RACE AND POLLUTION CORRELATION AS PREDICTOR OF ENVIRONMENTAL INJUSTICE

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ABSTRACT

One strand of the environmental justice literature claims that toxic, hazardous and dangerous waste facilities are disproportionately sited in low-income communities of color. This paper empirically demonstrates an alternative cause of environmental injustice - that low-income minorities are less likely to receive sizeable enough loans to buy a house in a cleaner area. It highlights a significant time in history, from 1999 to 2007, when wealth constraints were eased and loan amounts increased for people with the same income. The results show that minorities increase their consumption of environmental goods given an increase in loan amounts by more than whites (controlling for income), suggesting that people of color care about environmental quality, but, due to wealth constraints, do not have the same opportunities in the housing market.

JEL Classification: P46, P48, Q50, Q53, Q56, Q58, R20, R21, R31, R32

Keywords: Environmental injustice, wealth constraints, loan, income, housing market, air quality

Table of Contents

I. Introduction

The concept of environmental justice is concerned with the possibility that disadvantaged groups – the poor and racial and ethnic minorities – may face disproportionately higher health risks from exposure to hazardous materials, polluted air, and contaminated water. These individuals often represent a large fraction of residents living in communities located near these potential hazards. Seeking an explanation for this disproportionate exposure to risk, one strand of the environmental justice literature asserts that the demography of neighborhoods or census tracts can be used to predict the siting of environmental hazards. According to Bullard (1999) black communities became the dumping grounds for various types of unpopular facilities, including toxic wastes, dangerous chemicals, paper mills, and other polluting industries. Another study by the same author looked at the relationship between toxic waste and race from 1987-2007 and found race to be the most potent variable in predicting where commercial hazardous waste facilities were located in the U.S. Race was found to be more powerful than household income, the value of homes and the estimated amount of hazardous waste generated by industry (Bullard et al., 2007).

Several other studies have found significant evidence of environmental injustice, focusing on how proximity to hazardous pollution varies by race and economic status (Anderson et al., 1994a, 1994b; Pastor, 2002). While these studies imply that polluting industries tend to target minority neighborhoods, another study finds racial disparities in income and the subsequent impacts on the tradeoffs individuals make to be the driving force behind environmental injustice (Timmins, Depro, & O'Neil. 2012). In particular, individuals may sort in response to many neighborhood attributes, valuing school quality or public safety above pollution exposure.

This paper adds to the previous literature in several ways by exploring the role of wealth constraints in individual sorting behavior; in particular, I evaluate whether wealth constraints have a bigger impact on minorities, and determine whether minorities make decisions that would lead to environmental injustice patterns when constraints are large.

To be specific, I investigate the role that wealth constraints play in housing transactions among minorities. From an environmental justice point of view, are minorities more likely to move away from pollution sources when they can do so with smaller downpayments (i.e., when they face a smaller wealth constraint)? Furthermore, when confronted with a pollution source, are minorities or impoverished people unable to react and move? It is hypothesized that as loan amounts increase over time for people with the same income, their wealth constraints are eased, and people will move to houses in less polluted areas.

In order to analyze this question, I exploit variation in the availability of credit over the last decade. Over the course of the 2000's, the easing of downpayment restrictions (mainly during the Bush years leading up to the sub-prime crisis) made it easier for people to buy a house with a lower downpayment. Although this was unfortunate from the point of view of the housing collapse and the subprime mortgage crisis, it creates an interesting experiment in that we can see if people make different housing purchases and decisions with respect to pollution (and other negative factors – crime, bad schools, etc.) as the wealth constraint is eased. I demonstrate how homeowners' decisions about housing quality are affected by changes in the required downpayment, which effectively reduces the housing price that individuals pay by reducing their interest costs. I then show how this change in the wealth constraint affects the elasticity of

demand for various neighborhood amenities (i.e. proximity to toxic waste), as well as how the elasticity may vary by race and income.

In this paper, I first give a brief overview of environmental injustice, highlighting the larger effect it has on minorities. Next, in Section II, I review the relevant literature, discussing discrimination in the housing market and the extent to which housing quality (in particular, proximity to toxic waste) varies by race and income. I also introduce the general theory behind environmental injustice in this section. In Section III, I introduce the data I use, and in Section IV, I detail the economic methods I use to recover the demand for various house attributes. In Section V, I analyze my results, quantifying how the demand for proximity to toxic waste is different depending on race. I conclude Section VI with a discussion of the implications of minority households' choices that may ultimately inform us about the presence of environmental injustice, and make recommendations for future research.

II. Literature Review

I hypothesize that, with a decrease in the downpayment percentage holding income constant, individuals who had been constrained by their wealth will use the added flexibility to move to houses in less polluted areas. This demonstrates the role of wealth in affecting exposure to pollution. I hypothesize that this story plays a bigger role for minorities, leading to exposure patterns commensurate with environmental injustice. The following four studies demonstrate and support the hypothesis.

In a research article by Keister and Moller (2000), the authors address the lack of research into the causes and consequences of the wealth inequality in the United States. They discuss methods of creating empirical estimates of wealth accumulation and

distribution, and then present some estimates of trends in wealth inequality in the United States. They note that wealth has largely been ignored in studies of inequality. According to their research, sociologists typically focus on income, or the flow of money received by an individual or household, as an indicator of financial well-being. The authors summarize that research has shown that race affects wealth ownership, net of income. When wealth is included as an indicator of well being, racial inequality is considerably more severe than other indicators suggest. They summarize that the dominant explanation for racial variations in asset ownership suggests the differences in willingness to postpone consumption. The results confirm the hypothesis that a correlation exists between race and wealth. This finding is significant because wealth provides for both short and long-term financial security, bestows social prestige, contributes to political power, and can be used to produce more wealth, possibly in the form of real estate (Domhoff 1970, 1990, Henretta & Campbell 1978, Oliver & Shapiro 1995).

While Keister and Moller (2000) analyze the correlation between race and wealth, the next study addresses the relationship between race and homeownership/home equity. A connection exists between the two studies in that wealth and homeownership/equity can be synonymous. In other words, one can predict the other. Therefore if race inhibits the attainment of either wealth or homeownership/home equity, the other could not be attained. In a research article by Flippen (2001), three questions guide the study. First, what is the housing wealth position of Hispanics relative to their black and white peers? Second, do factors such as income, education, and employment stability have a greater effect on white housing than black or Hispanic housing? Third, what roles do risk tolerance, time horizon, and bequest preferences play in structuring racial and ethnic wealth inequality? Flippen makes note of the fact that up until his paper, the research done on housing inequality has

lacked credibility because of the difficulties associated with specifying discrimination. The focus of his investigation is on the pre-retirement population (51-61) from the Health and Retirement Study of 1995. It is hypothesized that discrimination based on race still exists even after characteristics such as income, risk tolerance, and life-cycle/assimilation differences are accounted for. The results in his study support the hypothesis that the disparity in housing wealth strongly suggests the role of discrimination in undermining minority asset accumulation. The study percentages are; 83% of white households are homeowners, only 59% of black and 57% of Hispanic households are homeowners. These disparities increase dramatically as household income falls. Among the lowest income quartile, white ownership is 63% compared to 39% black and 40% Hispanics. On average, black homeowners hold only 55 cents in housing equity for every dollar held by whites and Hispanics hold only 69 cents. The odds of black homeownership are 27% lower than for whites and they average over $213,000 less equity among owners, 32% for Hispanics, $14700 less equity. Flippen decomposes the amount of housing inequality that is attributable to each set of factors by substituting white household characteristics into black and Hispanic housing equations. He finds that if blacks had the same family structure as whites, their probability of home ownership would rise from 0.63 to 0.70 accounting for over 27% of the original race gap in ownership. Substituting white characteristics into the black housing equity equation produces a much more modest effect. All of these results combined confirm the hypothesis that racial and ethnic inequalities exist in the housing market.

One limitation of Flippen's study is the data sample. It is unclear whether he uses data spanning the entire United States or certain areas of the country. The correlations may have been significantly different depending on location of the data. Another limitation to

Flippen's study is the possibility that he overlooks a difference among whites, blacks, and Hispanics that could explain the differences instead of their racial differences.

While the previous article addressed the role of discrimination in undermining minority asset accumulation in the housing market, the next study addresses the role of discrimination in minority proximity to toxic waste in the housing market. In a research article by Hipp and Lakon (2010), three questions are addressed. First, what is the relative proximity to toxic waste sites for minority groups over a 10-year period from 1990 to 2000? Second, do neighborhoods with more highly educated residents experience less exposure to toxic waste sites? Third, do these effects differ if we take into account the toxicity of the emitted wastes? Hipp and Lakon focus on six very highly populous counties in southern California. Their study includes a high proportion of Latinos in the study sample and relative proximity of this sample to the US/Mexico border. The authors are able to view the relative proximity to toxic waste for the burgeoning Latino population in this region over a 10-year period. Data for the study were obtained from the US Census and the Toxic Release Inventory (TRI), information on the quantity of certain chemicals released into the environment by toxic waste facilities in the US (obtained at http://www.rtknet.org/triabout.html). The results of the study support the hypothesis that minority neighborhoods will be most impacted by the placement of toxic waste sites. The study indicates that a tract with 15% more Latinos is exposed to, on average, about 84% more toxic waste than an average tract over this period, whereas a tract with 15% more Asians is exposed to about 34% more toxic waste over this period. The results also indicate that more educated residents will be citizens who are more willing to engage in activity to prevent the placement of such sites and to reduce the output from currently existing sites, particularly when it comes to the most toxic chemicals. These results

strengthen the hypothesis of the present paper, which predicts that poor and minority populations, more likely to be less educated, will have larger wealth constraint problems and be more exposed to pollution. One limitation of the study is that although the authors extend the literature by exploring a longitudinal model, they are still limited in their ability to provide causal explanations. Another limitation is their process for measuring education levels and specifically knowledge about toxic waste and its consequences.

Finally, a research article by Pastor (2002) addresses the topic of environmental injustice. The following three questions addressed in his study are relevant to the main topic of this thesis. First, is the pattern of environmental inequity simply a manifestation of market outcomes rather than racial or class discrimination? Second, is the pattern a result of moves to higher-risk areas by minority residents driven by choice rather than dictate? Third, are there real and consequential effects in terms of wealth and health, in which case paying attention to environmental inequity could yield dividends for communities struggling for local improvement and empowerment? The investigation was conducted with colleagues at Occidental College in Los Angeles and at San Francisco State University. The focus of the investigation was on the southern California area. Data were used from the Toxic Release Inventory (TRI). It was hypothesized that environmental inequity existed in the studied region. Environmental inequity or injustice occurs when a community's right to determine how much pollution they will tolerate and for what tradeoffs is usurped by a particular firm and/or by the larger society in the form of inadequate regulation. Pastor's study results show that the relationship between income and proximity to hazards is best modeled by an 'inverted U'. The poorest communities suffered less since they make up an undesired workforce, the richest communities suffered less due to their political power, and the working-class communities, with communities of

color bearing an especially high burden, suffered the closest proximity to hazards. In addition, Pastor looks at the arrival of nearly all high-capacity toxic storage and disposal facilities in Los Angeles County, and then links those data to a geographically consistent small-area file of demographic data that spans the period 1970 to 1990. The results suggest that hazards had been placed in these working class communities of color. Pastor argues that even after accounting for other explanatory variables, race played an independent role. A limitation to this study is the use of aggregate level data.

Taken together, the results from these four papers indicate that a relationship exists between both race and wealth and race and home ownership/home equity. The previous studies focused on aggregate data. In the present study, I address individual choices and preferences to be able to understand the full effect of wealth constraints on minorities and housing market transactions.

III. Data

Before proceeding, I wish to note that Table 1 contains summary statistics of the data set. In this section, I describe a new data set that I have assembled, merging information about buyers in the housing market with housing transaction data and census tract qualities in the Los Angeles metropolitan area. I discuss the source data and the merging process, highlighting the most important features of the new data set.

The data set that I construct is drawn from several sources. The first source comes about because of the Home Mortgage Disclosure Act (HMDA), which was enacted by Congress in 1975 and requires lending institutions to report data on mortgage applications. The data set provides information on the race, income, and gender of the buyer/applicant, as well as the mortgage loan amount, mortgage lender's name, and the

census tract where the property is located. I used HMDA data for years 1998-2008. The second data source comes from Dataquick Information Services, a national real estate data company that provides information about each housing unit sold in the core counties of Los Angeles between 1998 and 2008.[1] The buyers' names are provided, along with the transaction price, exact street address, square footage, year built, lot size, number of rooms, number of bathrooms, number of units in building, and many other characteristics. Merging these two data sets is possible because the Dataquick data also includes information about the buyer's mortgage, including the loan amount and lender's name for all loans.

To ensure the validity of the HMDA/Dataquick merging procedure, I reference an academic research paper in the National Bureau of Economic Research that had conducted the same data merge for San Francisco (Bayer et al., 2012). Although the city is different, their results suggest that the merging process does not distort the data in any significant way. The authors did a simple comparison of the two samples to ensure that the set of houses for which we have a unique loan record from HMDA is representative of the universe of houses. Overall, their diagnostic checks provide strong evidence supporting the validity of their matching procedure. I merge the two data sets on the basis of the following variables: census tract, loan amount, date, and lender name.

An observation is a house purchase. Each line of data is one house that sells at a certain time. I dropped any observation where the owner had a different mailing address and house address. This would mean the owner was renting the residence and I only wanted to look at owner occupied houses. I also dropped any house that went through a major renovation since price will be associated with the most recent state assessed record.

[1] These data were used under a license agreement between the Duke Department of Economics and Dataquick.

If a house went through major improvements, then the reported attributes of the house would be mismatched with the price

Since I want to look at housing transactions over time, I need to make housing prices and loan amounts comparable across years. I do so by adjusting all prices from 1998-2008 by dividing both the raw house prices and raw loan amount by the CPI in January of 2000 (Bureau of Labor Statistics, 2000). I then create a variable for downpayment amount by subtracting the loan amount from the house price for each observation. Income is only observed when a home is purchased; therefore, I assume the income variable is constant over time.

The next data set I merge is comprised of TRI data (Toxic Release Inventory), Property crime rates, and school quality by census tract. The TRI data comes from the Environmental Protection Agency. The data provides information on the number and location of U.S facilities that emit toxic chemicals at the census tract level. Quantities reported by TRI facilities reflect chemicals released into the air and water and chemicals managed through recycling, energy recovery, treatment and disposal. I transform the variable for number of TRI facilities to 18 minus the number of TRI facilities in order to interpret the variable as an environmental good rather than an environmental disamenity. The number 18 is the maximum number of TRI sites in one census tract observed in my sample.

The source for the school quality data is the California Department of Education. The California Department of Education (CDE) provides Academic Performance Index (API) reports as part of its Accountability Progress Reporting (APR) system. The Academic Performance Index (API) is a yearly report for the school year reporting cycle. Local educational agencies that administer academic accountability programs use the data

in order to meet the requirements of California's Public Schools Accountability Act (PSAA) of 1999. The data is calculated by taking the scores from the three closest schools to the centroid of each tract. I do this separately for elementary and high schools.

The property crime data comes from the RAND California database, which provides figures describing the number of burglaries, larceny-theft, motor vehicle theft, and arson per 100,000 residents, organized by city. Property crimes do not involve force or threat of force against victims since the object of the offense is money or property.

Specifically, the data describe crime rates for cities in Los Angeles between 1986 and 2008. The crime rates are recorded by the centroid of each census tract by computing a distance-weighted average of the crime rate in each city. The centroid should be the geographic center of the tract. This takes account of odd shapes, so if you were to take a cutout of the tract and balance it on a pin, the centroid would be the point where it exactly balances. I focus my attention on violent crimes, as opposed to property crimes, since they are likely to be less subject to reporting error and more likely to have an effect on house prices (Gibbons 2004). I transform the variable for Property Crime to 10,676 minus the number of crimes in order to interpret the variable as a public good rather than a public disamenity. The number 10,676 is the maximum number of crimes in one census tract observed in my sample.

I calculate a housing services index variable by regressing house price on the number of bedrooms, the number of bathrooms, the house age, the house lot size, and the house square footage. Then, I generate a new variable, which is a compilation of all of the housing services.

I dropped observations with an income of 0. This is most likely a reporting error. There were only 7 observations of this kind. I dropped 5 observations with income top-

coded at $9,999,999. I dropped 4,828 observations because they were missing an income value. I dropped 6,714 downpayments that were less than 0. The TRI variable stands for the average number of TRI sites around a house when it was sold. Table 1 presents summary statistics for the merged data that I use for estimation. I include summary statistics for both individual household and census tract characteristics.

Table 1: Summary Statistics

Household Characteristics

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Income [1]	414,907	104.097	63.6637	26.0000	449.000
Loan Amount [2]	414,907	244,394	127,848	2,766.10	1,434,104
Rental Rate [3]	414,907	236,026	135,977	38,853.9	1,000,742

Census Tract Characteristics

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Public Safety	401,033	9,113.55	788.121	0.00000	10,144.0
School Quality HS	414,907	614.577	85.2687	395.000	808.000
TRI	414,907	18.3276	1.58703	1.00000	19.0000

[1] Income is measured in $1000's of dollars.
[2] Loan Amount is measured in dollars.
[3] Rental Rate is measured in dollars per year. Although Dataquick data does not provide house Rental Rates, I impute household rents by setting Rental Rate = Price * 0.75.

My household sample consists of over 400,000 observations. The household level characteristics we focus on are income, race, and wealth. The sample mean household income is around 104,000 with a standard deviation of 63,000.

IV. Model and Methodology

In 1999, Fannie Mae, the nation's biggest underwriter of home mortgages began to increase home ownership rates among minorities and low-income consumers, by easing the credit requirements on loans purchased from banks and other lenders. This action of easing credit for poor people would be evidenced by larger loan amounts, holding income fixed, the majority of which entered the market from 2005-2006 (Engdahl, 2007). In 2006, 20 percent of all mortgages were subprime, as opposed to 9 percent in 1996 (Trehan, 2007). Interest-only mortgages, subprime loans with adjustable rate mortgages (ARMs), and "stated income" loans (loans where the borrower did not have to provide documentation to verify the income stated on the application to finance home purchases), were risky products that targeted borrowers with poor credit (Bianco, 2008).

From a microeconomic standpoint, this unique situation caused wealth constraints to decrease, which led to increased income and exogenous shifts in people's budget constraints. I first estimate a hedonic price regression to check the implicit prices for neighborhood attributes. The implicit prices derived from the hedonic regression can be used in the household budget constraint in which expenditures on neighborhood attributes are included. That constraint relaxes as wealth constraints are eased. I therefore regress neighborhood attributes on loan amount while controlling for income to see how people change their choice of attributes after a change in this budget constraint. If relaxing the budget constraint increases household consumption of an attribute such as air quality, then we can assume that wealth constraints had been impacting household consumption of that attribute. By repeating this regression for groups of different races, I can test whether these constraints appear to be particularly strong for minorities. If so, then wealth

constraints could be a source of the disproportionate exposure to pollution for minority groups, like that described in the literature review.

i. Hedonic Analysis: Rental Rate Regression

The hedonic model estimates how much people value certain attributes of a house (Palmquist, 2001). More specifically, the derivative of house price with respect to a housing attribute yields the "implicit price" of the latter. Using hedonic price regressions, I will explain the effect of wealth constraints on house attributes choices for each race in terms of these implicit prices.

Using ordinary least squares, I first run a hedonic price regression, where the Rental Rate of the house is regressed on the attributes of the house (air quality, school quality, public safety).

$$RentalRate = (\beta_0 + P_A(AirQuality) + P_S(SchoolQuality) + P_{PS}(PublicSafetyQuality) + P_{sF}(HouseSquareFootage) \ldots + \mathrm{E}_i \quad (1)$$

The coefficients on the attributes are the implicit prices that people are willing to pay for marginal increases in the attributes. I derive the slope of individual's budget constraint in hedonic attribute space by dividing the implicit price of school quality (P_S) by the implicit price of air quality (P_A); i.e., $-P_S/P_A$. The right hand side of the equation decomposes Rental Rate, or the user cost of housing, into the contributions of air quality, school quality, public safety, House Square Footage, and a constant. When credit is eased, borrowing costs fall, subsequently lowering user costs. The theory doesn't explicitly predict a change in a person's wealth, but when user costs drop then implicit costs drop as well, hence increasing a person's purchasing power (i.e. expanding his budget constraint).

The model assumes that the individual will spend his income on some combination of air, school, and public safety, and housing services. I am interested in the combination of attributes that will be purchased with the new income.

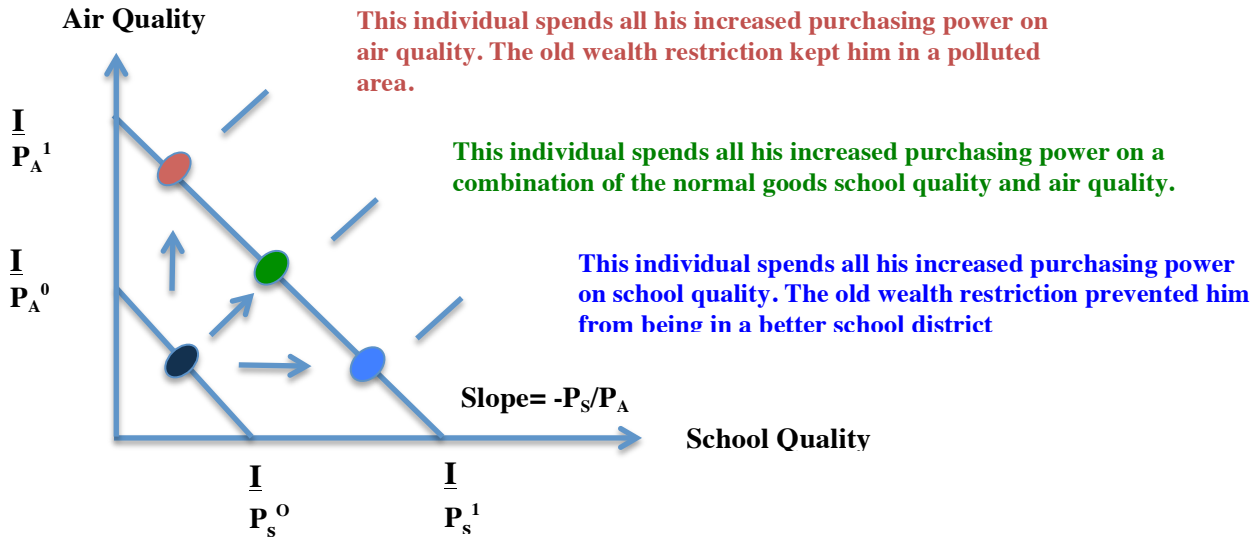

Figure 1: Hedonic Model of Individual Budget Constraints in two periods: the old high credit constraints and the new low credit constraints.

Figure 1 shows the possible reactions to the increase in purchasing power, holding expenditures on Public Safety, air quality, and school quality constant. Increased air quality, school quality, and Public Safety all make houses more attractive. If borrowing costs decrease, the implicit costs of air quality and school quality both drop (from P_s^O to P_s^1 and from P_A^0 to P_A^1) and the budget constraint shifts out.

I allow for different racial groups to face different market conditions by estimating a hedonic price regression for each race. The slope of the budget constraint shows how expensive the house attributes are relative to each other. If the implicit cost of school (P_S) is very large and/or the implicit cost of air (P_A) is very small, the reduction in user cost will have a much greater potential to increase air quality (A) instead of school quality (S).

If different racial groups face different implicit prices, we expect to see different responsiveness in school quality & air quality for that group.

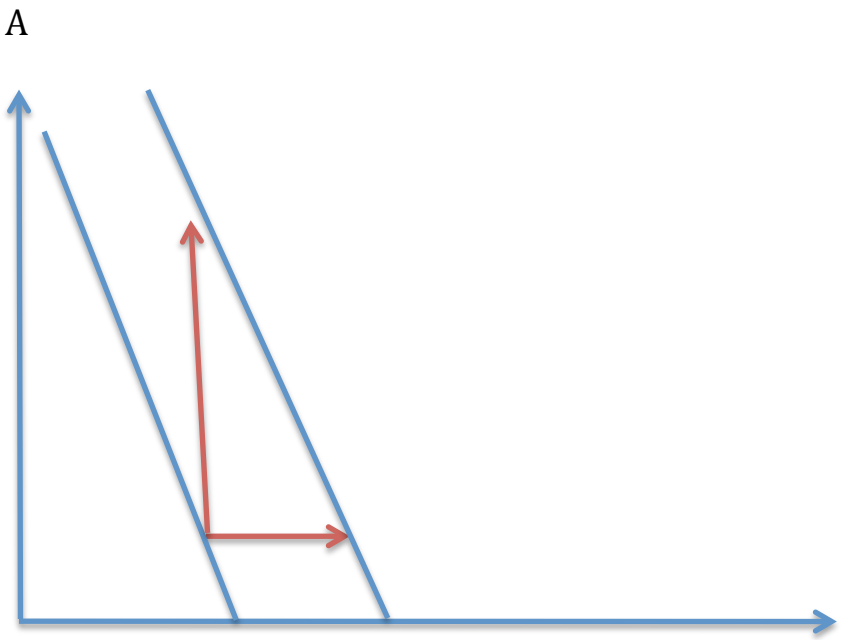

Figure 2: Individual budget constraints for a neighborhood with higher implicit cost of air quality versus school quality.

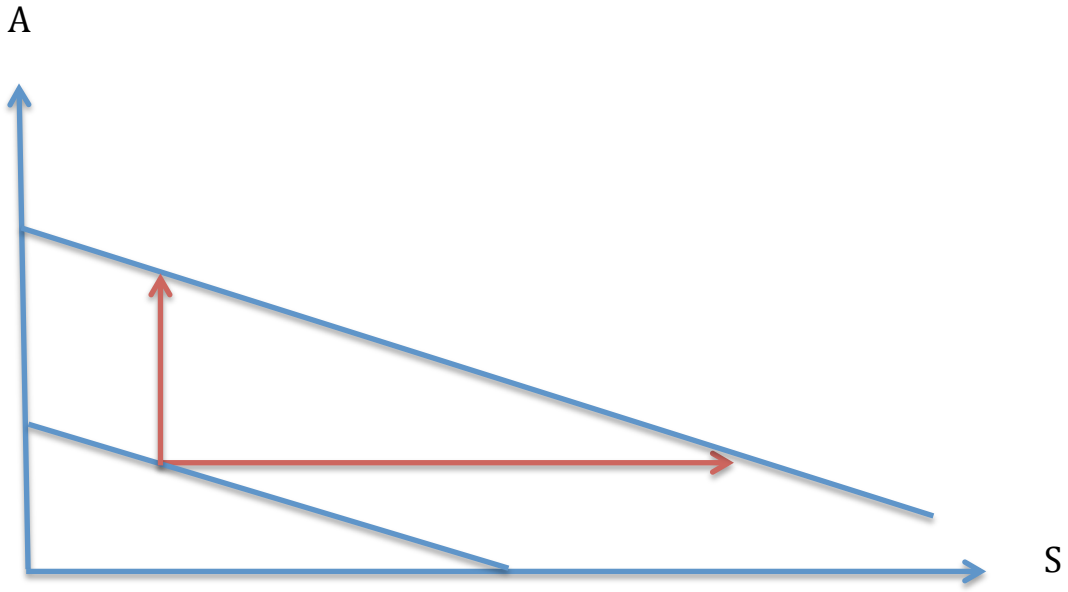

Figure 3: Individual budget constraints for neighborhoods with higher implicit cost of school quality versus air quality.

As compared to Figure 3, Figure 2 shows a higher relative price of schooling. We might expect the relaxation of the budget constraint to result in a stronger move from air quality in housing markets depicted in Figure 2 than depicted in Figure 3, and vice versa.

ii. Choice of Housing Attributes

In order to examine the amount of housing attributes people choose if their budget constraints shift out, I regress house attribute on loan amount. Instead of interpreting the estimated coefficient from this regression directly, I use them to calculate the income elasticity of loan amount. This makes it easier to compare the sensitivity of the response across race groups. Table 2 shows the results for each race.

$$AirQuality = \beta_0 + \beta_1(ApplicantIncome) + \beta_2(Loan) \ldots + \mathrm{E}_i \quad (2)$$

The derivative with respect to loan, the effect of loan amount on air quality, is equal to β_2. The value of β_2 is the effect of increasing loan amount while holding income constant. I calculate the elasticity of each good with respect to loan amount by multiplying β_2 by the quotient of average loan amount and average air quality/school quality/public safety for each race. I expect the elasticity of air quality with respect to loan amount to be greater for minorities. The size of the estimated coefficient will be influenced by the average loan size and average air quality faced by the two groups, so it might not be a perfect measure of sensitivity. In order to see evidence of the old wealth constraints causing minorities to consume less air quality, these income elasticities would have to be larger for minorities than for whites. That is, a 1% increase in loan amount leads to a much larger percentage increase in air quality for minorities than for whites.

V. Results & Discussion

In this section, I present the findings on the three hedonic regressions I ran to determine whether the coefficient on loan amount is significant for minorities. First, I regress the rental rate of the house on different house attributes to see what the implicit prices of each house attribute are for the four different races. Then I look to see how choices vary as borrowing costs change due to reduced credit constraints. I expect to see separate hedonic results for the different races due to potential segregation in the housing market driven by a preference of people to live in racially homogenous areas.

i. Hedonic Regression

Table 2 gives the results for the hedonic price regression in equation (1).

Table 2: Hedonic prices for House Attributes

	Hispanic	Black	Asian	White
air quality	0.080	0.145	0.544	0.692
	(6.76)**	(4.56)**	(19.47)**	(23.63)**
school quality HS	0.011	0.010	0.027	0.037
	(33.58)**	(13.80)**	(50.93)**	(78.52)**
public safety	0.024	0.017	-0.087	-0.251
	(8.97)**	(1.75)	(13.38)**	(51.59)**
House Square Footage	0.008	0.009	0.009	0.007
	(175.94)**	(91.97)**	(175.93)**	(210.33)**
_cons	-1.756	-4.032	-7.934	1.003
	(5.93)**	(4.51)**	(11.05)**	(1.54)
R^2	0.24	0.30	0.35	0.25
N	128,663	24,482	70,199	171,729
P_S/P_A §	0.1375	0.0690	0.0496	0.0535
	(41.24)	(17.85)	(315.76)	(474.70)
P_S/P_{PS}	0.4583	0.5882	-0.3103	-0.1474
	(65.57)	(2.76)	(207.27)	(3,048.98)
P_S/P_{SF}	1.3750	1.1111	3.0000	5.2857
	(1,008.37)	(177.32)	(2,281.19)	(5,026.92)

*p<0.05; ** p<0.01

§ The ratios give the slope of the household budget constraint, F-statistics given in parentheses.

The coefficients demonstrate willingness to pay (demand) for each good by race. The results suggest that on average, air quality is cheaper for minorities than whites. I calculate the slope of the budget constraint between the different neighborhood attributes to get the implicit price of one good in terms of another good, and to derive the slope of the budget constraints. If one good is relatively more costly than another good, that could explain why a certain race has lower demand for the costlier good. The last two rows of Table 2 show the estimated slopes of the household budget constraints in terms of air quality relative to school quality, public safety relative to school quality, and House Square Footage relative to school quality. According to the slope values, on average, whites face a lower price of school quality relative to air quality compared to other races. On average, minorities face a lower price of air quality relative to school quality.

ii. Effect of Loan Amount on Housing Attribute Choice

This subsection displays the results from four separate regressions where air quality, school quality, public safety, and finally housing services are regressed on applicant income and loan amount to determine sensitivity of demand with respect to loan amount. I use the estimated coefficients from these results to calculate the elasticity of the loan amount for each race. The elasticity results can be found in Table 6 below.

Table 3 shows the results from the regression specified by equation (2).

Table 3: school quality (API Scores) regressed on Income and Loan Amount

Race	Hispanic	Black	Asian	White
Income	15.462e-2	9.848e-2	0.388e-2	2.896e-2
	(23.85)**	(6.75)**	(0.57)	(8.40)**
Loan Amount	11.896e-5	13.852e-5	13.690e-5	9.468e-5
	(36.89)**	(19.23)**	(40.37)**	(55.66)**
_cons	537.642	528.084	597.619	612.865
	(1,027.57)**	(439.81)**	(850.75)**	(1,598.10)**
R^2	0.05	0.05	0.04	0.04
N	130,509	25,650	71,777	180,811

*p<0.05; ** p<0.01

Holding income fixed, increasing loan amount by one hundred thousand dollars leads to an increase of 11.896 units in the average API score of the schools chosen by Hispanics, 13.852 units in the average API score of the schools chosen by blacks, 13.690 units in the average API score of the schools chosen by Asians, and 9.468 units in the average API score of the schools chosen by whites.

Table 4 shows the results from the regression in equation (2).

Table 4: air quality regressed on Income and Loan Amount

Race	Hispanic	Black	Asian	White
Income	2.738e-3	2.456 e-3	1.004 e-3	0.773 e-3
	(16.02)**	(7.82)**	(8.37)**	(15.74)**
Loan Amount	0.133e-5	0.097e-5	0.102e-5	0.057e-5
	(15.64)**	(6.24)**	(17.08)**	(23.48)**
_cons	17.422	17.624	17.994	18.390
	(1,263.12)**	(681.29)**	(1,448.34)**	(3,364.36)**
R^2	0.01	0.01	0.01	0.01
N	130,509	25,650	71,777	180,811

*p<0.05; ** p<0.01

Holding income fixed, a one hundred thousand dollar increase in the loan amount leads to a decrease of 0.133 units in the average number of TRI sites chosen by Hispanics, a decrease of 0.097 units in the average number of TRI sites chosen by blacks, a decrease of 0.102 units in the average number of TRI sites chosen by Asians, and a decrease of 0.057 units in the average number of TRI sites chosen by whites.

Table 5 shows the results from the regression in equation (2).

Table 5: Public Safety regressed on Income and Loan Amount

Race	Hispanic	Black	Asian	White
Income	0.626	0.390	-0.505	-0.363
	(8.10)**	(3.37)**	(8.73)**	(10.60)**
Loan Amount	0.799e-3	0.835e-3	0.615e-3	0.181e-3
	(20.79)**	(14.62)**	(21.24)**	(10.69)**
_cons	8,765.866	8,635.777	9,146.444	9,184.669
	(1,408.16)**	(916.08)**	(1,531.12)**	(2,418.12)**
R^2	0.01	0.03	0.01	0.00
N	128,663	24,482	70,199	171,729

*p<0.05; ** p<0.01

Holding income fixed, a one thousand dollar increase in the loan amount leads to a decrease of 0.799 units of the average property crime rate chosen by Hispanics, a decrease of 0.853 units of the average property crime rate chosen by blacks, a decrease of 0.615 units of the average property crime rate chosen by Asians, and a decrease of 0.181 units of the average property crime rate chosen by whites.

Table 6 shows the results from the regression in equation (2).

Table 6: Housing Services Index regressed on Income and Loan Amount

Race	Hispanic	Black	Asian	White
Income	0.145e-3	0.039e-3	0.097e-3	0.170e-3
	(10.43)**	(1.25)	(3.62)**	(14.61)**
Loan Amount	0.092e-5	0.114e-5	0.105e-5	0.094e-5
	(134.12)**	(75.10)**	(78.53)**	(165.04)**
_cons	0.246	0.231	0.270	0.272
	(219.54)**	(91.22)**	(97.12)**	(211.09)**
R^2	0.24	0.33	0.15	0.25
N	130,506	25,642	71,756	180,747

*p<0.05; ** p<0.01

Holding income fixed, a one hundred thousand dollar increase in the loan amount leads to an decrease of 0.092 units of the housing services index chosen by Hispanics, a decrease of 0.114 units of the housing services index chosen by blacks, a decrease of 0.105 units of the housing services index chosen by Asians, and a decrease of 0.094 units of the housing services index chosen by whites.

Table 7 shows the calculated elasticities with respect to loan amount.

Table 7: Elasticity[2] of New Loan Amount, by race

	Hispanic	Black	Asian	White
Air Quality	0.0156[3]	0.0115	0.0142	0.0083
School Quality	0.0434	0.0522	0.0552	0.0398
Public Safety	0.0187	0.0202	0.0170	0.0053
Housing Services	0.0427	0.0509	0.0488	0.0464

[2] Elasticity= Estimated Coefficient on Loan Amount for Hispanics* (average of loan amount for Hispanic/average of air quality/school quality/public safety for Hispanics)
[3] 0.0156 = 0.133*(2.098/17.93)

Holding income fixed, a 1% increase in the loan amount leads to a 1.56% change in air quality chosen by Hispanics, a 1.15% change in the air quality chosen by blacks, a 1.42% in the air quality chosen by Asians, and a 0.83% change in the air quality chosen by whites. Holding income fixed, increasing loan amount by 1% leads to an 4.34% change in the amount of school quality chosen by Hispanics, a 5.22% change in the amount of school quality chosen by blacks, a 5.52% change in the amount of school quality chosen by Asians and a 3.98% change in the amount of school quality chosen by whites. Holding income fixed, a 1% increase in the loan amount leads to a 1.87% change in public safety chosen for Hispanics, a 2.02% change in public safety for blacks, a 1.70% change in public safety for Asians, and a 0.53% change in public safety for whites. Holding income fixed, a 1% increase in the loan amount leads to a 4.27% change in housing services chosen for Hispanics, a 5.09% change in housing services for blacks, a 4.88% change in housing services for Asians, and a 4.64% change in housing services for whites.

The three minority groups have more elastic responses than whites to the size of the loan, holding income fixed, for all four House Attributes. Assuming people have the same preferences for air quality, it can be concluded that minorities generally have smaller loans and live in more polluted areas, but would not prefer to do so. With regards to housing services, whites and Hispanics spend about the same amount of their increased income on housing services, but Blacks and Asians spend quite a bit more than them. One reason for this could be that minorities are generally much more constrained in the housing market, so when the credit constraints are relaxed, they buy more of everything. Whites, on the other hand, buy less house related products, perhaps because they already live in well-endowed houses and therefore choose to save the increased income or spend it elsewhere. Most likely, whites were initially less credit constrained than minorities and

probably already living in a house with good housing services so they had a lower demand for these goods once capital constraints were relaxed. Minorities were most likely more credit constrained and subsequently in neighborhoods with worse housing services than whites to begin with, so they demanded more of the every good when credit constraints were relaxed.

Why are certain house attributes relatively more or less expensive for different race groups? One explanation could be that different groups choose from different sets of houses because they want to live in racially homogenous neighborhoods. If we assume certain race groups prefer to assimilate in neighborhoods of the same race, Figure 3 could be an example of the budget constraint for an individual in a Hispanic neighborhood. Even if this individual's budget constraint shifts out, there wouldn't be much change in their quantity of school quality. If we also assume that everyone has the same preferences for air quality, one explanation for why Hispanics aren't choosing a house with better air quality is because they aren't being shown nicer houses in white or Asian neighborhoods.

VI. Conclusion

This study explores the role of wealth constraints in the housing market by examining individual sorting behavior to evaluate whether minorities are income-constrained in their choices of environmental amenities. In addition, the study aims to determine whether minorities change their decisions with regards to housing attributes when constraints are loosened.

From an environmental justice point of view, this paper looks at whether minorities are more likely to move away from pollution sources when they can do so with a larger loan. The present paper finds that as wealth constraints were eased between 1999

and 2007, when loan amounts increased over time for people with the same income, people moved to houses in less polluted areas.

With respect to the environmental amenities, minorities face a relatively lower price of air quality on average. An increase in the loan amount leads to greater decreases in the average number of TRI sites chosen by minorities, holding incomes fixed. Furthermore, minorities had more elastic responses to loan amount with respect to air quality. Assuming people have the same preferences for air quality, it can be concluded that minorities generally have smaller loans and live in more polluted areas, but would not prefer to do so.

When credit constraints are relaxed, all four races buy larger houses, with less pollution, and better schools. However, controlling for income and the size of the loan, minorities tend to buy more of each good. Holding the size of the increase the same, the minority groups pour more of the additional income into house attributes.

While this paper focused on various effects on environmental choices by race, future research might look more into how the effects of wealth constraints on choices of environmental amenities may differ by income. Preliminary explorations into the income variables suggested that there were significant differences for high-income individuals, but not for low-income individuals. An explanation for this could be that there is a base level of income that individuals must have in order to benefit from changes in credit conditions. Additionally, future research could look to see whether the same results hold in different cities and states.

Overall, the results from this paper suggest that people of color care about environmental quality but, due to wealth constraints, do not have the same opportunities in the housing market. Traditional environmental justice theories claim that distributions of

toxic, hazardous and dangerous waste facilities are disproportionately located in low-income communities of color. This suggests that low-income communities of color lack the political clout to prevent harmful, polluting facilities from being too close to their homes. The present paper, however, contributes an alternative cause of environmental injustice: low-income minorities are less likely to receive loans that are sizeable enough to buy a house in a cleaner area. This paper can help policy makers and stakeholders understand the reasons why different racial groups have different housing opportunities (i.e. implicit prices of some house attributes are relatively more expensive for minorities). With this knowledge, policy makers can be better equipped to enact policy that enhances equal opportunity of living in clean, less polluted environments for all racial groups.

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