



# Environmental Injustice and Residential Segregation: Investigating the Link<sup>‡</sup>

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## Abstract

Environmental Justice advocates claim that poor and minority communities are disproportionately exposed to environmental hazards. Furthermore, it is asserted that this differential exposure is primarily a product of institutional racism, both past and present, in the siting and management of environmental hazards. Therefore, much of the research into environmental injustice has concentrated on empirically investigating these claims. However, this approach implicitly rules out the possibility that differential exposure may, in part, be a consequence of the formation of communities.

A small handful of empirical papers (Been 1994, Been 1997, Mitchell 1999, Banzhaf and Walsh 2005) have explored the possibility of environmentally induced migration patterns with mixed results. However, to date, researchers have overlooked a potentially important confounding factor in this analysis – the interaction of income, preference for racial composition, and preference for environmental quality. This paper is a first attempt to merge insights from the literature on residential segregation with the possibility of environmentally driven household sorting. The research provides a theoretical analysis of the implications of these interactions. A locational equilibrium model is developed in which households have preferences over both racial composition and environmental quality.

The model is used to investigate whether the interaction between these preferences can lead households to sort in such a way that minorities, controlling for income, are disproportionately exposed to low environmental quality – even in the case where preferences for environmental quality are constant across racial groups and no discrimination is present in the market. The results demonstrate that in the presence of preferences for racial composition, it is possible to support, in equilibrium, a distribution that reflects what would traditionally be labeled as environmental injustice. However, this equilibrium is supported independent of the siting of environmental hazards and independent of any form of direct discrimination. It is supported simply by the introduction of racial preferences.

The findings also suggest that the initial distribution of households (at the time of siting) may be a critical factor in explaining the currently observe



consensus that, to some extent, minority and poor communities currently are exposed to higher levels of environmental hazards.

However, even if the current distributions indicate some level of inequity, the relationship between the distribution of hazards and households must be viewed as an endogenous process. On one hand, the selection of the location for environmental hazards may be a function of the demographic characteristics of a community.

Alternatively, household behavior in the selection of a location may be a function of

addressing environmental justice issues requires an understanding of the dynamics that lead to the current distributions. Specifically, this strand of research is interested in the other endogenous process: how household behavior impacts the distribution of demographics following the siting of environmental hazards. The most common motivation for this research is based on the potential role of income. Typically, a qualitative argument is constructed following the logic that the introduction of an environmental hazard will cause a reduction in property values. Consequently, an expected outcome is for rich individuals to move out (or avoid) and poor individuals to move in (or stay).

To date, this line of research has focused on identifying the existence of migratory behavior. Generally, the findings support this theory of "market dynamics." However, the literature has yet to investigate the preferences that lead to the current distribution of demographics. More so, while the discussion focuses almost entirely on income, the characterization literature has provided general evidence that even when researchers control for income, minorities are still(j7-t@FwgMnnnn

composition lead whites and blacks of identical income and tastes for environmental quality to consume disparate levels of environmental quality.

While the primary purpose of this research is to consider the role of tastes for racial composition in an environmental justice context, it is important to note that the findings can be generalized to a wide variety of local public goods. Specifically, the distribution of other local public goods (i.e., school quality, level of crime, etc.) across demographics may be, in part, impacted by tastes for racial composition.

These findings highlight the importance of recognizing the role of household self-selection by race for both policy and empirical research related to the distribution of local public goods. For example, empirical models that attempt to recover preferences or demand for local public goods across race may lead to incorrect inferences if tastes for race are not accounted for in the specification of model.

While this observation has not been directly investigated in an environmental justice context, Bayer et al. address this specific issue in a series of recent empirical papers including Bayer et al. (2003) and Bayer et al. (2005). They generally find evidence that race plays a role in household locational choice around local public goods. For example, in Bayer (2005), it is found that black households appear to trade off between highly educated and highly black neighborhoods. These findings are consistent with the predictions offered in this paper.

The remainder of the paper proceeds as follows: Section II discusses the relevant literature. The model is introduced and analytical results are discussed in Sections III. The computational strategy and numerical results are presented in Sections IV. Section V



community composition, these studies are limited in what they reveal regarding causal mechanisms.

Investigating the demographics at the time of the siting of environmental hazards is one approach that has been used to uncover causation and explain effective channels for policy. Interestingly, these studies often find race and income to be less significant in predicting siting decisions (two notable exceptions are Been (1994), Brooks and Sethi (1997)). The most significant demographic characteristic is the level of collection within a community (Hamilton (1993, 1995, 1999), Arora and Carson (1996), and Wolverton (2003)). This finding provides guidance to address inequities in the siting of environmental hazards. However, these findings, in conjunction with the currently observed distributions, implicitly suggest that over time low income and minority groups appear to have disproportionately migrated into these communities.

These results have motivated a handful of studies to formally investigate migration following the siting of environmental hazards (Been (1994, 1997), Mitchell (1999), Banzhaf and Walsh (2005)). In general these studies find evidence supporting the existence of migratory behavior. Specifically, the proportion of poor and minorities is found to increase over time in communities with environmental hazards. Therefore, even if inequities at the time of siting are addressed, the composition of these communities over time may still reflect environmental “injustice” as a result of migratory behavior.

Identifying and understanding the factors that lead to this specific migratory behavior is ultimately needed if issues of environmental justice are to be accurately characterized. To date, only qualitative discussions of potential factors have been



offered. For example, Been (1994) contends that the introduction of an undesirable environmental hazard is likely to cause property values to decrease as well as cause wealthier households to move away. She suggests that as a consequence of these lower

households of difference races: differences in income; discrimination; and racial (and race related) preferences.

Differences in income is an unambiguous and straightforward factor that effects locational choice. Minority status is correlated with lower income. Thus, minorities are overrepresented in low income communities.<sup>1</sup> However, studies have demonstrated that levels of observed residential segregation exceed the distributions that would be expected if income was the only factor affecting racial housing locations (see for instance Bayer et al. (2004)).

Discrimination was historically a significant factor impacting locational choice (Denton and Massey (1994)). Anti-discriminating reforms in the housing market were first introduced with the adoption of the Fair Housing Act of 1968. While the existence of discrimination in the housing market did not immediately disappear, the level was significantly reduced and continued to diminish in subsequent decades. However, discriminatory practices are believed to continue to play a role in racial locational choice.<sup>2</sup>

The literature related to racial preferences is vast. One strand of the literature utilizes surveys in an attempt to uncover racial preferences (Farley et al. (1978, 1994, 1997), Bob and Zubrinsky (1996), and Emerson et al. (2001)). Alternatively, several researchers have theoretically modeled and empirically tested the role of racial

preference, made in (W)AqH-e@qjj7wq)wgMwqq-y@H)gjWHA- @FjgAMWj7- @FjgAM)AqH-

studies provide substantial evidence that racial preference contribute to observed differences in the locational choice across race. Specifically, evidence exists that suggest that households generally have a preference to live with other households of the same race.

The model developed in this paper incorporates difference in income and racial

Each of the two regions consists of an equal amount of homogeneous land (hereafter, housing stock). The quantity of housing stock in each region is specified as  $k_1 = k_2 = k$ . These regions are differentiated by the exogenously set environmental quality of the region and by the endogenously determined racial composition.

Individuals choose region 1 or 2 to maximize their utility, given by:

$U = f(x, I, R, g)$  where,

$x =$  composite good

between race and income, environmental preferences are assumed to be constant across types.

The importance of perceived racial quality is determined by the combination of racial quality ( $R_{rj}$ ) and the parameter,  $\alpha_r$ . This parameter captures the relative importance for racial quality. To define perceived racial quality, begin by specifying  $C_{rj}$  as the fraction the population residing in region  $j$  that is of racial type  $r$ :

$$C_{rj} = \frac{n_{rj}}{\sum_{r=w,b} n_{rj}}$$

Then, the racial quality perceived by an individual of race  $r$  in region  $j$  is defined as:

$$R_{rj} = 1 - (D_r - C_{rj})^2, \quad R \in (0,1)$$

where,

$D_r$  = racial bliss point

Racial quality is an endogenously determined component of the utility function intended to capture racial preferences. The bliss point of race  $r$  represents the ideal fraction of race  $r$ 's racial group residing in a particular region (or community). As the actual composition of the region deviates from the bliss point, the individual experiences some disutility. Observe that racial quality is maximized ( $R = 1$ ) when the racial composition is equal to the bliss point ( $D_r = C_{rj}$ ).<sup>4</sup>

The model developed above can easily be generalized to include additional regions and types. Furthermore, types could be defined not only by race and income but

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<sup>4</sup> A more general, and much less tractable, functional form was tested in the model that allowed disutility to be asymmetric around the bliss point. Specifically, an individual was better off if the individuals moving in were of the same race. The model was generally insensitive to this alternative specification.

also by racial preference and environmental preference – creating additional heterogeneity. However, the model analyzed in the paper provides the necessary insight to show the potential implications of the interaction of racial and environmental preferences.

Equilibrium is an allocation of prices and individuals across regions such that the following conditions are satisfied:

EQ1. No individual of type  $i$ ,  $i$ , could be made better off by moving to another region:

$$V_{ij} \geq V_{ik} \text{ if } n_{ij} > 0 \text{ and } n_{ik} = 0$$

$$V_{ij} = V_{ik} \text{ if } n_{ij}, n_{ik} > 0$$

EQ2. Every individual must be living in one of  $r$  regions (no one is homeless):

$$\sum_{j=1,2} n_{wj} = N_w \text{ and } \sum_{j=1,2} n_{bj} = N_b$$



role of racial preferences, the model is solved both with and without the presence of racial preferences. The model without race is in s



$$\frac{dp_{w2}}{dG} = p_1 - y_w \quad (\text{V.5})$$

$$\frac{dp_{b2}}{dG} = p_1 - y_b \quad (\text{V.6})$$



indifferent between regions and the black population prefers  $j_2$ . Intuitively, the price gap just offsets the difference in environmental quality for the rich white population, but is too large for the poor black population – leading them to choose  $j_2$ .

Thus, without racial preferences, the only equilibrium that can be supported in the two type model is one in which the wealthy occupy the high environmental quality region whereas the poor occupy the low environmental quality region. This finding is consistent with the literature, specifically research that considers vertically differentiated sorting models (Epple 1984). Next, I introduce racial preference to the model.

#### Analytical Results: Two Type Model with Racial Preferences

First consider equilibrium SEG1 under which with the poor black population lives entirely in the  $j_2$ . This is the only supportable equilibrium in the absence of racial preferences (when  $g_1$  is assumed to be greater than  $g_2$ ). Conditions for equilibrium remain the same as above; however, with the introduction of racial preferences, the indifference relationship for the white population becomes:

$$(y_w - p_1) R_{w1} g_1 = (y_w - p_2) R_{w2} g_2 \quad (V.11)$$

$$R_2 = \left( \frac{y_w - p_1}{y_w - p_2} \right) \frac{g_1}{g_2} \text{ where } R = \frac{R_1}{R_2}; G = \frac{g_1}{g_2}$$

is determined by the white population and will depend on the overall perceived quality across regions.

Furthermore, observe that by assuming the population distribution across types and regions, the perceived racial quality is predetermined. Specifically, for equilibrium SEG1 the entire black population is fixed in  $j_2$  and the white population occupies the remaining land as well as  $j_1$  entirely. Thus, R



population will be even larger. Furthermore, for the black population, relative to before, the overall quality shifts toward  $j_2$ . Combining these results with the rich white population's higher willingness to pay for environmental quality, it is clear that the black population will be better off in  $j_2$ .

The results are not as clear if the racial quality in  $j_2$  is also preferred by the white population. In this case, for both the white and black populations, the overall quality shifts towards  $j_2$ . However, as mentioned above, the racial quality gap perceived by the white population is likely to be small; especially, when compared to the gap perceived by the black population. Therefore, it is likely that the white population will not only continue to perceive the overall quality in  $j_1$  to be higher, but also unambiguously favorable when compared to the black population's ranking. Thus, even if the white population reverses<sup>8</sup> their ranking in favor of  $j_2$ , this distribution is likely to remain stable as a result of the significantly larger racial quality gap perceived

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$$y_w - (y_w - \bar{p}_1)R_w G \quad y_b - (y_b - \bar{p}_1)R_b G \quad (V.17)$$

With the presence of racial preferences, it is now possible to support this distribution in equilibrium. The analysis is again complicated by the uncertainty over how relative racial quality is perceived by the white population. Assume  $j_1$  (the community with a smaller proportion of the white population) to have higher perceived racial quality for whites and continue with the assumption that  $j_1$  is the higher environmental equality region implying  $G > 1$ .

Observe that the role of environmental quality depends on the magnitude of the environmental quality gap ( $g_1$  vs.  $g_2$ ) as well as the preference parameter  $\beta$ . Similarly, role of race depends on the magnitude of the perceived racial gap ( $R_{r1}$  vs  $R_{r2}$ ) as well as the preference parameter  $\beta$ . In general, it follows that if the racial tastes are relatively strong in comparison to environmental tastes, then this equilibrium with the poor black population living in the high environmental quality region may be supportable. In

addition, the perceived racial quality gap for the black population  $\frac{R_{b1}}{R_{b2}}$  must be

relatively larger than the white population  $\frac{R_{w1}}{R_{w2}}$ . The indifference price decided by the

white population will reflect both higher environmental quality and perceived racial quality in  $j_1$ . Therefore, to be better off in  $j_1$ , the perceived racial quality gap for the black population must be significant enough to compensate for the relatively high price in  $j_1$ .<sup>10</sup>

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<sup>10</sup> Note that if the white population perceives racial quality to be more favorable in  $j_2$ , support for this distribution becomes stronger. Furthermore, equilibrium SEG1 will also always be supportable when this equilibrium (SEG2) is supportable.





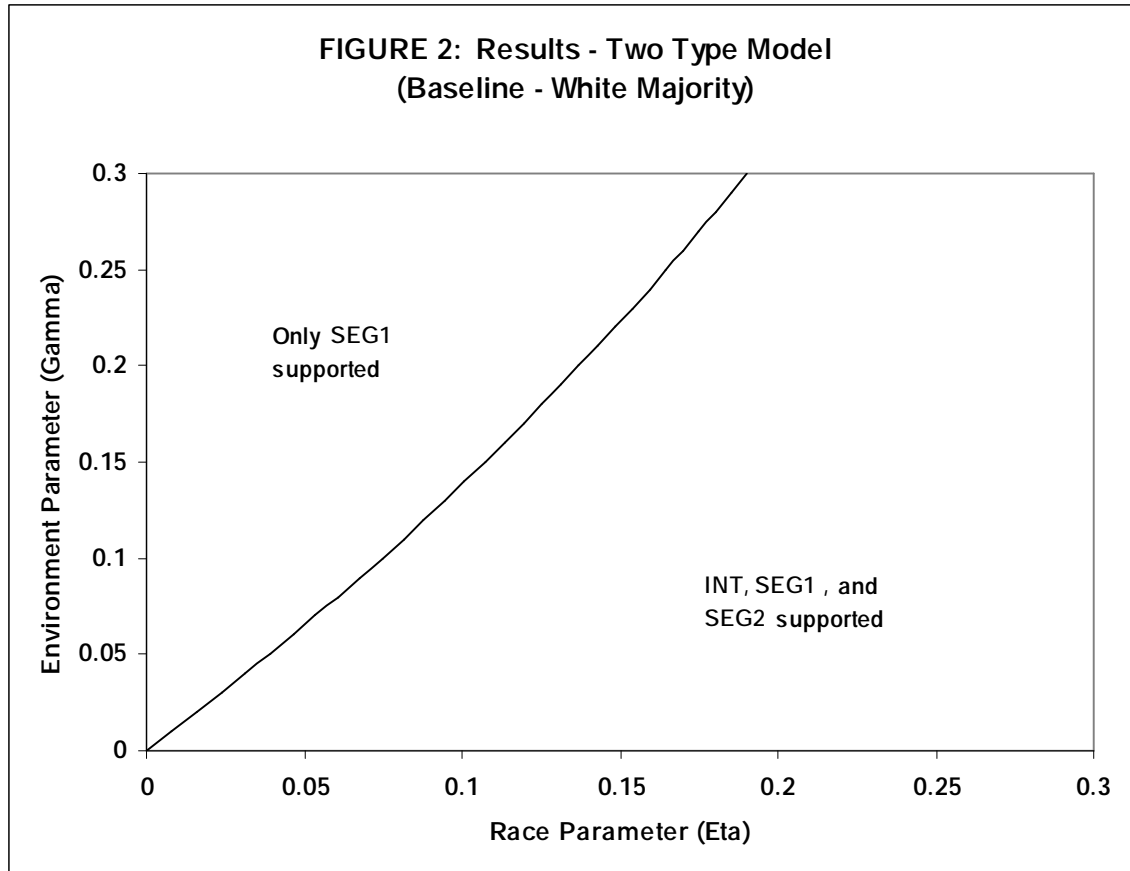








The analysis of Section III showed that once racial preferences are introduced, three different equilibria may be supportable. Figure 2 shows which equilibria are supportable as a function of  $\eta$  and  $\gamma$ .



As expected, the partial segregation distribution with the poor black population living in the low environmental quality region (SEG1) is still supported and robust following the introduction of racial preferences. With the assumed population distribution, both the white and black populations perceive racial quality to be more favorable in  $j_2$ . As predicted, for the black population the gap is significant with the perceived racial quality being more than twice as favorable in  $j_2$  ( $R_{b1} = 0.36$  vs.

$R_{b2} = 0.75$ ). Alternatively, for the white population the gap is minimal ( $R_{w1} = 0.96$  vs.  $R_{w2} = 0.99$ ).

Nevertheless, with the small perceived change in quality for the white population, the indifference price increases slightly in  $j2$  (for every parameter combination) once racial preferences are introduced.<sup>15</sup> Furthermore, there is a small parameter space where the white population's ranking of the regions reverses; thus, the indifference price in  $j2$  is slightly more than 0.25.<sup>16</sup> However, even in this range, the black population remains better off in the low environmental quality region.

An integrated distribution (INT) can also be supported once racial preferences are introduced. In contrast to the above cases, the population distribution across regions is not predetermined. In equilibrium, the distribution as well as the price in  $j_2$  is recovered. Support for this distribution lies in almost the exact parameter space as SEG2. However, along the threshold, the integrated equilibrium is not supported whereas SEG2 is supported. Recall that this equilibrium is highly unstable. Specifically, any change in the environmental quality or distribution would drive the distribution to one of the partial segregated equilibrium.

Finally, I consider the role of racial preferences by adjusting the racial bliss point

Observe that the parameter space where SEG2 and INT2 are supported increases significantly under the adjusted specification.<sup>19</sup> Consider the impact on SEG2 – the black population residing entirely in the high environmental quality region (j1). Under this population distribution, the white population now perceives j2 to have more favorable racial quality ( $R_{w1} = 0.96$  vs.  $R_{w2} = 0.99$ ). The black population continues to favor j1 ( $R_{b1} = 0.64$  vs.  $R_{b2} = 0.19$ ). For the black population the racial quality gap has increased. Furthermore, the relative gap between races increases from the previous specification. Consequently, the role of perceived racial quality is more significant in supporting the equilibrium.

Working through the parameterized model demonstrates the results predicted in the analytical analysis. With this approach in mind and the intuition gained from the two type model, I will now expand the model to include all four types. The evaluation of the full model allows for heterogeneity of income within each race. This generalization makes it possible to separate income and racial effects on locational choice.

The specification with all four types is evaluated using a similar approach to that laid out above. The population distribution was constructed using data from the 2000 US Census. I define rich households as households earning at least the median income. Using this approach, approximately 55% of the white population and 37% of the black population are categorically defined as rich households.<sup>20</sup> Holding the proportion of black households at 15% as in the two type model, the following table describes the assumed population distribution across the four types:

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<sup>19</sup> While not reflected in the figure, support for SEG1 also becomes more robust.

<sup>20</sup> The median household income in the US was reported to be \$41,994. For income distributions within race, the nearest break provided by the Census is \$40,000. Therefore, I use this break as the estimated median income.



TABLE 4: Assumed Exogenous Variable Values (Four Types)				
Exogenous Variables	Type			
	$w_H$	$w_L$	$b_H$	$b_L$
pop. ( $N_i$ )	0.95	0.75	0.1	0.2
income ( $y_i$ )	1	0.67	1	0.67
bliss ( $D_r$ )	0.8	0.8	0.8	0.8

Observe that the total white population exceeds the total black population and the total rich population exceeds the total poor population.<sup>21</sup> Thus, both white and rich individuals will reside in both regions. The remaining parameters are consistent with the two type model (as reported in Table 2). Recall that the environmental quality is assumed to be more favorable in  $j_1$ .

In contrast to the two type model, by considering four types there are many racial distributions across regions that are possible in equilibrium. However, using the assumed population distribution reduces the set of distributions that are possible. For example, it is not possible to have the rich white population living entirely within a region with the entire population of any other type. For tractability, only distributions that have one type split across regions will be explicitly considered. Several distributions in which two types lived across regions were tested and none were supported in equilibrium. Table 6 lists the considered potential equilibria:

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<sup>21</sup> While the assumed distribution of types impacts equilibrium results (e.g., prices), the fundamental conclusions are unaffected.



are at least as well off in  $j_2$ , and (3) the poor white population is indifferent between regions.

To provide a point of comparison, it is worth quickly discussing the model in the absence of racial preferences. Under these preferences, the model collapses to the two type model because race doesn't affect an individual's decision. Therefore, the only supportable equilibria are ones in which the total poor populations (both white and black) are living in the low environmental quality region. Figure 4 depicts this result by comparing achievable utility for each type across regions:

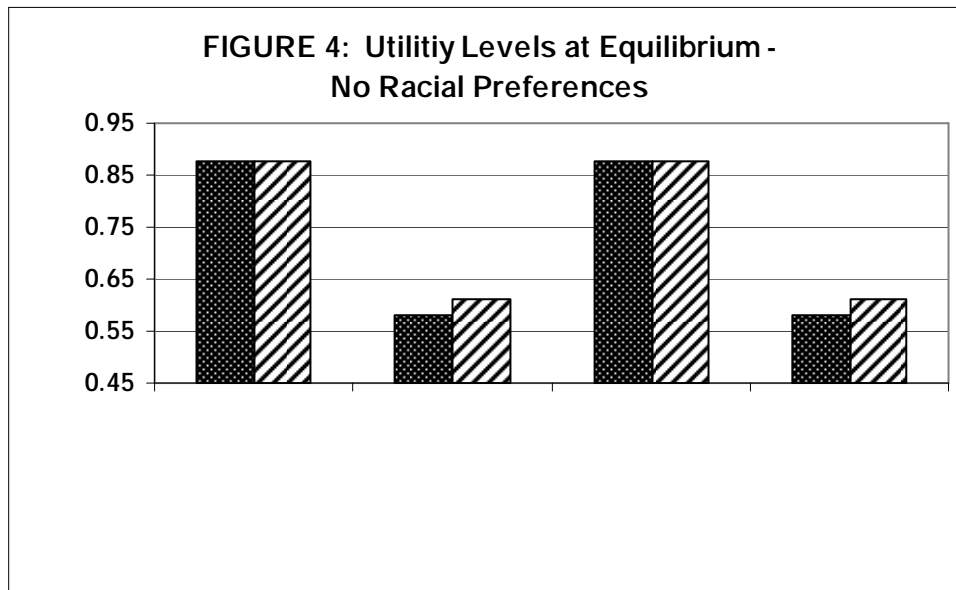


TABLE 6: Results (Four Types)					
Case	Location of Types			Supportable	Reason Unsupportable
	Both	j1	j2		
<b>Stratification by Race – Black pop. in region 2 (RB2)</b>					
RB2.WH	$w_H$	$w_L$	$b_H, b_L$	Yes	--
RB2.WL	$w_L$	$w_H$	$b_H, b_L$	Yes	--
<b>Stratification by Race – Black pop. in region 1 (RB1)</b>					
RB1.WH	$w_H$	$b_H, b_L$	$w_L$	Yes	--
RB1.WL	$w_L$	$b_H, b_L$	$w_H$	No	$V_{w_H 1}$ $V_{w_H 2}$
<b>Stratification by Income – Poor pop. in region 2 (IP2)</b>					
IP2.WH	$w_H$	$b_H$	$w_L, b_L$	No	$V_{b_H 1}$ $V_{b_H 2}$
IP2.BH	$b_H$	$w_H$	$w_L, b_L$	Yes	--
<b>Stratification by Income – Poor pop. in region 1 (IP1)</b>					
IP1.WH	$w_H$	$w_L, b_L$	$b_H$	No	

This case requires that prices adjust to make the rich white population indifferent between regions. At these prices, from condition EQ1, this equilibrium is supported if: (1) the poor white and poor black populations are at least as well off in j2 and (2) the rich black population is at least as well off in j1.<sup>23</sup> However, over the entire parameter space, the rich black population can always be made better off by moving to j2. Therefore, this equilibrium, which assumes the rich black population residing in j1, is not supportable.

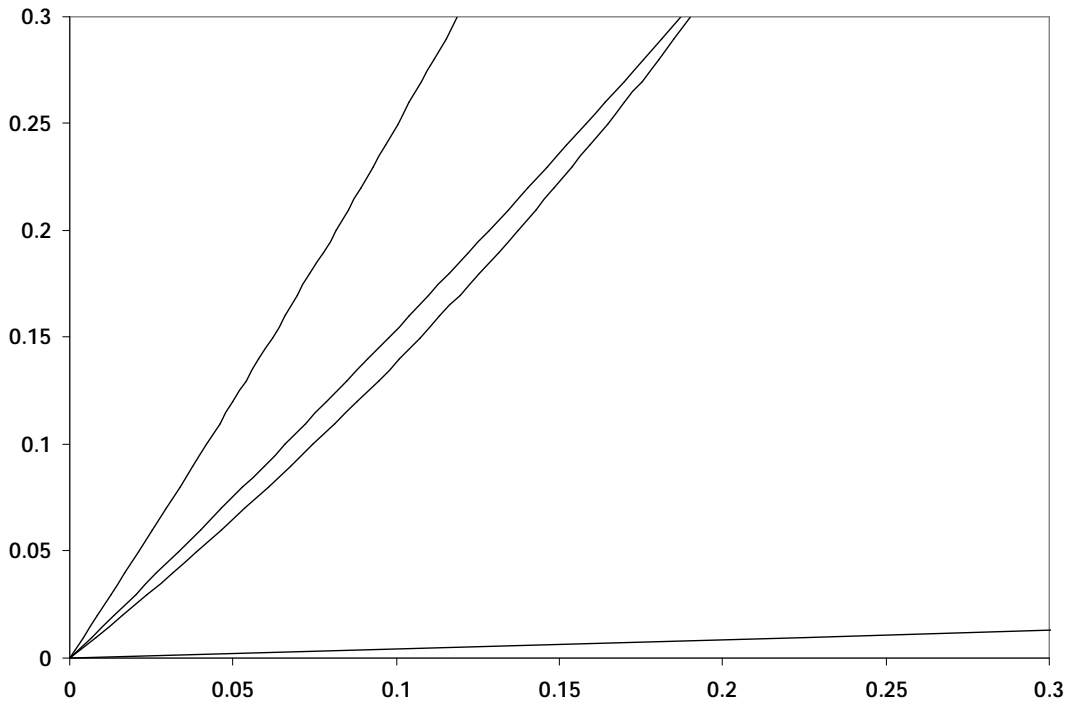
Intuitively, for the distribution assumed in this potential equilibrium, the rich white population will always perceive j1 to be more favorably than the rich black population. With the same income, the rich white and rich black populations have the same marginal willingness to pay for overall quality. Therefore, at the indifference prices for the rich white population, the rich black population will always prefer to live in j2. The general intuition behind the supportability of this equilibrium can be followed to understand the outcomes of all the equilibria – whether supportable or not.

The remainder of this section focuses on the four equilibria (Cases RB2.WH, RB2.WL, RB1.WH and IP2.BH) which can be supported. Figure 5 below depicts when these equilibria can be supported as a function of  $\alpha$  and  $\beta$ .

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<sup>23</sup> For all the cases considered, conditions EQ2 and EQ3 will be satisfied in equilibrium since the population distribution is fixed.

FIGURE 5: Results - Four Type Model  
(Baseline)



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assumed population distribution across race and as

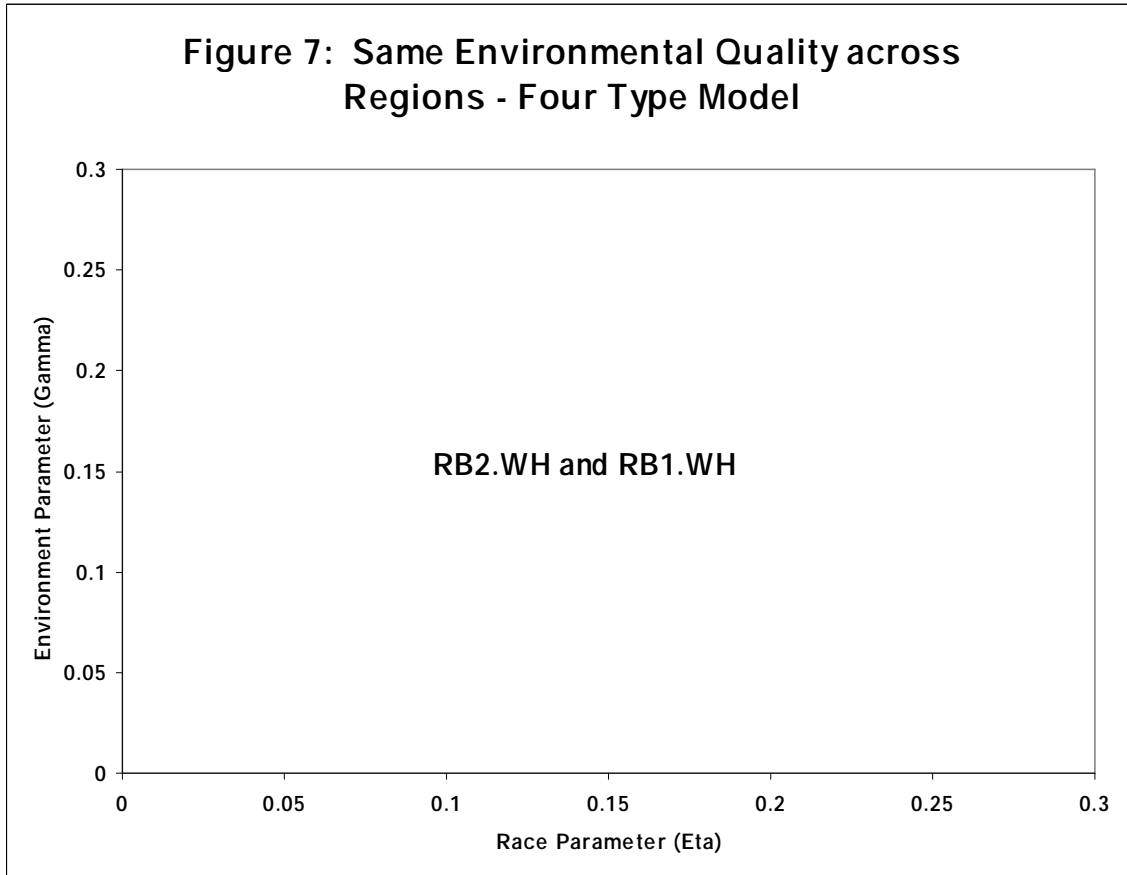
indifference price such that the poor black population would prefer  $j_2$  – even though the region has significantly lower racial and environmental quality.

In terms of environmental justice the results above are quite significant. When supportable, RB2 reflects a distribution that would









Following the introduction of an environmental hazard, the model returns to the specification discussed in the previous section ( $g_1 = 2$  vs.  $g_2 = 1$ ). Recall the summary of results provided in Figure 5. As posited in Section 4, the initial distribution of households plays an important role in understanding observed distribution when the economy returns to equilibrium. However, once the environmental hazard is introduced, the stability of the initial distribution depends on relative preference for environment and race.

Suppose the initial equilibrium is RB2. Following the introduction, this racial distribution remains a stable equilibrium if relative preferences fall within the supportable portion of the parameter space (i.e., to the right of the threshold for RB2.WL). However, if households' relative preferences exist to the left of the threshold, the equilibrium will

become unsupportable. Specifically, compared to the poor white population, the rich black population will have a higher willingness to pay to live in  $j_1$ . Consequently, equilibrium forces will drive the distribution to IP2.BH.

Assuming RB1 as the initial distribution leads to several interesting possible outcomes following the introduction of an environmental hazard. First, if household preferences exist within the portion of the parameter space where RB1 is supportable, the equilibrium will remain stable.

To the left of the threshold, the equilibrium becomes unstable. Under this scenario, the path to a new equilibrium is somewhat complex. At the prices in which the rich white population is indifferent, the poor black population is better off living in  $j_2$ . As a result, forces will drive the entire poor black population to migrate to the low environmental quality region by purchasing housing stock from the rich white population. However, this shift in population tips the racial quality perceived by the black population in favor of  $j_2$ . Ultimately, with the change in quality, at indifferent prices for the rich white population, the rich black population also favors  $j_2$ . Thus, the rich black population will replace the remaining rich white population in  $j_2$ .

At all parameter combinations left of the threshold, forces will drive the distribution to at least this point. However, as depicted in Figure 5, RB2.WL and IP2.BH are possible outcomes in equilibrium. Suppose, preferences fall within the small portion where only RB2.WL is supportable. Here the rich black population will continue moving into  $j_2$  by consuming housing stock from the poor white population until the entire rich black population resides in  $j_2$ . Ultimately, the poor white population will live in both regions and prices will reflect indifference for this population. At these prices, all types





words, equilibria which reflect stratification by race would continue to be supportable following the improvement.

Alternatively, if the economy reflected IP2.BH prior to the improvement, it is possible that this equilibrium would become unsupportable. Furthermore, the most likely result would be a shift to RB2. Specifically, at the indifference price for the rich black population, the poor white population would be better off living in j1. Consequently, the poor white population will migrate to j1 by consuming housing stock from the rich black population. Equilibrium will be reached when the distribution reflects RB2 and prices reflect indifference for the poor white population.

Even parameter combinations in which either RB1 or RB2 could be supported; the rich white population will always be willing to pay more than the poor white population to live in j1. Therefore, the economy will still be driven to RB2.

Working through this scenario also demonstrates in





these preferences do exist. Thus, not accounting for preference for racial composition may lead to incorrect or inaccurate inferences in empirical research. An ultimate consequence would be ineffective policies. These implications have not been thoroughly investigated in an environmental justice context.

It is important to note that this final remark is not only true for environmental justice, but can also be generalized to other local public goods (i.e., school quality, level of crime, etc.). Specifically, the observed consumption of local public goods across racial groups may be misinterpreted if racial preferences are not accounted.

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