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ABSTRACT

Racial Beliefs, Location And The Causes Of Crime*

The aim of this Paper is to show that both location and stereotypical racial beliefs matter for explaining the high criminality rate among blacks in cities. In our model, blacks and whites are identical in all respects. However, if, for not economic but extrinsic reasons, everybody (including blacks) believes that more blacks become criminals than whites, then we show that more blacks (for rational reasons) become criminals than whites, earn lower wages and reside in ghettos located far away from legal activities. There is a vicious circle in which blacks cannot escape because both location and labour market outcomes reinforce each other to imply high crime rates among blacks living in cities. This is referred to as the discriminating equilibrium. If there are no such beliefs in the economy, then another equilibrium emerges in which blacks and whites experience the same labour market and crime outcomes and live together. This is referred to as the non-discriminating equilibrium. The key feature of this belief-based model is that multiple equilibria are sustainable only because of space. Indeed, since location is endogeneous, workers who are believed to be criminals have fewer incentives to locate close to jobs. Since workers that are located further away from jobs have a lower net wage, their risk of capture is lower and hence the incidence of crime is greater. Consequently, if there were no spatial dimension in this economy so that all workers were residing in the same location, multiple equilibria would not emerge and the only sustainable equilibrium would be the non-discriminating one, even if all agents believe that more blacks are criminals than whites. In other words, beliefs alone cannot generate the discriminating equilibrium; it is the presence of both ‘negative’ beliefs and ‘bad’ locations that allow the discriminating equilibrium to exist. It is thus our contention that location and beliefs play a major role in explaining the high criminality rate among blacks.

JEL Classification: J15, K42, R14
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NON-TECHNICAL SUMMARY

It is commonly observed that crime is unevenly distributed across location and race. Concerning location, the rate of violent crime in cities with more than 250,000 population is 346 per 100,000 inhabitants whereas in cities with less than 10,000 inhabitants, the rate of violent crime is just 176 per 100,000. Similar figures can be found for property crimes or other less violent crimes. Moreover, in US metropolitan areas, crime rates are higher in central cities than in suburbs. Between 1985 and 1992, crime victimizations averaged 0.409 per household in central cities, while they averaged 0.306 per household in suburbs. Concerning race, it is well documented on average, more blacks than whites are criminals. For example, the proportion of black men 20–29 years old directly in trouble with the law (in jail or prison or on probation or parole) reached 23% in 1989. In 1993 in the US, the number incarcerated was 1.9% of the male work force, but among blacks, the number incarcerated was 8.8% of the work force and 25.3% under supervision relative to the work force. For black men aged 18–34, the ratios to the work force were 12.7% incarcerated and 36.7% under supervision. Since a disproportionate number of prisoners are high school dropouts, the proportion of less-educated men who were incarcerated, probated or paroled, was even greater.

The traditional way of explaining the spatial heterogeneity of crime rates is by using the social interaction models. They state that individual behaviour depends not only on individual incentives but also on the behaviour of peers and neighbours. In other words, an individual is more likely to commit crimes if his peers do, than if they do not. In the present Paper, we propose an alternative but complementary explanation of crime in cities than the one given by social interactions. Our Paper is original for at least two reasons. First, it is the first Paper to formalize the belief-based equilibrium idea with respect to blacks and crime. Second, and this is the most important reason, the mechanism that generates multiple equilibria is different from the one used in the papers above and, to the best of our knowledge, it has never been used before. The key feature of our belief-based model is that multiple equilibria are sustainable only because of space. Indeed, since location is endogenous, workers who are believed to be more criminal (blacks) have less incentives to locate close to jobs. Since workers that are located further away from jobs have a lower net wage, the risk of being caught is lower and hence the incidence of crime is greater. So, if there were no spatial dimension in this economy so that all workers were residing in the same location, we show that there cannot be multiple equilibria and that the only sustainable equilibrium would be the one in which blacks are not discriminated against, even if all agents believe that blacks are more criminals than whites. In other words, beliefs alone cannot generate the discriminating equilibrium; it is the presence

of both negative beliefs and bad locations that allow the discriminating equilibrium to exist. It is therefore our contention that location and beliefs play a major role in explaining the enormous over-representation of blacks in criminal activity.

To be more precise, by assuming that all legal economic activities are concentrated in the Business District (BD hereafter), we show that people living in ghettos (i.e. further away from the BD) are more likely to become criminals than those residing closer to jobs because the risk of being caught and sent to prison is lower. Furthermore, we also show that the incentives to be a criminal for a black depends positively on the expected number of black criminals so that there is a positive group externality on crime incentives even if the group characteristic (black) is *a priori* completely extrinsic. This is because this characteristic plays a role in the process of labour market discrimination and the levels of wages offered in this market since we assume that criminals are less productive than non-criminal workers. So, if everybody (including blacks) believe that whites are less criminal (and thus more productive) than blacks for no economic reasons (since whites are not more productive than blacks) but because of extrinsic reasons, then everybody will behave accordingly and will actually make these beliefs consistent. In other words, pure extrinsic reasons (i.e. that are not related to the fundamentals of the economy) may generate self-fulfilling `prophecies' where more blacks are criminals than whites, reside in ghettos further away from legal activities and receive lower wage rates.

We have in fact the following vicious circle. Because of beliefs, all agents in the economy believe that more blacks are criminals than whites. In the labour market, if blacks anticipate these beliefs, then they also anticipate that they will earn lower wages because criminality hurts workers' productivity. In the land market, blacks will reside in ghettos located far away from legal activities because they anticipate that, if caught and sent to prison, they will not bear anymore the cost of being away from legal activities (like e.g. search costs). Now, because blacks earn lower wages and live further away from the BD, they are more likely to commit crimes and, indeed, more are criminals than whites. 'Discriminating' prophecies in which space and location plays an important role are indeed self-fulfilling.

Depending on beliefs, two types of equilibria are indeed shown to exist: either race does not matter (the Non-Discriminating Market Equilibrium (NDME)) or race does matter (the Discriminating Market Equilibrium (DME)). We then compare these two equilibria. Because of the subtle reinforcing interactions between labour, crime and land markets, the DME generates on average more urban criminality than the NDME. Moreover, when the degree of racial discrimination is high enough, these two equilibria cannot be Pareto ranked.

Though the discriminated individuals (the blacks) are always worse off in the DME, the favoured group (the whites) may actually be better off in the DME.

Finally, by focussing on the Discriminating Market Equilibrium, we provide interesting comparative statistics on crime rates, wages and welfare levels of the two groups of agents with respect to policy or technological parameters. An important implication of these results is to show how the interplay of these three markets (crime, land and labour) actually magnify the first direct impact of such variables on one particular market. These comparative statistics are also useful to generate empirical implications on crime rates and wages and racial inequality, some of which are very much specific to our approach.

1 Introduction

Why is crime unevenly distributed across space? Why is crime unevenly distributed across race? In this paper, we propose a model based on location, wages and beliefs to explain why criminality is higher among blacks and even higher when they reside in ghettos. The aim of this paper is thus to show that both location and beliefs matter for explaining the high criminality rate among blacks in cities.

It is well known that there is more crime in big cities compared to small cities or rural areas (Glaeser and Sacerdote, 1996). For example, the rate of violent crime in cities with more than 250,000 population is 346 per 100,000 inhabitants whereas in cities with less than 10,000 inhabitants, the rate of violent crime is just 176 per 100,000 (Glaeser, 1998). Similar figures can be found for property crimes or other less violent crimes.

It is also well known that there are large differences within cities. According to Freeman (1999), persons who commit crime tend to be young, male, high school dropouts with troubled family histories and low scores on standardized tests. Moreover, a disproportionate number of those involved in crime are black, which creates a major social problem in America's inner cities.

Concerning race, it is well documented that blacks are on average more criminals than whites. For example, the proportion of blacks men 20 to 29 years old directly in trouble with the law (in jail or prison or on probation or parole) reached 23 percent in 1989 (Case and Katz, 1991). Freeman (1994) shows that, in 1993 in the U.S., the number incarcerated was 1.9 percent of the male work force, but among blacks, the number incarcerated was 8.8 percent of the work force and 25.3 percent under supervision relative to the work force. For black men aged 18-34, the ratios to the work force were 12.7 percent incarcerated and 36.7 percent under supervision. Since a disproportionate number of prisoners are high school dropouts, the proportion of less educated men who were incarcerated, probated or paroled, was even greater (Freeman, 1992).

Concerning location, it is also well documented that, within cities, crime is highly concentrated in a limited number of areas. For example, in U.S. metropolitan areas, crime rates are higher in central cities than in suburbs. Between 1985 and 1992, crime victimizations averaged 0.409 per household in central cities, while they averaged 0.306 per household in suburbs (Bearse, 1996, Figure 1). South and Crowder (1997, Table 2) also show that U.S. central cities have higher crime and unemployment rates, higher population densities and larger relative black populations than their corresponding suburban rings.

The question now is do we have a good model that can explain why race and location matter for explaining high crime rates in cities. Social interaction models stating that individual behavior depends not only on individual incentives but also on the behavior of peers and neighbors are a natural way to explain the concentration of crime by area. An individual is more likely to commit crime if his peers commit than if they do not commit crime (Glaeser, Sacerdote and Scheinkman, 1996). Freeman, Grogger and Sonstelie (1996)[1] provide a theoretical model that explains why criminals are concentrated in some areas of the city (ghettos) and why they tend to commit crimes in their own local areas and not in rich neighborhoods. Their explanation is based on the fact that, when criminals are numerous within an area, the chance to be caught is low so that criminals create a positive externality for each other. In this context, criminals concentrate their effort in (poor) neighborhoods where the probability to be caught is small. Case and Katz (1991), using the 1989 NBER survey of young living in low-income, inner-city Boston neighborhoods, found that residence in a neighborhood in which many other youths are involved in crime is associated with an increase in an individual's probability of committing crime. Exploiting a natural experience (i.e. the Moving to Opportunity experiment that has assigned a total of 614 families living in high-poverty Baltimore neighborhoods into richer neighborhoods), Ludwig, Duncan and Hirschfield (1998) show that the behavior or characteristics of neighbors influences juvenile criminal activity.

In the present paper, we propose an alternative but complementary explanation of crime in cities than the one given by social interactions. Indeed, by explicitly modelling the interaction between crime, land and labor markets, we highlight the role of beliefs (and thus history) in the decision of being criminal and its interaction with location and wages. In this context, a slight (initial) difference in beliefs can have a dramatic impact on the crime rate, the location and the labor market outcomes of blacks.

The belief-based equilibrium idea and the self-fulfilling prophecy in which negative beliefs about an identified group lead to a bad outcome for this group is of course not new to economics. For example, Framer and Terell (1996) have a model in which employers form beliefs about worker productivity based on some group mean productivity. This then leads to diminished human capital accumulation for the undervalued group. In Acemoglu (1995), employers have negative beliefs against the long-term unemployed, who in response decide to let their skills atrophy so that prophecies become self-fulfilling. Coate

[1] See also Deutsch, Hakim and Weinblatt (1987) and Deutsch and Epstein (1998).

and Loury (1993) develop a model in which employers have negative beliefs about the productivity of minority workers. This leads to self-fulfilling negative stereotypes. Finally, in Piketty (1998), social status leads to human capital accumulation which leads to more social status. This model also generates multiple equilibria.

Our paper is new for at least two reasons. First, it is the first paper to formalize the belief-based equilibrium idea with respect to blacks and crime. Second, and this is the most important reason, the mechanism that generates multiple equilibria is different from the one used in the papers above and, to the best of our knowledge, it has never been used before. The key feature of our belief-based model is that multiple equilibria are sustainable only because of space. Indeed, since location is endogeneous, workers who are believed to more criminal (blacks) have less incentives to locate close to jobs. Since workers that are located further away from jobs have a lower net wage, their opportunity cost of crime are lower and hence the incidence of crime is greater. So, if there were no spatial dimension in this economy so that all workers were residing in the same location, we show that there cannot be multiple equilibria and that the only sustainable equilibrium would be the one in which blacks are not discriminated against, even if all agents believe that blacks are more criminals than whites. In other words, beliefs alone cannot generate the discriminating equilibrium; it is the presence of both 'negative' beliefs and 'bad' locations that allow the discriminating equilibrium to exist. *It is therefore our contention that location and beliefs play a major role in explaining the enormous over-representation of blacks in criminal activity.*

To be more precise, by assuming that all legal economic activities are concentrated in the Business District (BD hereafter), we show that people living in ghettos (i.e. further away from the BD) are more likely to become criminals than those residing closer to jobs because their opportunity cost of being caught and send to prison is lower. Furthermore, we also show that the incentives to be a criminal for a black depends positively on the expected number of black criminals so that there is a positive group externality on crime incentives even if the group characteristic (black) is 'a priori' completely extrinsic. This is because this characteristic plays a role in the process of labor market discrimination and the levels of wages offered in this market since we assume that criminals are less productive than non criminal workers. So, if everybody (including blacks) believe that whites are less criminal (and thus more productive) than blacks for no economic reasons (since whites are not more productive than blacks) but because of extrinsic reasons, then everybody will behave accordingly and will actually make these beliefs consistent. In other words, pure extrinsic reasons (i.e. that are not related to the fundamentals of the economy) may generate self-fulfilling 'prophecies' where blacks are more criminals than whites, reside in ghettos further away from legal activities and receive lower wage rates.

We have in fact the following vicious circle. Because of beliefs, all agents in the economy believe that blacks are more criminals than whites. In the labor market, if blacks anticipate these beliefs, then they also anticipate that they will earn lower wages because criminality hurts workers' productivity. In the land market, blacks will reside in ghettos located far away from legal activities because they anticipate that, if caught and send to prison, they will not bear anymore the cost of being away from legal activities (like e.g. search costs). Now, because blacks earn lower wages and live further away from the BD, they are more induced to commit crimes and are indeed more criminals than whites. 'Discriminating' prophecies in which space and location plays an important role are indeed self-fulfilling.

Depending on beliefs, two types of equilibria are indeed shown to exist: either race does not matter (the Non Discriminating Market Equilibrium (NDME)) or race does matter (the Discriminating Market Equilibrium (DME)). We then compare these two equilibria. Because of the subtle reinforcing interactions between labor, crime and land markets, the DME generates on average more urban criminality than the NDME. Moreover, when the degree of racial discrimination is high enough, these two equilibria cannot be Pareto ranked. Though the discriminated individuals (the blacks) are always worse off in the DME, the favored group (the whites) may actually be better off in the DME.

Finally, by focussing on the Discriminating Market Equilibrium, we provide interesting comparative statics on crime rates, wages and welfare levels of the two groups of agents with respect to policy or technological parameters. An important implication of these results is to show how the interplay of these three markets (crime, land and labor) actually magnify the first direct impact of such variables on one particular market. These comparative statics are also useful to generate empirical implications on crime rates and wages and racial inequality some of which are very much specific to our approach.

The rest of the paper is as follows. In the next section, we describe the basic model. Section 3 derives the market equilibrium (i.e. equilibrium in labor, crime and land markets) when discrimination prevails and when it does not. In section 4, we examine the different properties and empirical implications of the market equilibrium. Finally, section 5 concludes.

2 The model

There are two types of individuals, blacks (B) and whites (W), who only differ by the color of their skin. In other words, the two types are differentiated only by an *extrinsic* characteristic $i \in \{B, W\}$, which is publicly observable by all agents (workers and firms) in the economy. This characteristic is completely extrinsic in the sense that it is, a priori, completely unrelated to any fundamental parameter of the economy. For simplicity, we normalize the size of each population to 1, i.e. $\overline{N}_B = \overline{N}_W = 1$ (where $\overline{N}_B$ and $\overline{N}_W$ are respectively the total number of blacks and whites). Workers of both types $\{B, W\}$ are heterogeneous in their incentives to commit crime so that they have different aversion to crime u (or alternatively crime productivity). Regardless of location and type, we assume that this parameter u is independently identically distributed (i.i.d.) across individuals according to a uniform distribution $F(u) = u$ on the interval $[0, 1]$.

All agents, workers and firms, are assumed to be risk neutral. The city, in which both firms and workers are located, is monocentric, i.e., all firms are exogenously located in the Business District (BD hereafter), linear, closed and all land is own by absentee landlords.[2] The BD is the place where all firms are located. Observe that our model can capture the case of both US and European cities since what matters here is the distance to jobs (or legal activities). In the present framework, the BD is the central business district in which all jobs are concentrated in the city-center. This corresponds to a typical European city since most jobs are created in the central part of the city. However, our model can also address the U.S. situation, where most jobs are created in the suburbs,[3] by flipping the city so that jobs are in the suburbs (suburban business district) and workers reside between the center and the city fringe. Obviously all results are exactly the same. This is why we call our job center the Business District since it can address both the case of a central

[2] All these assumptions are very standard in urban economics (see e.g. Brueckner, 1987 or Fujita, 1989). For example, the extension to a circular symmetric city is straightforward since any ray through the center looks like any other ray. So examining a single ray is almost the same as looking at the whole city.

[3] It should be noted that this is not true for all American cities. According to Glaeser, Kahn and Rappaport (1999) who focus on the 12 largest MSAs in 1990, there is a distinction between 'old' cities like e.g. New York, Chicago, Detroit (which, in terms of population, were in the top 12 in 1900 and are still in the top 12 in 1990) where most jobs are created in the city-center and 'new' or edge cities like e.g. Los Angeles, Atlanta, Houston (which, in terms of population, were not in the top 12 in 1900 but are in the top 12 in 1990) where most jobs are created in the suburbs.

and of a suburban business district.

There is a continuum of workers (blacks or whites) uniformly distributed along the linear city who endogenously decide their optimal residence between the BD and the city fringe. They all consume the same amount of land (normalized to 1 for simplicity) and the density of residential land parcels is taken to be unity so that there are exactly x units of housing within a distance x of the BD. Workers go to the BD to work (commuting costs) and thus bear a total cost tx at a distance x from the BD (where t is the commuting cost per unit of distance). In this paper, we adopt a more general and intuitive interpretation of t, which is viewed as the cost per unit of distance of being far away from legal activities and thus as a measure of job accessibility. This is because workers who live far away from jobs have poorer information, higher pecuniary and time costs and thus less job opportunities than those residing closer to jobs.

The timing of the model is as follows. In the first stage, all individuals choose their location in the city without knowing their type u but anticipating (with rational expectations) the average total population of criminals of type $i = B, W$. In the second stage, types (or honesty parameters) are revealed and individuals decide to commit crime or not. The assumption that types are revealed only after location choices have been made to take into account the relative inertia of the land market compared to the crime and labor markets. Obviously, individuals make quicker decisions in terms of crime or labor than in terms of residential location. In stage 3, honest and non-convicted workers participate in the labor market and, in stage 4, consume the composite good.

Observe that in the second stage, workers are stuck to their initial locations (decided in the first stage) and cannot relocate themselves. They then decide to become criminal or not by taking into account the fact that, the further away they reside from jobs, the higher is the opportunity cost of being far away from legal activities. Since there is full employment, what matters is the net wage, i.e. the wage net of commuting costs.

In our model, criminality is unobserved by employers (unless individuals are caught and convicted) so that employers must decide how much to pay the convicted as well as the unconvicted workers. When a worker engages in crime, regardless of his type, he can be caught and convicted with some exogenous probability $\alpha \in]0, 1[$. The direct reward from crime is Π and the public penalty, when convicted, is P. On top of that he/she is sent to prison and therefore cannot participate to the labor market. We denote by $\theta_i(x)$ the proportion of individuals of type $i = B, W$ at distance x from the center who commit crime and by $\overline{\theta}_i$, the average total population of criminals of type $i = B, W$. Since there is a continuum of workers, this variable is unaffected by any individual's decision.

We are now able to describe the different markets at works, namely labor, crime and land markets.

2.1 The labor market

An honest or non convicted worker offers inelastically 1 unit of labor. We assume that crime affects net productivity so that criminals are less productive than non criminal workers. This is a quite natural assumption since criminals tend to steal, to interfer negatively with co-workers, to have a higher probability to be physically injured because of parallel violent illegal activities...(see Dickens et al., 1989, and Rasmusen, 1996). The productivity of an honest worker is $m + y$ with $y > 0$ while that of a non convicted criminal is m. Employers compete with each other for workers but all of them can only observe the total fraction $\alpha\overline{\theta}_i$ of convictions for both types i of individuals. As stated above, they do not observe neither criminality nor marginal product. This leaves the proportion $1 - \alpha\overline{\theta}_i$ of the population unconvicted. We also assume that they cannot discriminate according to location (because workers can always misreport on their location). However they might discriminate according to the extrinsic observable characteristic i of the worker. Therefore the offered wage on the market w_i is type's i specific and will be equal to the average productivity of that worker. It is thus given by:

$$\begin{aligned} w_i &= w(\overline{\theta}_i) = \left(\frac{1-\overline{\theta}_i}{1-\alpha\overline{\theta}_i}\right)(m+y) + \left(\frac{\overline{\theta}_i(1-\alpha)}{1-\alpha\overline{\theta}_i}\right)m \qquad (1) \\ &= m + \left(\frac{1-\overline{\theta}_i}{1-\alpha\overline{\theta}_i}\right)y \end{aligned}$$

As expected, the wage rate of an individual of type i depends positively on m and y, the productivity parameters. An increase in the average crime rate $\overline{\theta}_i$ (as perceived by all agents) reduces w_i since the probability to face a 'low productive' criminal is increased for each employer. Finally, the probability of conviction α has a positive effect on wages. Indeed, when more criminals are on average convicted, the quality of the labor market pools increases from the firms' viewpoint. This, in turn, pushes up the wage rate paid to these workers.

2.2 Crime

Even though jobs, firms and workers have a location in the city, crime is assumed not to be localized. This means for example that people commit crimes outside of the city. This is however not important in our framework since the focus is not on punishment (like e.g. to increase the number of policemen in a certain area of the city) but on the decision to commit crime and its consequences on the labor and land markets. In this context, a worker of type (i, x, u), i.e. a worker of type $i = B, W$ located at a distance x from the BD with crime aversion $u \in [0, 1]$, must decide to be a criminal or not. The expected payoff of a criminal is given by:

$$V_i^C(x, u) = \alpha (\Pi - P) + (1 - \alpha) (\Pi + w_i^e - tx) - R(x) - u \tag{2}$$

where w_i^e is the expected wage rate of a type i worker which is equal to:[4]

$$w_i^e = m + \left(\frac{1 - \overline{\theta}_i^e}{1 - \alpha \overline{\theta}_i^e} \right) y$$

and $R(x)$ is the equilibrium land rent at a distance x from the BD.

Observe that the expected payoff (2) depends negatively on $\overline{\theta}_i^e$ the expected population of criminals of type $i = B, W$ since (expected) wages are reduced when $\overline{\theta}_i^e$ increases. Observe also that $w_i^e - tx$ is the net expected wage, i.e. the expected wage net of the cost of being far away from legal activities. In this context, if a worker is caught and put to prison, he/she bears no commuting costs while still paying the land rent. As explained above, this is because we view t as an access cost to legal activities. So when people are not in prison, there is a cost of living further away from legal economic activities. This is no longer true when individuals are in prison since they do not work anymore

[4] It would have been easy to explicitly introduced social networks in this model. For example, we could have introduced $s_i^e = s(\overline{\theta}_i^e)$, the expected social network benefit of a worker of type i, in (2) so that

$$V_i^C(x, u) = \alpha (\Pi - P) + (1 - \alpha) (\Pi + w_i^e + s_i^e - tx) - R(x) - u$$

In this case, if convicted and sent to prison, a worker looses his/her legal social network since he/she does not interact anymore with others. In this context, it is natural to assume that $s'(\overline{\theta}_i^e) < 0$, i.e. the social network of a type i worker is inversely related to the criminality rate of type i individuals (social networks are thus type-specific, i.e. blacks only interact with blacks and whites with whites). It should be clear that social networks have exactly the same role as wages and thus, introducing them, will just amplify the effects without changing the main results.

and do not interact with others. We assume however that, even in prison, individuals still pay the land rent because they keep their housings.[5]

In this context, the expected payoff of a non criminal is equal to:

$$V_i^{NC}(x,u) = w_i^e - tx - R(x)$$

Therefore a worker of type (i,x,u) chooses to be criminal if and only if $V_i^C(x,u) > V_i^{NC}(x,u)$. So the value of u making an individual of type (i,x,u) indifferent between crime and non crime is $\widetilde{u}(x,\overline{\theta}_i{}^e)$ and is given by:

$$\begin{aligned}\widetilde{u}(x,\overline{\theta}_i{}^e) &= \Pi - \alpha P - \alpha\left(w_i^e - tx\right) \\ &= \Pi - \alpha P + \alpha tx - \alpha\left[m + \left(\frac{1-\overline{\theta}_i{}^e}{1-\alpha\overline{\theta}_i^e}\right)y\right]\end{aligned}$$

Thus, $\theta_i(x,\overline{\theta}_i^e)$, the equilibrium crime rate of workers of type (i,x) is:

$$\theta_i(x,\overline{\theta}_i^e) = \theta(x,\overline{\theta}_i^e) = F\left(\Pi - \alpha P + \alpha tx - \alpha\left[m + \left(\frac{1-\overline{\theta}_i{}^e}{1-\alpha\overline{\theta}_i^e}\right)y\right]\right) = \widetilde{u}(x,\overline{\theta}_i{}^e) \tag{3}$$

We constraint the parameters to be such that:

$$Assumption\ H1: \qquad \alpha y < \Pi - \alpha P - \alpha m < 1 - 2\alpha t$$

It can easily be checked that under assumption $H1$, the crime rate is always strictly interior, i.e. $\widetilde{u}(x,\overline{\theta}_i{}^e) \in (0,1)$ for all $(x,\overline{\theta}_i{}^e) \in [0,2]\times[0,1]$. We have the following straightforward proposition.[6]

Proposition 1 *The crime rate $\theta_i(x,\overline{\theta}_i^e)$ of individuals of type i located at distance x from the BD is increasing in x and in the average expected crime rate $\overline{\theta}_i^e$ of these individuals. We also have the following results:*

$$\frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial\Pi} > 0 \quad ; \quad \frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial P} < 0 \quad ; \quad \frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial\alpha} \lesseqgtr 0$$
$$\frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial m} < 0 \quad ; \quad \frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial y} < 0 \quad ; \quad \frac{\partial\theta(x,\overline{\theta}_i^e)}{\partial t} > 0$$

[5] We can easily relax this assumption and assume that, when criminals are caught, they do not pay anymore the land rent. It should be clear that this will not change any of our results since everything will be divided by an exogeneous parameter $1-\alpha$. We keep this assumption in order to simplify the algebra.

[6] It is important to keep in mind that we are not in equilibrium so that to compute the results of Proposition 1, we have held $\overline{\theta}_i^e$ constant when varying any generic variable. This allows us to give the basic intuitions of the model.

The following comments are in order. First, the incentives to commit crime for a particular individual depends (among other things) on the location of that individual in the city. More precisely, everything else being equal, *people living further away from the BD (legal activities) are more likely to become criminals.* Indeed, on average, criminals pay smaller transportation costs than honest individuals at any given distance x because, if caught and send to prison, they do not need anymore to commute to the BD to work. Therefore, the larger the distance x, the higher the expected savings on costs of access to legal activities for a criminal and thus the greater the incentives to be dishonest for a given individual. In this context, when individuals reside far away from jobs, the incentives to become criminal are higher than when they live closer to the BD because they do not need anymore to work. Location influences crime decision through the opportunity cost of being further away from legal activities. In other words, *individuals living in ghettos (i.e. further away from legal activities) are more likely to become criminals than those residing closer to jobs because their opportunity cost (in terms of access to legal activities) of being caught and send to prison is lower.* As a consequence, the crime rate $\theta_i(x, \overline{\theta}_i^e)$ of individuals of type i located at distance x from the BD is increasing in x (i.e.. $\partial\theta(x, \overline{\theta}_i^e)/\partial x > 0$).

A second interesting feature of proposition 1 is the fact that the actual incentives to be a criminal for an individual of type $i = B, W$, depends positively on the expected crime rate $\overline{\theta}_i^e$ of individuals sharing the same type i in society. In other words, there is *a positive group externality* on crime incentives even if the group characteristic is 'a priori' completely extrinsic! This is because this characteristic plays a role in the process of labor market discrimination and the levels of wages w_i offered on that market. The higher the perceived average crime rate of individuals of type i as a group, the lower the wage rate w_i they are offered by employers. This in turn, reduces their individual's incentives to remain honest and therefore affect positively their actual crime rate.[7]

Last, from (3), we obtain a straightforward comparative statics analysis on $\theta_i(x, \overline{\theta}_i^e)$. It is obviously increasing in the gains of crime Π, decreasing in the penalty level P (as for example in the seminal paper of Becker, 1968), decreasing in productivity parameters (since they increase the opportunity cost of crime). It is also increasing in the unit cost of transportation t. Indeed, when individuals are further away from legal economic activities, the opportunity

[7]This effect, going through discrimination on the labor market, has been illustrated by Rasmusen (1996) in a non spatial context. See also Sah (1991) for a learning crime group externality not related to discrimination on the labor market, as well as other group externalities associated to the technology of repression.

cost to commit crime is reduced. Finally and interestingly, the impact of the probability of conviction α on the crime rate is a priori ambiguous. First, an increased probability of being arrested reduces the incentives to crime as it increases the expected penalty αP and the expected opportunity cost to work αw_i. It also reduces crime by reducing labor market discrimination and increasing the wage rate w_i (this can be seen from (1)). On the other hand, it reduces the expected costs of transportation to legal activities αtx, which in itself makes crime more profitable. Clearly, the closer the individual to the BD, the weaker the last effect, and the more likely, the negative impact of α on crime. There is therefore a difference between enforcement α and punishment P. In our setting, if P increases (for example by increasing the number of years in prison for a given crime), then there are less criminals in the city. On the other hand, if α rises (for example by increasing the number of policemen), then as shown above, the number of criminals can increase or decrease. Interestingly, it can be shown that, for $\alpha < 1/2$, the crime rate $\theta_i(x, \overline{\theta}_i^e)$ is increasing in α for a large enough distance x to legal activities and a high enough expected crime rate $\overline{\theta}_i^e$.

2.3 The land market

In order to analyze the land market, we can compute the expected utility of a worker of type (i, x, u) before the revelation of u. This is because individuals make their residential location decisions before they know their crime ability.[8] We have therefore:

$$\begin{aligned}
EV_i(x) &= \int_0^{\widetilde{u}(x,\overline{\theta}_i^e)} V_i^C(x,u)du + \int_{\widetilde{u}(x,\overline{\theta}_i^e)}^1 V_i^{NC}(x,u)du \\
&= \int_0^{\widetilde{u}(x,\overline{\theta}_i^e)} \left[\alpha(\Pi - P) + (1-\alpha)\left(\Pi + w_i^e - tx\right) - u\right] du \\
&\quad + \int_{\widetilde{u}(x,\overline{\theta}_i^e)}^1 \left[w_i^e - tx\right] du - R(x) \\
&= \left[\alpha(\Pi - P) + (1-\alpha)\left(\Pi + w_i^e - tx\right)\right] \theta(x, \overline{\theta}_i^e)
\end{aligned}$$

[8] Another interpretation would be to think that the location choice is made by altruistic parents of the current generation before they actually know about the individual crime aversion of their offspring.

$$+ [w_i^e - tx]\left(1 - \theta(x, \overline{\theta}_i^e)\right) - \int_0^{\widetilde{u}(x,\overline{\theta}_i^e)} u\, du - R(x)$$

Observe that this expected utility is based on $\overline{\theta}_i^e$, the expected proportion of criminals of type $i = B, W$. In equilibrium, since there are no relocation costs, all workers of type i have the same utility level v_i so that the bid rent of an individual of type i at a distance x from the BD is equal to:[9]

$$\begin{aligned} \Psi_i(x, v_i) &= [\alpha(\Pi - P) + (1-\alpha)(\Pi + w_i^e - tx)]\,\theta(x, \overline{\theta}_i^e) \\ &\quad + [w_i^e - tx]\left(1 - \theta(x, \overline{\theta}_i^e)\right) - \int_0^{\widetilde{u}(x,\overline{\theta}_i^e)} u\, du - v_i \end{aligned} \tag{4}$$

with

$$\frac{\partial \Psi_i(x, v_i)}{\partial x} = -\left[1 - \alpha\theta(x, \overline{\theta}_i^e)\right] t < 0 \tag{5}$$

$$\frac{\partial^2 \Psi_i(x, v_i)}{\partial x^2} = \alpha t \frac{\partial \theta(x, \overline{\theta}_i^e)}{\partial x} = (\alpha t)^2 > 0 \tag{6}$$

$$\frac{\partial^2 \Psi_i(x, v_i)}{\partial x \partial \overline{\theta}_i^e} = \alpha t \frac{\partial \theta(x, \overline{\theta}_i^e)}{\partial \overline{\theta}_i^e} > 0 \tag{7}$$

The following comments are in order. First, the equilibrium land rent decreases from the city-center to the suburbs (see (5)). Indeed, when individuals of type i reside further away from the BD, bid rents have to be reduced in order for the utility v_i to be the same (and thus constant across locations) since both the proportion of criminals $\theta(x, \overline{\theta}_i^e)$ and the cost of being away from legal activities t increase with distance x.[10] Second, $\Psi_i(x, v_i)$ is a convex function of distance (see (6)) and the cross effect, distance plus $\overline{\theta}_i^e$, is positive (see 7). Indeed, when workers are very distant to jobs, they have a very high chance

[9]The bid rent is a standard concept in urban economics (see e.g. Fujita, 1989). It indicates the maximum land rent that a worker of type i located at a distance x from the BD is ready to pay in order to achieve the utility level v_i.

[10]It is important to keep in mind the reason of the increasing relation between $\theta(x, \overline{\theta}_i^e)$ and x (see Proposition 1): When individuals reside far away from the BD, they are more induced and thus more likely to become criminals because, if caught and send to prison, they will save more on t. Therefore, for these workers not to be criminals, it must be that their aversion to risk u is very high, so that, on average, the proportion of criminals $\theta(x, \overline{\theta}_i^e)$ is higher further away than closer to the BD.

to be criminal so that the land rent must adjust. This is even more true when the (expected) proportion of criminals increases. Technically, (7) means that the bid rent function becomes flatter when $\overline{\theta}_i^e$ (the expected proportion of criminals of type $i = B, W$) increases. This is because when $\overline{\theta}_i^e$ increases, the probability to become criminal is higher and the attraction to the center (legal activities), which is captured by t, decreases (since prisoners do not bear access costs to work). We will see below that when blacks will be discriminated against (because of beliefs) so that they will be more criminals than whites, then (7) implies that blacks reside further away from legal activities than whites because they are less attracted to the BD since, if caught and send to prison, they do not pay anymore the cost t.

3 The market equilibrium

We are now able to give a precise definition of a market equilibrium (that takes into account labor, crime and land markets) with rational expectations. In fact, depending on whether beliefs matter or not, two types of equilibria prevail. In the first one, the non discriminating market equilibrium (NDME), there is no discrimination between blacks and whites. In the second one, the discriminating market equilibrium (DME), white workers are perceived by all agents (including blacks) as less criminal than blacks for no economic reasons or intrinsic characteristics (since whites are not more productive than blacks) but because of extrinsic reasons or beliefs. In other words, pure extrinsic reasons (i.e. that are not related to the fundamentals of the economy) affect the behavior of all agents who behave like their beliefs and thus 'prophecies' become self-fulfilling.

Definition 1 *A Non Discriminating Market Equilibrium (NDME) with rational expectations (Figure 1) is a couple* $(\overline{\theta}^*, v^*)$ *such that:*

$$\Psi(2, v^*) = 0 \tag{8}$$

$$\overline{\theta}^* = \int_0^2 \theta(x, \overline{\theta}^*) \frac{dx}{2} \tag{9}$$

where $\theta(x, \overline{\theta})$ *is defined by (3).*

Definition 2 *A Discriminating Market Equilibrium (DME) with rational expectations (Figure 2) is a 4-uple* $(\overline{\theta}_B^*, \overline{\theta}_W^*, v_B^*, v_W^*)$ *such that:*

$$\Psi_W(1, v_W^*) = \Psi_B(1, v_B^*) \tag{10}$$

$$\Psi_B(2, v_B^*) = 0 \tag{11}$$

$$\overline{\theta}_W^* = \int_0^1 \theta(x, \overline{\theta}_W^*) dx \tag{12}$$

$$\overline{\theta}_B^* = \int_1^2 \theta(x, \overline{\theta}_B^*) dx \tag{13}$$

where $\theta(x, \overline{\theta}_i)$ *is defined by (3).*

In the NDME, there is no discrimination between individuals according to the extrinsic characteristic $i \in \{B, W\}$ and all markets (labor, crime and land markets) interact with each other. Equation (8) says that in the land market, the rent paid at the limit of the city of size 2 has to be equal to the outside rent normalized to 0 (see Figure 1). Equation (9) says that, under rational expectations, the expected crime rate perceived by all agents has to be the average spatial crime rate in the city. From these two equations, one then obtains the equilibrium level of indirect utility v^* of urban dwellers and the equilibrium average criminality $\overline{\theta}^*$ as a function of the different exogenous parameters (α, Π, P, t, y, m). Indeed, from (8) and (9) and using the fact that: $\widetilde{u}(2, \overline{\theta}^*) = \Pi - \alpha P - \alpha\,(w^* - 2t)$, we have:

$$\begin{aligned} v^* &= \frac{\widetilde{u}(2, \overline{\theta}^*)^2}{2} + w^* - 2t \\ &= \frac{\widetilde{u}(2, \overline{\theta}^*)^2}{2} - \frac{\widetilde{u}(2, \overline{\theta}^*)}{\alpha} + \frac{\Pi - \alpha P}{\alpha} \end{aligned} \tag{14}$$

and

$$\overline{\theta}^* = \Pi - \alpha P - \alpha\,(w^* - t) \tag{15}$$

Now, by plugging (15) into (1), we determine the following equilibrium wage rate

$$w^* = m + \left(\frac{1 - \overline{\theta}^*}{1 - \alpha \overline{\theta}^*} \right) y \tag{16}$$

By using the value of (16), we then easily obtain v^*, $\overline{\theta}^*$ and the land rent equilibrium $R(x)$ (using (4)). Observe that the exact location of black and white workers is indeterminate since all individuals obtain the same utility level v^* whatever x. Observe also that crime and land rents are spatially differentiated according to the functions $\theta(x, \overline{\theta}^*)$ and $\Psi(x, v^*)$ but are not differentiated according to race.

On the other hand, a DME is when there is discrimination in the labor, crime and land markets, based on the extrinsic characteristic $i \in \{B, W\}$. Thus, according to (7), blacks reside in the suburbs and whites at the vicinity of the BD since blacks are more criminal than whites and thus less attracted to the center. Once again, what matters here is the distance to jobs (which captures both European and American cities) so that blacks live further away from the BD than whites. In this context, (10) and (11) reflect equilibrium conditions in the land market (see Figure 2). Equation (10) says that, in the land market, there is racial discrimination so that at the frontier $x = 1$, the bid rent offered by individuals of type W is equal to the bid rent offered by individuals of type B. Equation (11) in turn says that the bid rent of a black worker must be equal to zero at the city fringe. Finally, (12) and (13) reflect the fact the discriminating equilibrium should be self fulfilling in the sense that the expected crime rate perceived by all agents for someone of type $i = B, W$ has to be equal to the average spatial crime rate in the city of individuals of that group $i = B, W$. Thus, in the DME equilibrium, from (10) and (11) and by using the fact that: $\widetilde{u}(x, \overline{\theta}_i^*) = (\Pi - \alpha P - \alpha w_i^* - tx)$, we have:

$$v_B^* = \frac{\widetilde{u}(2, \overline{\theta}_B^*)^2}{2} - \frac{\widetilde{u}(2, \overline{\theta}_B^*)}{\alpha} + \frac{\Pi - \alpha P}{\alpha} \tag{17}$$

$$v_W^* = v_B^* + \left[\frac{\widetilde{u}(1, \overline{\theta}_W^*)^2}{2} - \frac{\widetilde{u}(1, \overline{\theta}_W^*)}{\alpha} \right] - \left[\frac{\widetilde{u}(1, \overline{\theta}_B^*)^2}{2} - \frac{\widetilde{u}(1, \overline{\theta}_B^*)}{\alpha} \right] \tag{18}$$

$$\overline{\theta}_B^* = \Pi - \alpha P - \alpha \left(w_B^* - t/2 \right) \tag{19}$$

$$\overline{\theta}_W^* = \Pi - \alpha P - \alpha \left(w_W^* - t/2 \right) \tag{20}$$

Now, by plugging (19) and (20) into (1), we determine the following equilibrium wage rates:

$$w_B^* = m + \left(\frac{1 - \overline{\theta}_B^*}{1 - \alpha \overline{\theta}_B^*} \right) y \tag{21}$$

$$w_W^* = m + \left(\frac{1 - \overline{\theta}_W^*}{1 - \alpha \overline{\theta}_W^*} \right) y \tag{22}$$

Then, by using the values of (21) and (22), we easily obtain v_B^*, v_W^*, $\overline{\theta}_B^*$, $\overline{\theta}_W^*$ and the land rent equilibrium $R(x)$ (using (4)).

[*Insert Figures* 1 *and* 2 *here*]

3.1 Existence and unicity of market equilibria

We would like to see first if the NDME and the DME exist and are unique. We have:[11]

Proposition 2 *Assume that $\alpha y/(1-\alpha) < 1$ and that assumption $H1$ holds. Then, there exists*

- *(i) a unique Non Discriminating Market Equilibrium $(\overline{\theta}^*, v^*)$,*

  and

- *(ii) a unique Discriminating Market Equilibrium $(\overline{\theta}_B^*, \overline{\theta}_W^*, v_B^*, v_W^*)$.*

Proposition 2 tells us that under the reasonable assumption that crime rates are always interior solutions in the urban area, there exists multiple equilibria in terms of crime, location and labor markets. There are in fact two types of equilibria: the non discriminating one (NDME) in which the 'extrinsic' characteristic $i = B, W$ is irrelevant to the nature of the equilibrium and the discriminating equilibrium (DME) in which, on the contrary, 'extrinsic' characteristics play a fundamental role in the pattern of allocation of resources. The discrimination showed by this last equilibrium is rationally self-fulfilling. Because everybody expects individuals of type i to act differently from individuals of type $j \neq i$ in terms of criminality, working and location choices, they actually behave differently and the initial expectations are confirmed ex post.

It should be noted that the existence of the DME is strongly associated with the spatial nature of 'access' to legal activities. To see that, consider the extreme case in which space does not matter (i.e. $t = 0$). Then $\theta(x, \overline{\theta}_i^e)$ does not depend on x anymore and is given by

$$\theta(x, \overline{\theta}_i^e) = \theta(\overline{\theta}_i^e) = \Pi - \alpha P - \alpha \left[m + \left(\frac{1 - \overline{\theta}_i{}^e}{1 - \alpha \overline{\theta}_i^e} \right) y \right]$$

[11]All proofs of propositions are given in the Appendix.

It is easy to see that, in such a case, there exists a unique $\overline{\theta}^*$ such that $\theta(\overline{\theta}^*) = \overline{\theta}^*$ and, therefore, there cannot exist a Discriminating Market Equilibrium satisfying (12) and (13) with $\overline{\theta}_B^* \neq \overline{\theta}_W^*$. The only equilibrium is trivially non discriminating with, at all distance x, the same crime rate $\overline{\theta}^*$ and the same equilibrium wage w^*. This shows that space (captured by t) is the main reason for multiple equilibria in this model.

It is also worth emphasizing that an important aspect of the analysis is the fact that the discrimination process is reinforced through the interplay of the three channels: labor, crime and housing (see Figure 3 in which a solid line denotes a direct effect whereas a dotted line denotes an indirect effect) and each market reinforces and magnifies the other. This is true for both equilibria but it is even more important in the DME. Indeed, the labor market affects both crime and housing through wages since when wages are higher, crime is reduced and individuals tend to reside closer to the BD. Crime affects wages through productivity (the higher the proportion of criminals of a given group, the lower the group productivity and thus wages) and location through mainly group externalities (when the proportion of criminals of type i is high, individuals tend to be more criminals and thus to locate further away to the BD since the access cost t is lower). Space affects crime through commuting costs and/or location (people tend to be more criminals when commuting costs increase and/or when they reside further away from jobs) but affects only indirectly the labor market through crime.

There is thus a vicious circle, especially in the DME. Indeed, the discrimination (extrinsic beliefs) blacks implies that the opportunity cost of crime for these individuals is lower, therefore reinforcing criminal behavior of that group. At the same time, the (implicit) spatial discrimination against black workers (since the slope of the bid rents of group i in the DME depends crucially on the proportion of criminals of this group; see (7)) pushes them away from the BD and thus reduces their access to work and to legal economic activities. This again increases their individual crime incentives. In turn, the higher criminality rate among these individuals rationalizes and amplifies discrimination in the labor market by reducing their wages and thus forces them to live in 'cheap' neighborhoods (land rents are low) located far away from the BD.

To summarize, in the DME, since all agents believe that blacks are more criminals, their wages are lower and their residential locations are further away from jobs. Because of these two features, blacks have more incentives to commit crimes and thus become more criminals. The key feature of this belief-based model is that multiple equilibria are sustainable only because of space. Indeed, if there were no spatial dimension in this economy, multiple equilibria would not emerge and the only sustainable equilibrium would be the non-discriminating one. In other words, beliefs cannot by themeselves generate the discriminating equilibrium; it is the presence of both 'negative' beliefs and 'bad' locations that allow the discriminating equilibrium to exist.

$[Insert\ Figure\ 3\ here]$

3.2 Allocations and welfare in the NDME and DME

It is now useful to compare the allocation outcomes in the NDME and the DME.

Proposition 3 *When they are discriminated against,*

- *(i) blacks are on average more criminal and earn lower wages than when they are not discriminated;*
- *(ii) blacks are on average more criminal and earn lower wages than whites, i.e.,*

$$\begin{aligned} \overline{\theta}_W^* &< \overline{\theta}^* < \overline{\theta}_B^* \\ w_B^* &< w^* < w_W^* \end{aligned}$$

- *(iii) blacks live further away from legal activities than whites.*

The average urban crime rate in the DME is always larger than the average crime rate in the NDME, i.e.

$$\frac{\overline{\theta}_W^* + \overline{\theta}_B^*}{2} > \overline{\theta}^*$$

The following comments are in order. First, this result is consistent with the spatial mismatch hypothesis (Kain, 1968) in which the increasing distance between the location of ghettos and jobs has a dramatic impact on wages, unemployment and crime. In our framework, in the DME, being black implies (on average) to live further away from legal activities, to earn lower wages and to be more criminal. Of course, this is on average since the disutility to commit crime u is uniformly distributed among workers so that a black worker with a very high u is less likely to become criminal than a white with a very low u, even though if the former lives in a poor black neighborhood and the latter in a rich white neighborhood. We have thus generated a link between location (the land market) and a seemingly unrelated phenomenon: wages and crime. This is true only when all agents (including blacks themselves) share the same belief about blacks' criminality (the DME). Second, comparing the two different equilibria (the NDME and the DME), it is clear that when everybody thinks that blacks are more criminals than whites, they become more criminals and therefore earn lower wage (because of lower productivity) compared to the NDME, in which all agents believe that blacks do not differ from whites. Figure 4 illustrates this feature and the fact that $\overline{\theta}_W^* < \overline{\theta}^* < \overline{\theta}_B^*$. It is easy to see from this figure that distant locations from legal activities imply more criminality but, when discrimination prevails, criminality rates diverge between blacks and whites. Note finally that in the DME, the urban crime rate is larger than in the NDME. The increase in the average crime rate of black individuals more than compensates the reduction of the whites' crime rate.

$[Insert\ Figure\ 4\ here]$

The following proposition provides some welfare comparisons between the NDME and the DME:

Proposition 4 *When there is enough wage or crime discrimination (i.e.* $w_W^* - w_B^* > \alpha t$*), then:*

$$v_B^* < v^*$$
$$v_W^* > v^*$$

Not surprisingly, Proposition 4 shows that the discriminated black workers are worse off in the DME equilibrium than in the NDME. More interestingly, it also shows that whenever discrimination in the DME is large enough, then on the contrary, white workers are better off than in the NDME. The reason is that in the DME equilibrium, the wage rate of blacks is reduced compared to the NDME whereas it is increased for whites (this is referred to as the direct wage effect). This implies that the capacity of bidding for land rents (the level of bid rents) decreases for blacks whereas it increases for whites (this is referred to as the bid rent capacity effect). However, in the DME, whites have to bid away blacks at the outskirts of the city so that the competition in the land market is fiercer than in the NDME. The overall effect is in favor of whites since both the direct wage effect and bid rent capacity effect are strong enough to outweigh the increased competition in the land market. This shows that we cannot Pareto rank the two types of equilibria, the NDME and the DME, since whites prefer when blacks are discriminated against whereas obviously blacks prefer the other equilibrium.

4 Comparative statics

Differentiation of the equilibrium equations related to the NDME and the DME provides useful comparative statics on crime, wages and welfare. Let us start with welfare.

Proposition 5

- *The equilibrium utility in the NDME v^* is increasing in m and y and decreasing in t.*
- *The equilibrium utility of blacks v_B^* is increasing in m and y and decreasing in t.*
- *When m, y and/or t varies, the equilibrium utility of whites v_W^* can increase or decrease.*

The results for m, y, t for the NDME welfare and the DME black individual welfare are quite intuitive and reflects the effect of reduced or increased criminality on wage discrimination. Interestingly, an increase in the crime reward Π or an increase in the penalty P has a priori ambiguous effects on the welfare level of blacks in both the NDME and the DME. For example, when the booty Π increases, blacks become more criminals since the reward is higher (direct effect), but, because they are more criminals, their wage is lower and there are thus induced to be less criminal (indirect effect). The net effect is thus ambiguous. We have exactly the same result for the punishment P. It can however be shown that, when the average crime rate is not too large, an increase in Π (resp. a decrease in P) reduces the equilibrium welfare level of blacks. Comparative statics in the DME for whites are generally more ambiguous. This reflects the fact that, for whites, a variation in one parameter affects simultaneously the crime rate of both blacks and whites and these effects can go in opposite directions from the view point of white workers. This is partly due to the fact that whites have to bid away blacks in order to occupy the core of the city.

We want now to emphasize the interaction of the three markets (labor, crime and land) and how they affect the equilibrium criminality and wage rates. We have the following set of results.

Proposition 6 *In any equilibrium (NDME and DME), the equilibrium average crime rate for each type of worker is increasing in Π and t and is decreasing in P, m and y. The effect of α is ambiguous.*

The comparative statics on the equilibrium average crime rate of a given group of agents i are just reflecting the corresponding comparative statics in Proposition 1 for a given expected crime rate. Hence, it is not surprising to see that the equilibrium criminality rate increases with Π and t and decreases with y, m, and P whereas the effect is ambiguous for the probability of conviction α.

More interestingly, the next comparative statics results illustrate how the three markets (land, labor and crime) reinforce each other and give rise to a *magnification effect* of the exogenous variables on the equilibrium crime rate and the equilibrium wage rate. We have indeed:

Proposition 7 *In any equilibrium (NDME and DME),*

- *when the booty* Π *or the spatial access cost* t *rises, the resulting increase in the equilibrium crime and wage rates for each type of worker is larger than the direct increase in crime and wage rates, holding constant the average crime rate of that type of individual.*
- *when the penalty* P *or the productivity parameters* m *or* y *rises, the resulting decrease in the equilibrium crime and wage rates for each type of worker is lower than the direct decrease in crime and wage rates, holding constant the average crime rate of that type of individual.*
- *the effect of the probability detection* α *is ambiguous.*

Proposition 7 shows that discrimination in crime and wages is reinforced by the interactions of the three markets (crime, labor and land), and the complete effect (positive or negative) of a generic variable on the equilibrium crime rate and the equilibrium wage rate is always larger than the direct impact of this same variable. Consider for instance the case when Π increases. At any x, individuals become more criminals. This is therefore a direct effect based on reward and captured by the increase of the equilibrium crime rate holding constant the average crime rate of one type of individuals. Now, this direct effect on the crime market will also affect both labor and land markets. Indeed, in the labor market, employers reduce wages because they perceive these workers as more criminals and in the land market, the level of land rent decrease because workers anticipate their wage reduction. Because of these two effects (lower wages and lower land rents), workers are even more criminals and the average crime rate increases. This intuition runs for all the results in Proposition 7. It is thus because we have considered the complete interactions of these three markets and because workers rationally anticipate these interactions that we obtain these magnification results.

The magnification effects have interesting policy implications. They suggest that one should take into account the full interactions of the three markets (labor, crime and land) in order to understand fully the impact of a policy instrument. Indeed, any policy that only focuses on one market will systematically underestimate the full impact on crime rates, housing and wages. Similarly, a change in one instrument directly affecting one market will also have implications for variables directly related to another market, feeding back, in turn, to the first market. For instance, an increase in penalty rates P has a direct impact on crime rates but also indirect effects on wages and land rents. This, in turn, will feed back on the crime market, amplifying the initial impact on crime rates. Similarly, a policy change in the cost t, which is in fact related to the spatial degree of "access" to legal activities, has not only effects on the land rent but also on crime and wage rates. This, in turn, will feed back on the land market. We believe that these results should be taken into account when transportation and urban space related policies are implemented.

Finally, in the DME, we can also have the following interesting comparative statics on the extent of discrimination in crime and wages:

Proposition 8

- *The difference in criminality rates between blacks and whites* $\theta_B^* - \theta_W^*$ *increases with* Π *and* t *and decreases with* P *and* m*.*
- *The difference in wages between blacks and whites* $w_W^* - w_B^*$ *increases with* Π *and* t *and decreases with* P *and* m*.*

Consequently, our analysis predicts that greater crime opportunities Π and lower penalty rates P should be associated with larger inequalities between blacks and whites with respect to crime rates and wages. Similarly, when space matters more (i.e. larger 'transportation' cost t), criminality and wage rates between blacks and whites will increasingly diverge. Finally criminality rates and wages inequalities between blacks and whites should be countercyclical with economic activity (as captured by the productivity parameter m). In other words, our model predicts that, in booms, one should observe less differences in criminality rates and less inequality between blacks and whites compared to slumps where these differences should be amplified. The general message of these results is that, through all these channels and across urban areas, wages inequality between blacks and whites should be positively associated to the differences in criminality rates.

5 Conclusion

In this paper, we have emphasized the importance of the interaction between labor, crime and land markets in explaining the high crime rates among blacks who live in ghettos. If, for no economic but for extrinsic reasons, everybody (including blacks) believes that blacks are more criminals than whites, then all agents will behave accordingly and blacks would be on average more criminals than whites. In the labor market, this implies that blacks are less productive and thus earn lower wages than whites because criminality hurts workers' productivity. In the land market, this implies that blacks reside in ghettos located far away from legal activities because, if caught and send to prison, they do not bear anymore the cost of being away from legal activities. Now, because blacks earn lower wages and live in ghettos, they are more induced to commit crimes and are indeed more criminals than whites. There is thus a vicious circle in which blacks cannot escape because both location and race reinforce each other to imply high crime rates among blacks living in cities.

The key feature of this belief-based model is that multiple equilibria are sustainable only because of space. Indeed, if there were no spatial dimension in this economy so that all workers were residing in the same location, multiple equilibria would not emerge and the only sustainable equilibrium would be the non-discriminating one, even if all agents believe that blacks are more criminals than whites. In other words, beliefs alone cannot generate the discriminating equilibrium; it is the presence of both 'negative' beliefs and 'bad' locations that allow the discriminating equilibrium to exist.

We have also shown that the interactions of labor, crime and land markets yield magnification effects in the sense that a slight change of any parameter amplifies the effect on blacks' crime rates because each market reinforces the other. This suggests that one should take into account the full interactions of these three markets in order to fully capture the impact of a policy instrument on crime rates. We have also shown the impact of a technological shock on inequality and crime rates' differences between blacks and whites by predicting that in slumps these differences are amplified.

A simple way of extending this paper would be to introduce a dynamic overlapping generation model. In this context, it would only suffice that in the first period, everybody believes that blacks are more criminals than whites, then even with no prejudices in all other periods, blacks would be stuck in bad locations, earn lower wages and therefore be more criminals. This would suggest therefore that history matters to explain the high crime rates among blacks.

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Appendix

Proof of Proposition 2:

(i) *Non Discriminating Equilibrium*
The non discriminating equilibrium conditions become

$$\begin{aligned}\overline{\theta}^* &= \int_0^2 \theta(x,\overline{\theta}^*)\frac{dx}{2} \\ \Leftrightarrow & \left[\Pi - \alpha P - \alpha\left[m + \left(\frac{1-\overline{\theta}^*}{1-\alpha\overline{\theta}^*}\right)y\right]\right] + \alpha t = \overline{\theta}^*\end{aligned}$$

Let the following function $\Theta(\overline{\theta})$ be:

$$\Theta(\overline{\theta}) = \left[\Pi - \alpha P - \alpha\left[m + \left(\frac{1-\overline{\theta}^*}{1-\alpha\overline{\theta}^*}\right)y\right]\right] + \alpha t - \overline{\theta}$$

This function is decreasing in $\overline{\theta}$ as $\frac{\alpha}{1-\alpha}y < 1$. Moreover, under assumption $H1$, $\Theta(0) = \Pi - \alpha P - \alpha m - \alpha y + \alpha t > 0$ and $\Theta(1) = \Pi - \alpha P - \alpha m + \alpha t - 1 < 0$. Thus, there exists a unique non discriminating equilibrium crime rate $\overline{\theta}^* \in (0,1)$ such that $\Theta(\overline{\theta}^*) = 0$.

(ii) *Discriminating Equilibrium.*
The discriminating equilibrium conditions become:

$$\overline{\theta}_W^* = \int_0^1 \theta(x,\overline{\theta}_W^*)dx \qquad \text{and} \qquad \overline{\theta}_B^* = \int_1^2 \theta(x,\overline{\theta}_B^*)dx$$

which are equivalent to:

$$\Pi - \alpha P - \alpha\left[m + \left(\frac{1-\overline{\theta}_W^*}{1-\alpha\overline{\theta}_W^*}\right)y\right] + \frac{\alpha t}{2} = \overline{\theta}_W^*$$

and:

$$\Pi - \alpha P - \alpha\left[m + \left(\frac{1-\overline{\theta}_B^*}{1-\alpha\overline{\theta}_B^*}\right)y\right] + \frac{3}{2}\alpha t = \overline{\theta}_B^*$$

Let the following function $\Theta_W(\overline{\theta})$ and $\Theta_B(\overline{\theta})$ be:

$$\Theta_W(\overline{\theta}) = \Pi - \alpha P - \alpha\left[m + \left(\frac{1-\overline{\theta}}{1-\alpha\overline{\theta}}\right)y\right] + \frac{\alpha t}{2} - \overline{\theta}$$

and:

$$\Theta_B(\overline{\theta}) = \Pi - \alpha P - \alpha \left[m + \left(\frac{1-\overline{\theta}}{1-\alpha\overline{\theta}} \right) y \right] + \frac{3}{2}\alpha t - \overline{\theta}$$

The functions $\Theta_W(\overline{\theta})$ and $\Theta_B(\overline{\theta})$ are decreasing in $\overline{\theta}$ when $\frac{\alpha}{1-\alpha}y < 1$. Because of assumption $H1$, $\Theta_W(0) = \Pi - \alpha P - \alpha(m+y) + \frac{1}{2}\alpha t > 0$ and $\Theta_W(1) = \Pi - \alpha P - \alpha m + \frac{1}{2}\alpha t - 1 < 0$. Similarly $\Theta_B(0) = \Pi - \alpha P - \alpha(m+y) + \frac{3}{2}\alpha t > 0$ and $\Theta_B(1) = \Pi - \alpha P - \alpha m + \frac{3}{2}\alpha t - 1 < 0$. Hence there exists a unique $\overline{\theta}_W^*$ (resp. $\overline{\theta}_B^*$) $\in (0,1)$ such that $\Theta_W(\overline{\theta}_W^*) = 0$ (resp. $\Theta_B(\overline{\theta}_B^*) = 0$). Therefore there exists a unique discriminating equilibrium $(\overline{\theta}_B^*, \overline{\theta}_W^*, v_B^*, v_W^*)$. ■

Proof of Proposition 3:

It is easy to see that:

$$\Theta_W(\overline{\theta}) < \Theta_B(\overline{\theta})$$

and

$$\Theta(\overline{\theta}) = \frac{1}{2}\left[\Theta_W(\overline{\theta}) + \Theta_B(\overline{\theta})\right]$$

Hence, the first result *(i)* that compares the average equilibrium crime rates in the NDME and the DME follows. The second result *(ii)* comparing the equilibrium wages follows immediately from the fact that wages for a particular group are decreasing in the equilibrium average crime rate of individuals of that group. Thus $\overline{\theta}_W^* < \overline{\theta}^* < \overline{\theta}_B^*$ implies that $w_B^* < w^* < w_W^*$. The third result *(iii)* stems directly from (7). Finally, for the last result, we have:

$$\Theta'(\overline{\theta}) = -1 + \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta})^2}$$

which implies that $\Theta''(\overline{\theta}) > 0$ and thus $\Theta(.)$ is convex. Moreover it is easily checked that :

$$\Theta(\overline{\theta}) = \frac{1}{2}\Theta_W(\overline{\theta}) + \frac{1}{2}\Theta_B(\overline{\theta}) \tag{23}$$

and

$$\alpha t = \Theta_B(\overline{\theta}) - \Theta_W(\overline{\theta}) \tag{24}$$

which implies:

$$\Theta\left(\frac{\overline{\theta}_W^* + \overline{\theta}_B^*}{2}\right) < \frac{1}{2}\Theta(\overline{\theta}_W^*) + \frac{1}{2}\Theta(\overline{\theta}_B^*) = \frac{1}{2}\Theta_B(\overline{\theta}_W^*) + \frac{1}{2}\Theta_W(\overline{\theta}_B^*)$$

since $\Theta_B(\overline{\theta}^*_B) = 0$ and $\Theta_W(\overline{\theta}^*_W) = 0$. Furthermore, from (24), $\Theta_B(\overline{\theta}^*_W) = \alpha t$ and $\Theta_W(\overline{\theta}^*_B) = -\alpha t$. Hence

$$\Theta\left(\frac{\overline{\theta}^*_W + \overline{\theta}^*_B}{2}\right) < 0 = \Theta(\overline{\theta}^*)$$

and thus

$$\frac{\overline{\theta}^*_W + \overline{\theta}^*_B}{2} > \overline{\theta}^*$$

■

Proof of Proposition 4

Consider the function $\Omega(X) = \frac{X^2}{2} - \frac{X}{\alpha}$, where $X \in [0, 1]$. Then clearly this function is convex, decreasing in X. Using (14), (17) and (18), we have:

$$\begin{aligned}
v^* &= \Omega\left(\widetilde{u}(2, \overline{\theta}^*)\right) + \frac{\Pi - \alpha P}{\alpha} \\
v^*_B &= \Omega\left(\widetilde{u}(2, \overline{\theta}^*_B)\right) + \frac{\Pi - \alpha P}{\alpha} \\
v^*_W &= v^*_B + \Omega\left(\widetilde{u}(1, \overline{\theta}^*_W)\right) - \Omega\left(\widetilde{u}(1, \overline{\theta}^*_B)\right)
\end{aligned} \tag{25}$$

Since from Proposition 3 $\overline{\theta}^* < \overline{\theta}^*_B$, then $\widetilde{u}(2, \overline{\theta}^*) < \widetilde{u}(2, \overline{\theta}^*_B)$ and $v^* > v^*_B$. This proves the first result.

We also have:

$$v^*_W - v^* = \Omega\left(\widetilde{u}(2, \overline{\theta}^*_B)\right) - \Omega\left(\widetilde{u}(2, \overline{\theta}^*)\right) + \Omega\left(\widetilde{u}(1, \overline{\theta}^*_W)\right) - \Omega\left(\widetilde{u}(1, \overline{\theta}^*_B)\right)$$

The convexity of $\Omega(X)$ then yields:

$$\Omega\left(\widetilde{u}(1, \overline{\theta}^*_W)\right) - \Omega\left(\widetilde{u}(2, \overline{\theta}^*_W)\right) > -\Omega'\left(\widetilde{u}(2, \overline{\theta}^*_W)\right)\left[\widetilde{u}(2, \overline{\theta}^*_W) - \widetilde{u}(1, \overline{\theta}^*_W)\right]$$

and

$$\Omega\left(\widetilde{u}(2, \overline{\theta}^*_B)\right) - \Omega\left(\widetilde{u}(1, \overline{\theta}^*_B)\right) > \Omega'\left(\widetilde{u}(1, \overline{\theta}^*_B)\right)\left[\widetilde{u}(2, \overline{\theta}^*_B) - \widetilde{u}(1, \overline{\theta}^*_B)\right]$$

Observing now that $\widetilde{u}(2, \overline{\theta}^*_W) - \widetilde{u}(1, \overline{\theta}^*_W) = \widetilde{u}(2, \overline{\theta}^*_B) - \widetilde{u}(1, \overline{\theta}^*_B) = \alpha t$, we easily obtain:

$$\begin{aligned}
\Omega\left(\widetilde{u}(1, \overline{\theta}^*_W)\right) - \Omega\left(\widetilde{u}(2, \overline{\theta}^*_W)\right) &> -\Omega'\left(\widetilde{u}(2, \overline{\theta}^*_W)\right)\alpha t \\
\Omega\left(\widetilde{u}(2, \overline{\theta}^*_B)\right) - \Omega\left(\widetilde{u}(1, \overline{\theta}^*_B)\right) &> \Omega'\left(\widetilde{u}(1, \overline{\theta}^*_B)\right)\alpha t
\end{aligned}$$

Furthermore, since from Proposition 3 $\overline{\theta}_W^* < \overline{\theta}^*$, then $\widetilde{u}(2,\overline{\theta}_W^*) < \widetilde{u}(2,\overline{\theta}^*)$ and $\Omega(\widetilde{u}(2,\overline{\theta}^*)) < \Omega(\widetilde{u}(2,\overline{\theta}_W^*))$. Finally, we have:

$$
\begin{aligned}
v_W^* - v^* &> \Omega\left(\widetilde{u}(1,\overline{\theta}_W^*)\right) - \Omega\left(\widetilde{u}(2,\overline{\theta}_W^*)\right) + \Omega\left(\widetilde{u}(2,\overline{\theta}_B^*)\right) - \Omega\left(\widetilde{u}(1,\overline{\theta}_B^*)\right) \\
&> \left[-\Omega'\left(\widetilde{u}(2,\overline{\theta}_W^*)\right) + \Omega'\left(\widetilde{u}(1,\overline{\theta}_B^*)\right)\right]\alpha t
\end{aligned}
$$

and

$$
-\Omega'\left(\widetilde{u}(2,\overline{\theta}_W^*)\right) + \Omega'\left(\widetilde{u}(1,\overline{\theta}_B^*)\right) = \widetilde{u}(1,\overline{\theta}_B^*) - \widetilde{u}(2,\overline{\theta}_W^*) = w_W^* - w_B^* - \alpha t
$$

Hence

$$
v_W^* - v^* > 0 \text{ when } w_W^* - w_B^* > \alpha t.
$$

■

Proof of Proposition 5:

We want to prove the following table:

	v^*	v_B^*	v_W^*
Π	?	?	?
P	?	?	?
m	+	+	?
y	+	+	?
t	−	−	?

For $k = m, y, t$, the differentiation of (25), yields:

$$
\frac{\partial v^*}{\partial k} = \Omega'\left(\widetilde{u}(2,\overline{\theta}^*)\right)\frac{\partial \widetilde{u}(2,\overline{\theta}^*)}{\partial k} \text{ and } \frac{\partial v_B^*}{\partial k} = \Omega'\left(\widetilde{u}(2,\overline{\theta}_B^*)\right)\frac{\partial \widetilde{u}(2,\overline{\theta}_B^*)}{\partial k}
$$

Therefore using Proposition 1 and noting that $\Omega'(.) < 0$, we easily obtain the announced comparative statics for $k = m, y, t$. Concerning v_W^*, by differentiating (25), it is easily checked that:

$$
\frac{\partial v_W^*}{\partial k} = \Omega'\left(\widetilde{u}(2,\overline{\theta}_B^*)\right)\frac{\partial \widetilde{u}(2,\overline{\theta}_B^*)}{\partial k} + \Omega'\left(\widetilde{u}(1,\overline{\theta}_W^*)\right)\frac{\partial \widetilde{u}(1,\overline{\theta}_W^*)}{\partial k} - \Omega'\left(\widetilde{u}(1,\overline{\theta}_B^*)\right)\frac{\partial \widetilde{u}(1,\overline{\theta}_B^*)}{\partial k}
$$

so that the sign is ambiguous.

For $k = \Pi$, we get

$$\begin{aligned} \frac{\partial v^*}{\partial \Pi} &= \Omega'\left(\widetilde{u}(2, \overline{\theta}^*)\right) \frac{\partial \widetilde{u}(2, \overline{\theta}^*)}{\partial \Pi} + \frac{1}{\alpha} \\ \frac{\partial v_B^*}{\partial \Pi} &= \Omega'\left(\widetilde{u}(2, \overline{\theta}_B^*)\right) \frac{\partial \widetilde{u}(2, \overline{\theta}_B^*)}{\partial k} + \frac{1}{\alpha} \end{aligned}$$

The term $\Omega'\left(\widetilde{u}(2, \overline{\theta}^*)\right) \frac{\partial \widetilde{u}(2,\overline{\theta}^*)}{\partial \Pi}$ (resp. $\Omega'\left(\widetilde{u}(2, \overline{\theta}_B^*)\right) \frac{\partial \widetilde{u}(2,\overline{\theta}_B^*)}{\partial k}$) is negative and reflects the negative impact of increased crime generated by a larger bounty Π on wages for honest individuals and non convicted criminals. The term $1/\alpha$, on the other hand, is positive and shows the positive impact on welfare of receiving a marginal additional unit of bounty Π whenever non convicted. From this, it is clear that in general the sign of $\frac{\partial v^*}{\partial \Pi}$ and $\frac{\partial v_B^*}{\partial \Pi}$ is ambiguous. It is then easy to see that similar calculations hold for the penalty rate P. Hence again the ambiguity. This ambiguity is even more true for v_W^*. ■

<u>Proof of Proposition 6:</u>

For the proof of this proposition, we use the following notation: We denote by $\overline{\theta}^E$ the average equilibrium crime rate for each type of agent so that in the NDME $\overline{\theta}^E = \overline{\theta}^*$ while in the DME, $\overline{\theta}^E = \overline{\theta}_i^*$ for a type i worker. Then, we want to prove the following results:

$$\frac{\partial \overline{\theta}^E}{\partial \Pi} > 0 \quad , \quad \frac{\partial \overline{\theta}^E}{\partial P} < 0, \quad \frac{\partial \overline{\theta}^E}{\partial m} < 0 \quad , \quad \frac{\partial \overline{\theta}^E}{\partial y} < 0 \quad , \quad \frac{\partial \overline{\theta}^E}{\partial t} > 0 \quad , \quad \frac{\partial \overline{\theta}^E}{\partial \alpha} \lesseqgtr 0$$

Observe that $\overline{\theta}^E$ is characterized by:

$$\Theta_E(\overline{\theta}^E) = 0$$

with $\Theta_E(.)$ being equal to $\Theta(.)$, $\Theta_W(.)$, or $\Theta_B(.)$ according to the equilibrium we consider. Hence, for any generic exogenous variable k, we have:

$$\frac{\partial \overline{\theta}^E}{\partial k} = -\frac{\partial \Theta_E}{\partial k} / \frac{\partial \Theta_E}{\partial \theta}$$

which has the sign of $\frac{\partial \Theta_E}{\partial k}$. Using now the definition of $\Theta(.)$, $\Theta_W(.)$, or $\Theta_B(.)$, it is immediate to see that

$$Sign \frac{\partial \Theta_E}{\partial k} = Sign \int \frac{\partial \theta(x, \overline{\theta}^E)}{\partial k} \frac{dx}{2}$$

Therefore, using Proposition 1, the comparative statics on the equilibrium average crime rate $\overline{\theta}^E$ follows immediately. ■

Proof of Proposition 7

For the proof of this proposition, it is convenient to introduce the following notations:

- $\widetilde{u}^E(x) \equiv \widetilde{u}(x, \overline{\theta}^E)$ denotes the equilibrium crime rate function at a distance x from the BD, i.e. $\widetilde{u}^E(x) = \widetilde{u}(x, \overline{\theta}^*) = \theta(x, \overline{\theta}^*)$ in the NDME and $\widetilde{u}^E(x) = \widetilde{u}(x, \overline{\theta}_i^*)$ in the DME;
- $w^E \equiv w(\overline{\theta}^E)$ denotes the corresponding equilibrium wage rate, i.e. $w^E = w(\overline{\theta}^*)$ in the NDME and $w^E = w(\overline{\theta}_i^*)$ in the DME;
- For any generic exogenous variable k,

$$\frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial k}|_{\overline{\theta}^E} \text{ and } \frac{\partial w(\overline{\theta}^E)}{\partial k}|_{\overline{\theta}^E}$$

  denotes respectively the impact of a change in the variable k on the equilibrium crime rate $\widetilde{u}(x, \overline{\theta}^E)$ at distance x from the BD and on the wage rate, holding constant the value of the average crime rate $\overline{\theta}^E$ of one type of agents. This last notation implies that individuals react to changes in any parameter k without taking into account the fact that these changes affect the equilibrium variable $\overline{\theta}^E$ (see Proposition6)).

In this context, we want to show for the equilibrium crime rate that:

$$\begin{aligned}
\frac{\partial \widetilde{u}^E(x)}{\partial \Pi} &> \frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial \Pi}|_{\overline{\theta}^E} > 0 \quad , \quad \frac{\partial \widetilde{u}^E(x)}{\partial t} > \frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial t}|_{\overline{\theta}^E} > 0 \\
\frac{\partial \widetilde{u}^E(x)}{\partial P} &< \frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial P}|_{\overline{\theta}^E} < 0 \\
\frac{\partial \widetilde{u}^E(x)}{\partial m} &< \frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial m}|_{\overline{\theta}^E} < 0 \quad , \quad \frac{\partial \widetilde{u}^E(x)}{\partial y} < \frac{\partial \widetilde{u}(x, \overline{\theta}^E)}{\partial y}|_{\overline{\theta}^E} < 0 \\
\frac{\partial \widetilde{u}^E(x)}{\partial \alpha} &\lesseqgtr 0
\end{aligned}$$

and for the equilibrium wage rate that:

$$\begin{aligned}
\frac{\partial w^E}{\partial \Pi} &> \frac{\partial w(\overline{\theta}^E)}{\partial \Pi}|_{\overline{\theta}^E} > 0 \quad , \quad \frac{\partial w^E}{\partial t} > \frac{\partial w(\overline{\theta}^E)}{\partial t}|_{\overline{\theta}^E} > 0 \\
\frac{\partial w^E}{\partial P} &< \frac{\partial w(\overline{\theta}^E)}{\partial P}|_{\overline{\theta}^E} < 0 \\
\frac{\partial w^E}{\partial m} &< \frac{\partial w(\overline{\theta}^E)}{\partial m}|_{\overline{\theta}^E} < 0 \quad , \quad \frac{\partial w^E}{\partial y} < \frac{\partial w(\overline{\theta}^E)}{\partial y}|_{\overline{\theta}^E} < 0 \\
\frac{\partial w^E}{\partial \alpha} &\lesseqgtr 0
\end{aligned}$$

It is immediate to see that, using Proposition 6, the comparative statics on the crime rate function $\widetilde{u}^E(x)$ at a distance x from the BD is given by:

$$\frac{\partial \widetilde{u}^E(x)}{\partial k} = \frac{\partial \theta(x, \overline{\theta}^E)}{\partial k} + \frac{\partial \theta(x, \overline{\theta}^E)}{\partial \overline{\theta}^E} \frac{\partial \overline{\theta}^E}{\partial k}$$

The first term of the RHS reflects the direct effect of the generic exogenous variable k whereas the second term shows the equilibrium effect coming through the variation of the equilibrium average crime rate of the group. Using the fact that $\partial \theta(x, \overline{\theta}^E)/\partial \overline{\theta}^E > 0$ and Proposition 1, we obtain the results announced in the proposition. Finally the comparative statics on the equilibrium wages w^E follows again from

$$\frac{\partial w^E}{\partial k} = \frac{\partial w(\overline{\theta}^E)}{\partial k} + \frac{\partial w(\overline{\theta}^E)}{\partial \overline{\theta}^E} \frac{\partial \overline{\theta}^E}{\partial k}$$

The first term on the RHS is the direct effect on wages following a change in k while the second term shows the implied adjustment due to the variation of the equilibrium crime rate. ■

Proof of Proposition 8:

We would like to demonstrate the following table:

	$\overline{\theta}^*_B - \overline{\theta}^*_W$	$w^*_W - w^*_B$
Π	$+$	$+$
P	$-$	$-$
m	$-$	$-$
t	$+$	$+$

Let us start with the comparative statics of $\overline{\theta}^*_B - \overline{\theta}^*_W$. Consider the case of $k = \Pi$, P, m. It is then easily verified that

$$\frac{\partial(\overline{\theta}^*_B - \overline{\theta}^*_W)}{\partial k} = \frac{\frac{\partial \Theta_B}{\partial k}}{1 - \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_B)^2}} - \frac{\frac{\partial \Theta_W}{\partial k}}{1 - \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2}}$$

implying

$$\frac{\partial \Theta_B}{\partial k} = \frac{\partial \Theta_W}{\partial k}.$$

Hence, for $k = \Pi$, P, m, we have:

$$\text{Sign}\frac{\partial(\overline{\theta}^*_B - \overline{\theta}^*_W)}{\partial k} = \text{Sign}\frac{\partial \Theta_B}{\partial k} \times \left[\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_B)^2} - \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2}\right] > 0 \text{ iff Sign}\frac{\partial \Theta_B}{\partial k} > 0$$

since $\overline{\theta}^*_B > \overline{\theta}^*_w$. Therefore, the sign of $\frac{\partial(\overline{\theta}^*_B - \overline{\theta}^*_W)}{\partial k}$ for each $k = \Pi$, P, m is the one given in the proposition.

Consider now t. We have

$$\frac{\partial \Theta_B}{\partial t} = \frac{3}{2} \qquad \text{and} \qquad \frac{\partial \Theta_W}{\partial t} = \frac{1}{2}$$

and thus

$$\begin{aligned}
\text{Sign}\frac{\partial(\overline{\theta}^*_B - \overline{\theta}^*_W)}{\partial t} &= \text{Sign}\left[1 + \frac{1}{2}\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_B)^2} - \frac{3}{2}\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2}\right] \\
&= \text{Sign}\left[1 - \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2} + \frac{1}{2}\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_B)^2} - \frac{1}{2}\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2}\right] > 0
\end{aligned}$$

since $1 - \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2} > 0$ and $\frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_B)^2} > \frac{\alpha(1-\alpha)y}{(1-\alpha\overline{\theta}^*_W)^2}$.

Concerning the comparative statics of $w_W^* - w_B^*$, observe that

$$w_W^* - w_B^* = \frac{(1-\alpha)\,(\overline{\theta}_B^* - \overline{\theta}_W^*)}{(1-\alpha\overline{\theta}_B^*)(1-\alpha\overline{\theta}_W^*)} y$$

which is increasing in $(\overline{\theta}_B^* - \overline{\theta}_W^*)$, $\overline{\theta}_W^*$ and $\overline{\theta}_B^*$. Hence for all $k = \Pi$, P, m, t such that

$$\text{Sign}\frac{\partial(\overline{\theta}_B^* - \overline{\theta}_W^*)}{\partial k} = \text{Sign}\frac{\partial\overline{\theta}_W^*}{\partial k} = \text{Sign}\frac{\partial\overline{\theta}_B^*}{\partial k}$$

we should get

$$\text{Sign}\frac{\partial(w_W^* - w_B^*)}{\partial k} = \text{Sign}\frac{\partial(\overline{\theta}_B^* - \overline{\theta}_W^*)}{\partial k}$$

By using the results of Proposition 1, the announced comparative statics of $(w_W^* - w_B^*)$ are straightforward to obtain. ■

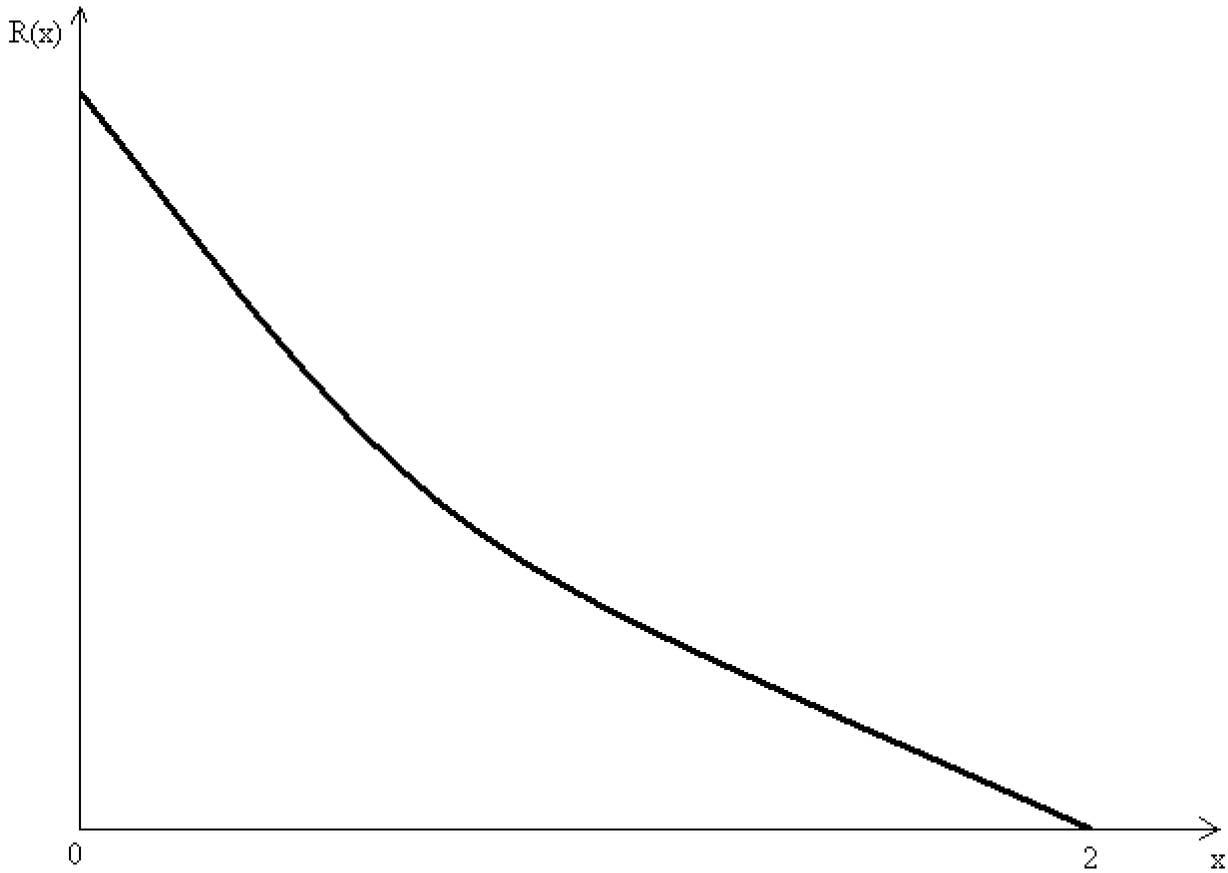

Figure 1: The Non Discriminating Market Equilibrium

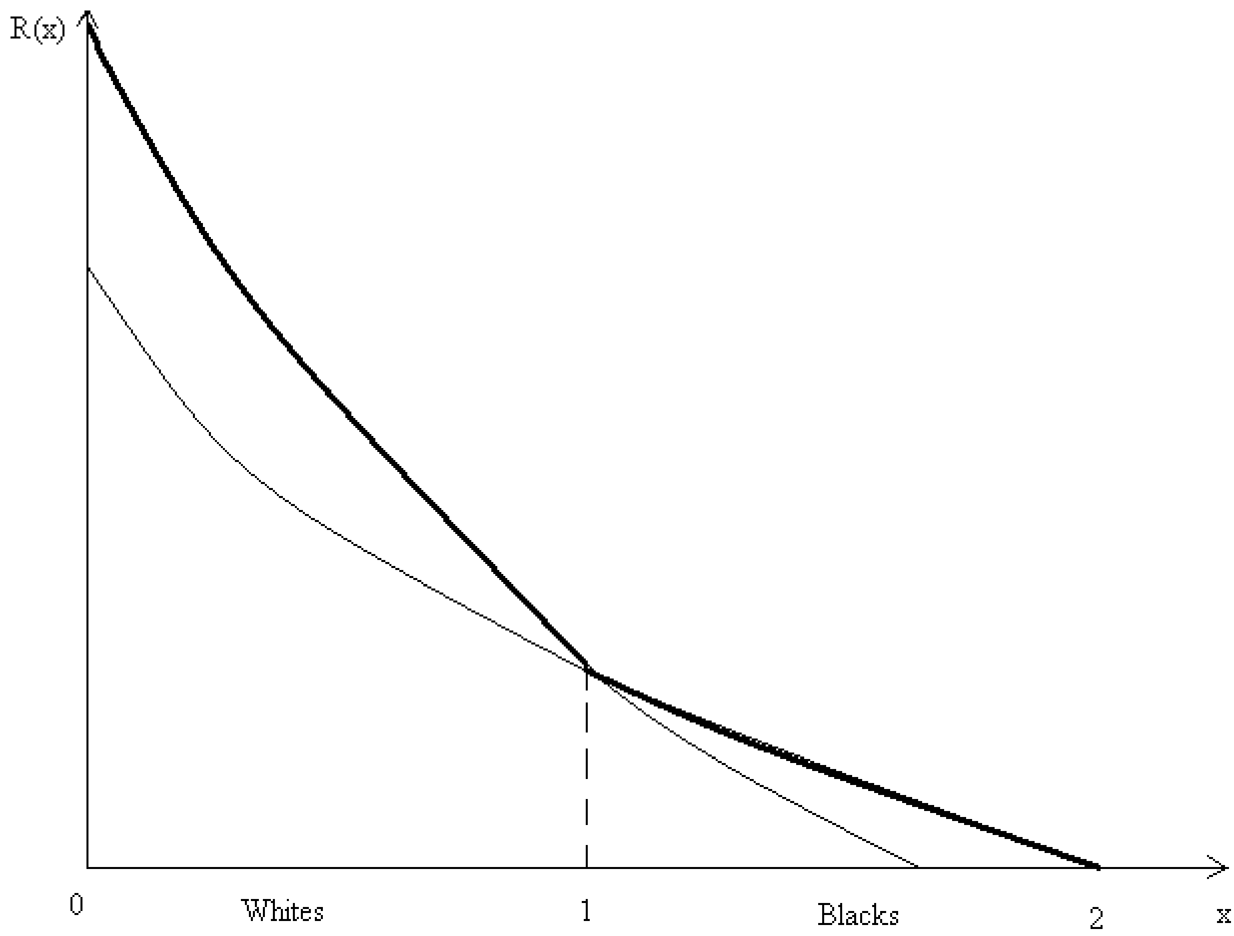

Figure 2: The Discriminating Market Equilibrium

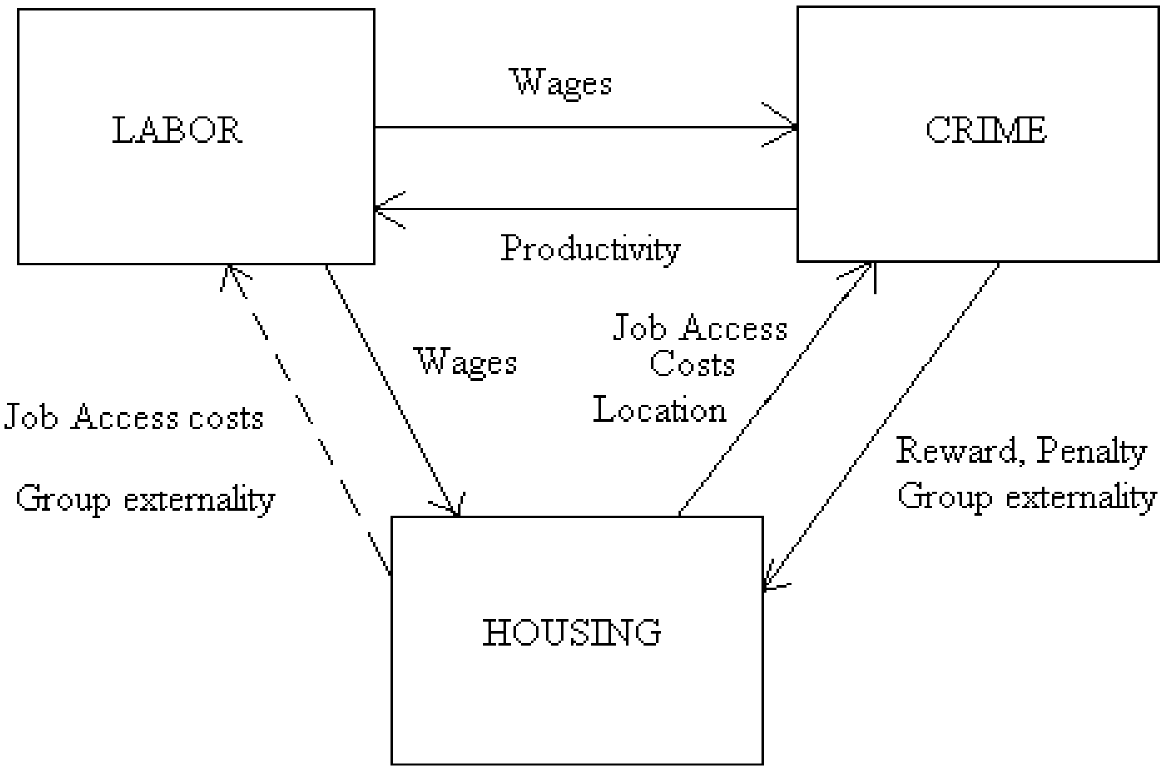

Figure 3 : The Interaction Between Labor, Crime and Land Markets

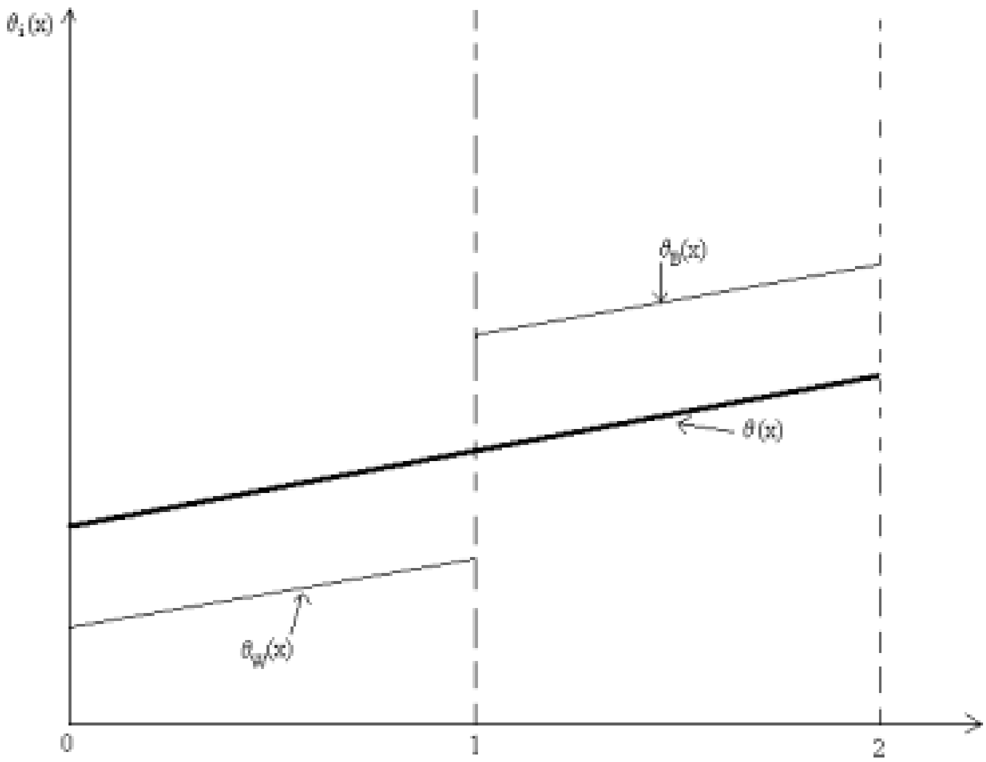

Figure 4: The Proportion of Criminals According to Location and Race