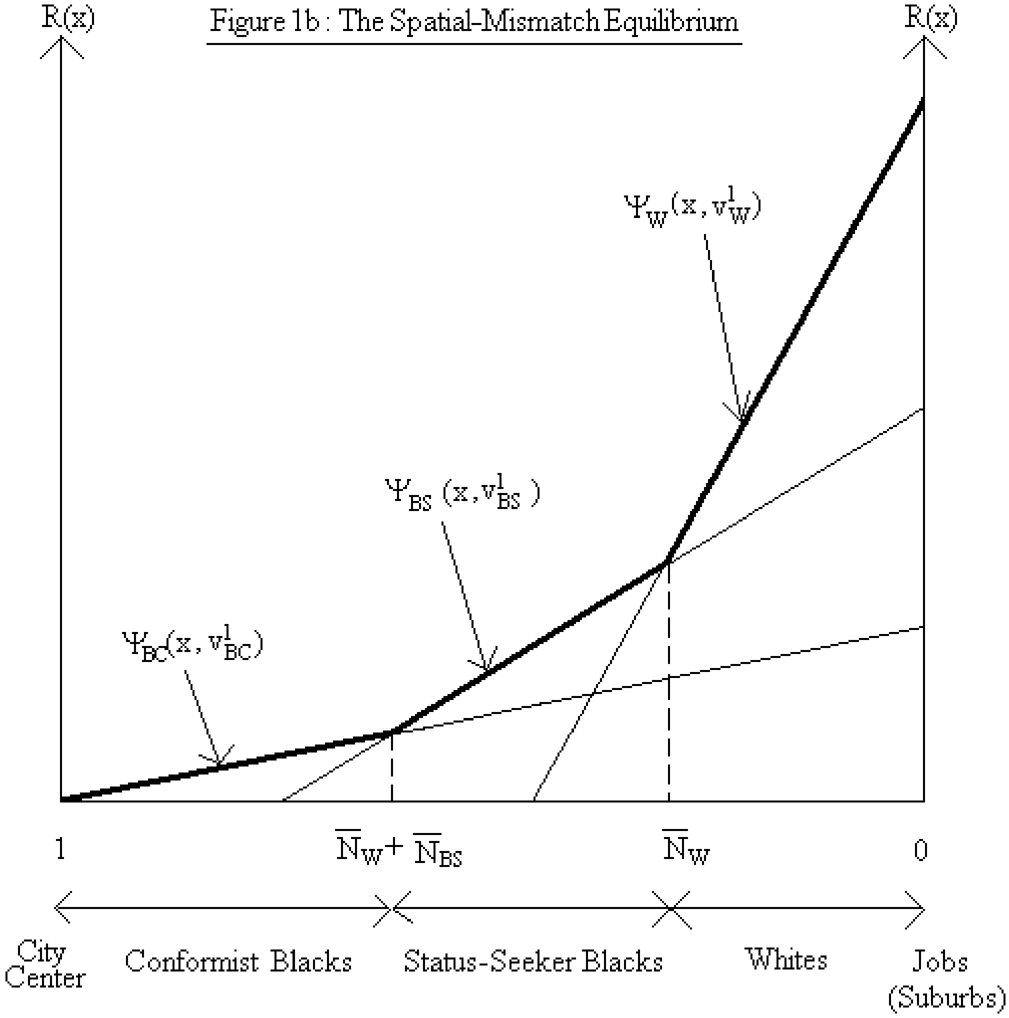

Figure 2 : The Spatial-Match Equilibrium

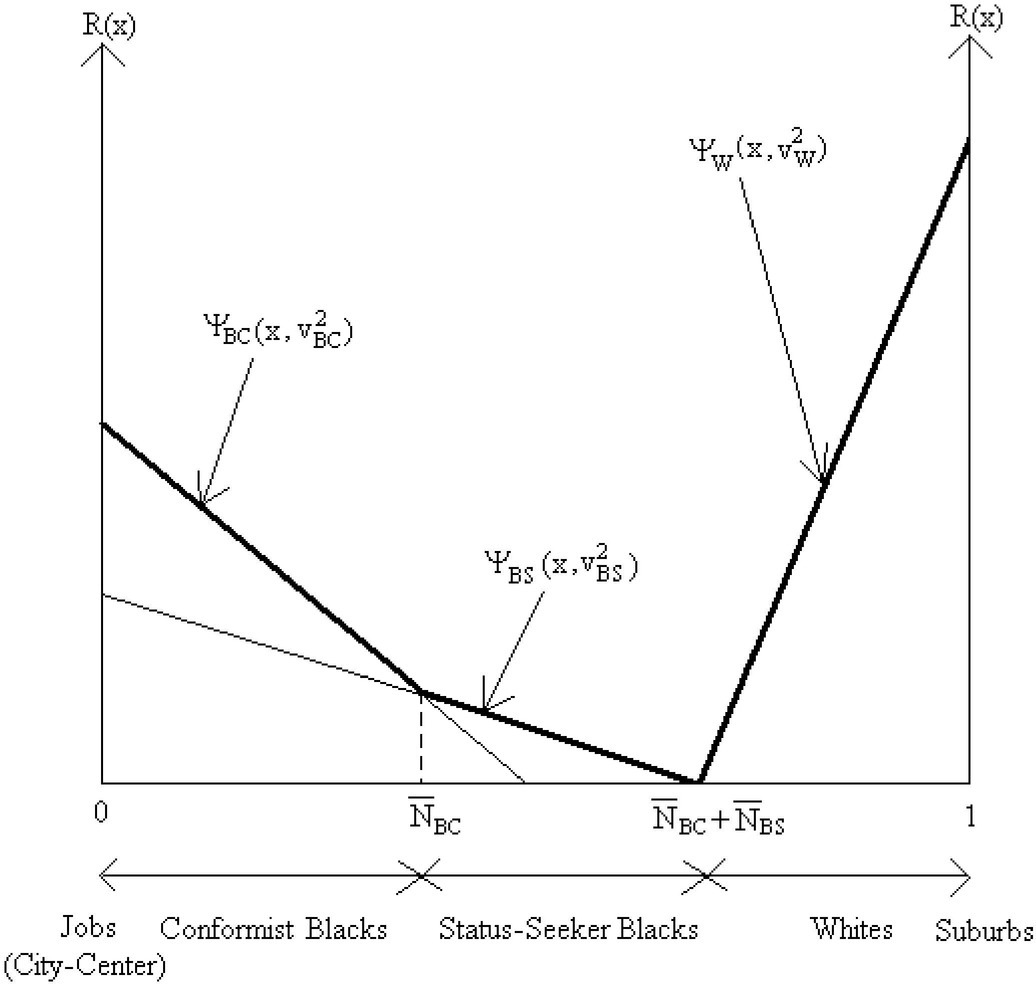

Table 1a: Illustrations of the Spatial-Mismatch Equilibrium. American MSAs with the worse spatial mismatch for blacks in 2000

	Blacks			*Whites*			
	% Pop	*SM*	*% Un*	*% Pop*	*SM*	*% Un*	*Population*
Atlanta, GA MSA	29	54	8.98	63	40	3.09	4,112,198
Baltimore, MD, PMSA	27	52	11.69	67	37	3.05	2,552,994
Chicago, IL PMSA	19	69	17.27	66	34	4.18	8,272,768
Cleveland-Lorain-Elyria, OH, PMSA	19	62	14.09	77	31	4.17	2,250,871
Detroit, MI, PMSA	23	71	14.89	71	36	4.27	4,441,551
Houston, TX, PMSA	17	57	10.85	61	40	4.46	4,117,646
Los Angeles-Long Beach, CA, PMSA	10	62	15.57	49	37	6.64	9,519,338
Miami, FL, PMSA	20	65	13.44	70	36	6.23	2,253,362
New York, NY, PMSA	25	70	14.63	49	44	5.61	9,314,235
Newark, NJ, PMSA	22	65	13.90	66	34	3.96	2,032,989
Oakland, CA, PMSA	13	55	12.08	55	37	3.95	2,392,557
Philadelphia, PA-NJ, PMSA	20	64	13.93	72	34	4.47	5,100,931
Saint Louis, MO-IL, MSA	18	63	14.21	78	38	4.11	2,603,607
Washington, DC-MD-VA-WV, PMSA	26	56	8.64	60	42	2.63	4,923,153

Source: Raphael and Stoll (2000) and Census (2000), calculations from the authors.
% Pop: Percentage of black or white individuals in the population in the MSA or PMSA.
SM: Measure of the Spatial Mismatch between people and jobs using a dissimilarity index
% Un: Percentage of black male unemployed in the MSA or PMSA.

Table 1b: Illustrations of the Spatial-Match Equilibrium.
American MSAs with the worst spatial mismatch for whites in 2000

	Blacks			*Whites*			
	% Pop	*SM*	*% Un*	*% Pop*	*SM*	*% Un*	*Population*
Anniston, AL, MSA	18	17	13.74	79	37	4.85	112,249
Athens, GA, MSA	20.5	16	13.74	73.2	38	5.95	153,444
Billings, MT, MSA	1	9	4.17	93	24	4.63	129,352
Decatur, AL, MSA	12	18	9.33	83	40	6.22	145,867
Dothan, AL, MSA	23	19	13.46	73	32	3.10	137,916
Eugene-Springfield, OR, MSA	1	20	12.90	91	35	6.51	322,959
Florence, AL, MSA	12	21	12.22	86	44	4.17	142,950
Hattiesburg, MS, MSA	26	18	14.54	72	30	3.58	111,674
Rocky Mount, NC, MSA	43	23	12.82	53	34	2.22	143,026
Salt Lake City-Ogden, UT, MSA	1	26	10.03	88	36	4.18	1,333,914
Savannah, GA, MSA	35	23	10.23	61	42	3.32	293,000
Sherman-Denison, TX, MSA	6	11	8.23	87	39	4.13	110,595

Source: Raphael and Stoll (2000) and Census (2000), calculations from the authors.
% Pop: Percentage of black or white individuals in the population in the MSA or PMSA.
SM: Measure of the Spatial Mismatch between people and jobs using a dissimilarity index
% Un: Percentage of black male unemployed in the MSA or PMSA.

Table 2a: Base Case

	Spatial-Mismatch	*Spatial-Match*	$1 \longrightarrow 2$
	Equilibrium (k=1)	*Equilibrium (k=2)*	
u_W^m (%)	3.3	4.7	$+$
u_{BS}^m (%)	13.2	8.8	$-$
u_{BC}^m (%)	18.1	8.2	$-$
$\widetilde{d}^m/\overline{d}$ (%)	17.7	19.2	$+$
z_W^m (%)	2.0	1.8	$-$
z_B^m (%)	.9	.6	$-$
Ω_W^k	.022	.017	$-$
Ω_B^k	.004	.002	$+$
U.D. W	.487	.711	$+$
U.D. BS	2.168	1.381	$-$
U.D. BC	3.147	1.282	$-$
V.D. W	.297	.261	$-$
V.D. B	.131	.083	$-$
v_W^m	9.226	9.521	$+$
v_{BS}^m	8.436	9.195	$+$
v_{BC}^m	8.076	9.271	$+$
P_W^m	3.707	3.671	$-$
P_B^m	.814	.887	$+$
TP^m	4.521	4.558	$+$
LR_W^m	.888	.480	$-$
LR_{BS}^m	.007	.001	$-$
LR_{BC}^m	.002	.006	$+$
TLR^m	.897	.487	$-$
S^m	14.451	14.508	$+$
$\overline{d}$=.96, α=.9, μ=30, λ=10, β=30, δ=.07, κ=.5, η=.5, t=.5, p=15, γ=10,			
y_E=10, y_U=2, $\overline{N}_{BC}$=10%, $\overline{N}_{BS}$=10%, $\overline{N}_W$=80%, e_{BC}=.1, e_{BS}=-.2, e_W=2.			

U.D.: Unemployment Duration $= 1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration $= 1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$

Table 2b: Variations from Base Case

	Base Case	$\beta = 0$	$\lambda = 0$	$\alpha = 0$
Equilibrium 1 (2)				
u_W^m	3.3 (4.7)	3.2 (3.2)	2.9 (6.1)	3.3 (4.7)
u_{BS}^m	13.2 (8.8)	13.2 (13.2)	14.6 (6.1)	13.8 (8.9)
u_{BC}^m	18.1 (8.2)	13.5 (13.5)	33.9 (5.5)	17.8 (8.2)
$\widetilde{d^m}/\overline{d}$	17.7 (19.2)	18.1 (18.1)	16.2 (19.9)	17.7 (19.2)
z_W^m	2.0 (1.8)	1.5 (1.5)	3.5 (2.4)	2.0 (1.8)
z_B^m	.9 (.6)	.3 (.3)	2.5 (1.2)	.9 (.6)
Ω_W^m	.022 (.017)	.011 (.011)	.067 (.032)	.022 (.017)
Ω_B^m	.004 (.002)	.001 (.001)	.033 (.007)	.004 (.002)
U.D. W	.487 (.711)	.470 (.470)	.430 (.938)	.484 (.711)
U.D. BS	2.168 (1.381)	2.176 (2.176)	2.446 (.927)	2.285 (1.392)
U.D. BC	3.147 (1.282)	2.229 (2.229)	7.338 (.830)	3.083 (1.279)
V.D. W	.297 (.261)	.215 (.215)	.517 (.355)	.299 (.261)
V.D. B	.131 (.083)	.046 (.046)	.363 (.169)	.133 (.083)
v_W^m	9.226 (9.521)	9.235 (9.645)	9.256 (9.407)	9.228 (9.521)
v_{BS}^m	8.436 (9.195)	8.432 (8.842)	8.320 (9.412)	8.387 (9.190)
v_{BC}^m	8.076 (9.271)	8.440 (8.850)	6.805 (9.491)	8.100 (9.273)
P_W^m	3.707 (3.671)	3.756 (3.756)	3.602 (3.567)	3.707 (3.671)
P_B^m	.814 (.887)	.846 (.846)	.707 (.902)	.812 (.887)
TP^m	4.521 (4.558)	4.602 (4.602)	4.309 (4.469)	4.519 (4.558)
LR_W^m	.888 (.480)	.888 (.480)	.888 (.480)	.888 (.480)
LR_{BS}^m	.007 (.001)	.007 (.001)	.007 (.001)	.007 (.001)
LR_{BC}^m	.002 (.006)	.002 (.006)	.002 (.006)	.002 (.006)
TLR^m	.897 (.487)	.897 (.487)	.897 (.487)	.897 (.487)
S^m	14.451 (14.508)	14.575 (14.575)	14.124 (14.372)	14.448 (14.508)

The first number is for Equilibrium 1, the second number in brackets is for Equilibrium 2
U.D.: Unemployment Duration = $1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration = $1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$

Table 3a: Affirmative Action

	Base Case: $\phi = 0\%$	$\phi = 5\%$	$\phi = 15\%$
Equilibrium 1 (2)			
u_W^m (%)	3.3 (4.7)	3.6 (5.1)	4.2 (5.6)
u_{BS}^m (%)	13.2 (8.8)	12.0 (7.2)	9.4 (4.7)
u_{BC}^m (%)	18.1 (8.2)	16.2 (6.7)	12.4 (4.3)
$\widetilde{d}^m/\overline{d}$ (%)	17.7 (19.2)	13.8 (15.3)	4.5 (6.0)
$\widehat{d}^m/\overline{d}$ (%)	17.7 (19.2)	18.1 (19.5)	18.8 (20.1)
z_W^m (%)	2.0 (1.8)	1.9 (1.7)	1.6 (1.5)
z_B^m (%)	.9 (.6)	1.0 (0.7)	1.3 (1.1)
Ω_W^m	.022 (.017)	.019 (.015)	.014 (.012)
Ω_B^m	.004 (.002)	.005 (.003)	.009 (.007)
U.D. W	.487 (.711)	.526 (.760)	.619 (.849)
U.D. BS	2.168 (1.381)	1.942 (1.113)	1.479 (.699)
U.D. BC	3.147 (1.282)	2.763 (1.029)	2.023 (.641)
V.D. W	.297 (.261)	.275 (.245)	.234 (.220)
V.D. B	.131 (.083)	.147 (.103)	.193 (.164)
v_W^m	9.226 (9.521)	9.206 (9.496)	9.158 (9.451)
v_{BS}^m	8.436 (9.195)	8.533 (9.322)	8.739 (9.527)
v_{BC}^m	8.076 (9.271)	8.223 (9.392)	8.528 (9.587)
P_W^m	3.707 (3.671)	3.888 (3.844)	4.300 (4.245)
P_B^m	.814 (.887)	.632 (.707)	.206 (.278)
TP^m	4.521 (4.558)	4.520 (4.552)	4.506 (4.523)
LR_W^m	.888 (.480)	.888 (.480)	.888 (.480)
LR_{BS}^m	.007 (.001)	.007 (.001)	.007 (.001)
LR_{BC}^m	.002 (.006)	.002 (.006)	.002 (.006)
TLR^m	.897 (.487)	.897 (.487)	.897 (.487)
S^m	14.451 (14.508)	14.458 (14.507)	14.457 (14.483)

The first number is for Equilibrium 1, the second number in brackets is for Equilibrium 2
U.D.: Unemployment Duration = $1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration = $1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$

Table 3b: Affirmative Action

	Base Case	*Constraining*	*No discrimination*	*Optimal*
	$\phi^1 = 0\%$	$\overline{\phi}^1 = 19.1\%$	$\widehat{\phi}^1 = 20.0\%$	$\phi^{o1} = 9.9\%$
	$\phi^2 = 0\%$	$\overline{\phi}^2 = 20.4\%$	$\widehat{\phi}^2 = 12.7\%$	$\phi^{o2} = 1.3\%$
Equilibrium 1 (2)				
u_W^m (%)	3.3 (4.7)	4.4 (5.9)	5.2 (5.5)	3.8 (4.8)
u_{BS}^m (%)	13.2 (8.8)	8.3 (3.7)	5.5 (5.2)	10.7 (8.4)
u_{BC}^m (%)	18.1 (8.2)	10.9 (3.4)	7.0 (4.8)	14.3 (7.8)
$\widetilde{d}^m/\overline{d}$ (%)	17.7 (19.2)	0 (0)	0 (8.4)	9.5 (18.2)
$\widehat{d}^m/\overline{d}$ (%)	17.7 (19.2)	19.1 (20.4)	20 (20)	18.4 (19.3)
z_W^m (%)	2.0 (1.8)	1.5 (1.4)	1.3 (1.5)	1.7 (1.8)
z_B^m (%)	.9 (.6)	1.5 (1.4)	2.4 (1.0)	1.1 (.6)
Ω_W^m	.022 (.017)	.012 (.011)	.009 (.013)	.016 (.016)
Ω_B^m	.004 (.002)	.012 (.011)	.030 (.005)	.007 (.002)
U.D. W	.487 (.711)	.660 (.889)	.788 (.829)	.570 (.724)
U.D. BS	2.168 (1.381)	1.297 (.545)	.832 (.780)	1.713 (1.307)
U.D. BC	3.147 (1.282)	1.747 (.499)	1.077 (.717)	2.391 (1.213)
V.D. W	.297 (.261)	.220 (.210)	.185 (.225)	.254 (.257)
V.D. B	.131 (.083)	.220 (.210)	.344 (.147)	.166 (.087)
v_W^m	9.226 (9.521)	9.137 (9.431)	9.072 (9.461)	9.183 (9.514)
v_{BS}^m	8.436 (9.195)	8.824 (9.606)	9.050 (9.486)	8.633 (9.229)
v_{BC}^m	8.076 (9.271)	8.648 (9.660)	8.959 (9.548)	8.373 (9.304)
P_W^m	3.707 (3.671)	4.495 (4.499)	4.495 (4.144)	4.081 (3.715)
P_B^m	.814 (.887)	0 (0)	0 (.388)	.434 (.842)
TP^m	4.521 (4.558)	4.495 (4.499)	4.495 (4.532)	4.515 (4.557)
LR_W^m	.888 (.480)	.888 (.480)	.888 (.480)	.888 (.480)
LR_{BS}^m	.007 (.001)	.007 (.001)	.007 (.001)	.007 (.001)
LR_{BC}^m	.002 (.006)	.002 (.006)	.002 (.006)	.002 (.006)
TLR^m	.897 (.487)	.897 (.487)	.897 (.487)	.897 (.487)
S^m	14.451 (14.508)	14.449 (14.458)	14.451 (14.491)	14.460 (14.509)

The first number is for Equilibrium 1, the second number in brackets is for Equilibrium 2
U.D.: Unemployment Duration = $1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration = $1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$

Table 4a: Employment Subsidies

	Base Case: $\sigma = 0$	$\sigma = .05$	$\sigma = .2$
Equilibrium 1 (2)			
u_W^m (%)	3.3 (4.7)	3.6 (5.1)	4.5 (5.9)
u_{BS}^m (%)	13.2 (8.8)	11.7 (6.9)	8.0 (3.6)
u_{BC}^m (%)	18.1 (8.2)	15.8 (6.4)	10.4 (3.3)
$\widetilde{d}^m/\overline{d}$ (%)	17.7 (19.2)	18.2 (19.6)	19.2 (20.4)
z_W^m (%)	2.0 (1.8)	1.9 (1.7)	1.5 (1.4)
z_B^m (%)	.9 (.6)	1.0 (.7)	1.6 (1.5)
Ω_W^m	.022 (.017)	.018 (.015)	.012 (.011)
Ω_B^m	.004 (.002)	.006 (.003)	.013 (.011)
U.D. W	.487 (.711)	.535 (.770)	.674 (.891)
U.D. BS	2.168 (1.381)	1.896 (1.060)	1.239 (.536)
U.D. BC	3.147 (1.282)	2.688 (.979)	1.660 (.491)
V.D. W	.297 (.261)	.271 (.242)	.215 (.210)
V.D. B	.131 (.083)	.150 (.108)	.230 (.213)
v_W^m	9.226 (9.521)	9.201 (9.491)	9.129 (9.430)
v_{BS}^m	8.436 (9.195)	8.553 (9.347)	8.851 (9.611)
v_{BC}^m	8.076 (9.271)	8.253 (9.417)	8.687 (9.664)
P_W^m	3.707 (3.671)	3.702 (3.659)	3.675 (3.623)
P_B^m	.814 (.887)	.828 (.900)	.855 (.910)
TP^m	4.521 (4.558)	4.530 (4.559)	4.530 (4.533)
LR_W^m	.888 (.480)	.888 (.480)	.888 (.480)
LR_{BS}^m	.007 (.001)	.007 (.001)	.007 (.001)
LR_{BC}^m	.002 (.006)	.002 (.006)	.002 (.006)
TLR^m	.897 (.487)	.897 (.487)	.897 (.487)
S^m	14.451 (14.508)	14.469 (14.516)	14.485 (14.492)
T^m/TP^m (%)	0 (0)	.2 (.2)	.8 (.9)

The first number is for Equilibrium 1, the second number in brackets is for Equilibrium 2
U.D.: Unemployment Duration = $1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration = $1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$

Table 4b: Employment Subsidies

	Base Case	*No discrimination*	*Optimal*	*AA equivalent*
	$\sigma^1 = 0$	$\widehat{\sigma}^1 = .357$	$\sigma^{o1} = .166$	$\widetilde{\sigma}^1 = .023$
	$\sigma^2 = 0$	$\widehat{\sigma}^2 = .111$	$\sigma^{o2} = .062$	$\widetilde{\sigma}^2 = .001$
Equilibrium 1 (2)				
u_W^m (%)	3.3 (4.7)	5.2 (5.5)	4.3 (5.2)	3.4 (4.8)
u_{BS}^m	13.2 (8.8)	5.5 (5.2)	8.7 (6.5)	12.5 (8.8)
u_{BC}^m (%)	18.1 (8.2)	7.0 (4.8)	11.4 (6.0)	17.0 (8.2)
$\widetilde{d}^m/\overline{d}$ (%)	17.7 (19.2)	20 (20)	19.0 (19.7)	17.9 (19.2)
z_W^m (%)	2.0 (1.8)	1.3 (1.6)	1.6 (1.6)	2.0 (1.8)
z_B^m (%)	.9 (.6)	2.4 (1.0)	1.4 (.8)	1.0 (.6)
Ω_W^m	.022 (.017)	.009 (.013)	.013 (.014)	.020 (.017)
Ω_B^m	.004 (.002)	.030 (.005)	.011 (.003)	.005 (.002)
U.D. W	.487 (.711)	.788 (.829)	.645 (.783)	.509 (.713)
U.D. BS	2.168 (1.381)	.832 (.780)	1.362 (.995)	2.041 (1.374)
U.D. BC	3.147 (1.282)	1.077 (.717)	1.845 (.918)	2.929 (1.276)
V.D. W	.297 (.261)	.185 (.225)	.225 (.238)	.284 (.261)
V.D. B	.131 (.083)	.344 (.147)	.209 (.115)	.139 (.083)
v_W^m	9.226 (9.521)	9.072 (9.461)	9.144 (9.484)	9.215 (9.520)
v_{BS}^m	8.436 (9.195)	9.050 (9.486)	8.794 (9.379)	8.490 (9.198)
v_{BC}^m	8.076 (9.271)	8.959 (9.548)	8.605 (9.447)	8.159 (9.274)
P_W^m	3.707 (3.671)	3.638 (3.644)	3.682 (3.656)	3.705 (3.671)
P_B^m	.814 (.887)	.861 (.908)	.851 (.902)	.820 (.888)
TP^m	4.521 (4.558)	4.499 (4.553)	4.533 (4.559)	4.525 (4.558)
LR_W^m	.888 (.480)	.888 (.480)	.888 (.480)	.888 (.480)
LR_{BS}^m	.007 (.001)	.007 (.001)	.007 (.001)	.007 (.001)
LR_{BC}^m	.002 (.006)	.002 (.006)	.002 (.006)	.002 (.006)
TLR^m	.897 (.487)	.897 (.487)	.897 (.487)	.897 (.487)
S^m	14.451 (14.508)	14.455 (15.512)	14.486 (14.516)	14.460 (14.509)
T^m/TP^m (%)	0 (0)	1.6 (.5)	.7 (.3)	.09 (.004)

The first number is for Equilibrium 1, the second number in brackets is for Equilibrium 2
U.D.: Unemployment Duration $= 1/\kappa\theta_{ik}^m\ (\Omega_{ik}^m)^{1-\eta}$, $ik = W, BC, BS$, $m = 1, 2$
V.D.: Vacancy Duration $= 1/\kappa(\Omega_i^m)^{-\eta}$, $i = W, B$, $m = 1, 2$