Why Do Blacks Live in The Cities and Whites Live in the Suburbs?

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Abstract

This paper estimates a discrete choice model of housing product demand to study the causes of black urbanization. Our estimation strategy incorporates that there are unobserved product attributes which are correlated with observed product attributes. We bound racial differences in household willingness to pay for product attributes without implementing an instrumental variables strategy. Thus, we relax a number of assumptions implicit in "hedonic two step" housing research. Our primary explanation for excess black urbanization focuses on the disutility from commuting and the bundling of housing and labor markets.

1 Introduction

Over 75% of households in the United States live in metropolitan areas. While the average middle class white household lives in the suburbs, the average middle class African-American household lives in the center city. In 1990, a black household was 31 percentage points more likely than a white household to live in a metropolitan area's center city.

Why do blacks live in cities and whites live in the suburbs? One explanation is tied to income inequality. On average, blacks have lower incomes and may lack the resources to move into suburbia's larger, newer homes. A second hypothesis is that whites have a higher willingness to pay to live with other whites than blacks have to live with whites. Given that white households have always been over-represented in the suburbs, this emergent community attribute may be a magnet for encouraging further white migration. A third hypothesis is tied to place of work and the disutility from commuting. If minority household employment is disproportionately located in center cities and if the disutility from commuting is high, then this provides an incentive to live in the center city. A fourth hypothesis is that whites and blacks have different preferences over housing structure. The housing stock in the suburbs is newer. A

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final hypothesis is that blacks and whites have different preferences over local public goods such as avoiding poverty.[2]

To understand the causes of black urbanization and white suburbanization, we need to model housing demand. In choosing a housing product within a metropolitan area, a household simultaneously chooses a structure, a community, a commuting time to work and one's tenure status as a renter or an owner. Modeling the choice of this bundled commodity is so challenging that previous researchers have divided this problem into independent pieces. Some studies focus on tenure choice while others focus solely on community choice. We view this as a mistake because a household makes its optimal housing choice facing a budget constraint and will consider the trade-offs associated with each housing product. For example, not all housing structures are available in each community, thus a household who wants a shorter commute may have to settle for a smaller house or a rental unit in a worse community.

Hedonics and discrete choice methods have been the two leading approaches for identifying willingness to pay for housing attributes. Building on Rosen's (1974) framework, housing researchers have used hedonic techniques to estimate the marginal price of housing attributes. A few papers have attempted to estimate a "second stage" to identify structural demand parameters (Palmquist 1984, Coulson and Bond 1990, Cheshire and Sheppard 1998, and Gyourko and Voith 2000). Discrete choice methods offer an alternative method for measuring demand parameters. Quigley (1985) estimates a nested logit model in which households choose a community and then choose a housing structure in that community. Our work is most closely related to that of Nechyba and Strauss and Bayer. Necheyba and Strauss (1998) study community choice in New Jersey to measure the demand for schools and Bayer (2000) estimates a discrete locational choice model to study school demand in California.

Within the typical metropolitan area, there are millions of homes. There are too many products to estimate a discrete choice model where households choose among individual homes. This paper uses hedonics to assign similar homes the same "product type". This approach allows us to reduce the dimensionality of the housing choice problem down to the simpler problem of households choosing between 272 housing products. For recent migrants within the Philadelphia metropolitan area in 1990, we estimate a discrete choice model to recover structural housing demand parameters over tenure status, commuting time, structure type and community.

The approach we follow in this paper resolves several important econometric problems faced in previous studies of

[2] We recognize that another hypothesis is that black households seeking suburban housing products are discriminated against (Yinger 1986, Munnell et. al. 1996). Detecting and accounting for perceived or actual discrimination is a daunting task that is beyond the scope of this paper (Heckman 1998).

housing product demand. First, the price of a housing unit will be correlated with unobserved (to the econometrician) attributes of the home. Standard discrete choice approaches, such as the well known conditional logit, that treat the housing price as uncorrelated with the error term will yield a downward biased estimate of the price elasticity of the demand for housing. Product level fixed effects are included to control for unobserved community and structure attributes. Second, we propose a new approach for estimating racial differences in willingness to pay for product attributes that weakens standard identification assumptions. Empirical differentiated product demand models require a set of instruments that are correlated with observed product characteristics and uncorrelated with unobserved product characteristics (Berry, Levinsohn and Pakes (1995)). In practice, these instruments may not exist. We show how to calculate a set of bounds for the difference between black and white willingness to pay for product characteristics without specifying a set of instruments.

A third contribution of our study is to incorporate the existence of "Edge City" employment centers when estimating the disutility from commuting. Across the United States, employment is suburbanizing (Garreau 1992 Small and Song 1994). The rise of suburban "Edge Cities" means that many suburban residents no longer face a long commute to work. In an economy where all employment is concentrated in a single employment center, all households will face the same commuting trade-off when considering any suburban housing product. We exploit the population variation in place of work in order to provide new estimates of commuter value of time. Since households differ with respect to place of work, we can estimate residential product specific fixed effects and still measure willingness to pay to avoid commuting. Accounting for the fact that households with the same preferences may value the same housing product differently, because their place of work differs, distinguishes our study from other equilibrium locational choice papers based on aggregate community data such as Epple and Sieg (1999).

We use our model's estimates to simulate how suburbanization rates change as we conduct counter-factual experiments. Household income differentials do not explain suburbanization differentials. Both blacks and whites are willing to pay to avoid commuting. Since blacks tend to work in occupations and industries that are over-represented in the center city, these commute minimizers are likely to urbanize. Our simulations indicate that black residential suburbanization rates would rise sharply if these households held suburban jobs.

In the next section, we layout our discrete choice model of housing demand. We then outline what data we use to estimate the model. To prepare the groundwork for the paper's structural model, we present detailed descriptive statistics concerning our sample's demographics and a description of the types of housing products that different households purchase. We report hedonic housing regressions and use the estimated index weights to construct 272 housing products. The structural model of housing choice is presented and its estimates are fully discussed. In the last section, we use these estimates to test alternative explanations for racial difference in locational choice.

2 A Model of Housing Demand

In this section, we build a model of housing demand for households choosing a product within a metropolitan area. Our econometric modeling strategy is motivated by several fundamental empirical concerns. Both housing units and households are heterogeneous in important ways. In our analysis, we take account of several dimensions along which housing products may be differentiated. The first is the physical attributes of the housing product such as the number of rooms, bedrooms and the unit's age. Second, houses differ by location. Neighborhoods have important attributes that need to be included in a model of housing demand. Third, some housing units are owned while others are rented.

Both our approach and the hedonic "two step" (see Epple 1987) have the common goal of recovering willingness to pay for various attributes of a home. However, a key problem for hedonics is that many of the attributes of a housing unit and its community are typically unobserved by the econometrician. In our econometric analysis, we address this problem by estimating product level fixed effects. Prices will be correlated with unobserved product attributes for the simple reason that higher quality commands a higher price in the market place. If the researcher omits product level fixed effects, she will underestimate own price elasticities. This has been documented in recent empirical work by Petrin (1999) in his study of demand for minivans, Nevo (2000) in his study of demand for breakfast cereals and in Berry, Levinsohn and Pakes (1995) in their study of automobile demand. In all three cases, price elasticities are underestimated by an order of magnitude when the econometrician fails to account for unobserved product level heterogeneity.[3]

2.1 An Econometric Model.

The primitives of the model are household preferences, demographics and product characteristics. The econometrician is assumed to observe both individual purchase decisions and demographic traits. The conditional indirect utility function of a consumer depends on the observed and unobserved product attributes, household demographics and models parameters. There are $i = 1, ..., I$ households and $j = 1, ..., J$ housing products products. Formally, we write a household's utility function as $U(x_j, \xi_j, p_j, d_i, \varepsilon_{ij}; \theta)$. The vector x_j is a $k \times 1$ vector of observed characteristics of product j and ξ_j is a product fixed effect. For each product j there is a unique parameter ξ_j that estimates the utility

[3] Not surprisingly, in our earlier models of housing demand without product level fixed effects, we found that the households' sentivitiy to prices was an order of maginitude lower than the specification studied in this paper.

from the unobservable attributes of the product. Throughout this paper we assume that the housing market hedonic price equilibrium is such that supply equals demand for each product.

The price of product j is p_j, the individual's demographic chracterstics are d_i which are assumed to be observable to the econometrician, ε_{ij} is a disturbance to the consumer's decision making that is drawn independently for each i and j and θ is a vector of parameters.

The data used in estimating the model are:

x_j : Is a 4 by 1 vector of observable characteristics of product j.

- The unit's structure index measured in dollars, $sindex_j$.
- The percentage of head of households who are black in the community associated with the j^{th} product, $mblack_j$.
- The percentage of head of households who are college educated in the community associated with the jth product, mba_j .
- An indicator variable for whether the product is owned or rented, own_j.

d_i : Is a 4 by 1 vector of demographics characteristics of household i.

- An indicator variable for whether or not the head of household is white, $white_i$.
- The number of people in household i, $person_i$.
- The income of household i, $income_i$.
- The age of the head of household i, age_i.

$comm_{ij}$: The commute time of household i to product j, taking the household head's place of work as given.

The utility function used in this research is of the form:

$$u_{ij} = \xi_j + \beta_1 \log(income_i - price_j) + f(x_j, income_i - p_j, comm_{ij}, d, \pi) + \varepsilon_{ij} \tag{2.1}$$

In the specification we use, we allow an agent's marginal utility to depend on observed demographic characteristics of household i through the function $f(x_j, income_i - p_j, comm_{ij}, d_i, \pi)$. The arguments of f include all of the characteristics of home j, x_j, household i's consumption of a composite commodity, $income_i - p_j$, the commute time of household i to housing product j and household i's demographic characteristics d_i. We let π denote a vector of parameters.

One possible model of $f(x_j, income_i - p_j, comm_{ij}, d, \pi)$ is:

$$f(x_j, income_i - p_j, comm_{ij}, d, \pi) = \pi_1' * x_j + \pi_2' * x_j * d_j + \pi_3' * (income_i - p_j) * d_j + \pi_4' * comm_{ij} * d_i \quad (2.2)$$

Where $\pi_1, \pi_2, \pi_3, \pi_4$ each are a row vector of parameters. Clearly, this model will not be identified since $\pi_1' * x_j$ will be co-linear with ξ_j. Instead, we will use the following model for f:

$$f(x_j, income_i - p_j, comm_{ij}, d, \pi) = \pi_2' * x_j * d_j + \pi_3' * (income_i - p_j) * d_j + \pi_4' * comm_{ij} * d_i \quad (2.3)$$

Clearly, we no longer have a co-linearity problem with ξ_j and in our application our model will therefore be identified. The term f therefore models the relationship between marginal utilities and demographic variables. This brings up a subtle point, the product intercept, ξ_j should now be thought of as representing two terms. The first is the levels of the utility function in the product characteristics, that is $\pi_1' * x_j$ from equation (2.2) and the second are other product characteristics that are unobserved to the econometrician. A more detailed version of the utility function can be found in Appendix One.

The advantage of the specification used in this research is we are able to estimate the consumer's utility for each product, accounting for both observed and unobserved characteristics using an extremely flexible specification. The empirical specification we use will be extremely flexible, we have nearly 300 parameters including a full set of demographic interactions with the observed product characteristics.

Also, in our specification we do not need to find instruments for the unobserved product characteristic as in many other discrete choice papers such as Berry, Levinsohn, and Pakes (1995), Nevo (2000), Petrin (2000), Bayer (2000) among others. We believe in our application it would be difficult to construct variables that are correlated with observed product characteristics but uncorrelated with unobserved product characteristics. However, failing to use instruments comes at a price, we will not be able to separately identify the level of the utility function in the x_j from the utility derived from unobserved product characteristics.

The main identifying assumption of our model is that ε_{ij} is independent of the other right hand side variables in equation (2.1). There of course, may be reasons why this assumption is violated. However, our identifying assumptions are weaker than much of what has been used in the previous discrete choice literature. Much of the previous work in modeling housing demand and locational choice, such as Palmquist (1985) fails to account for unobserved product characteristics. Implicitly, this previous literature has assume that unobserved product characteristics are orthogonal to observed characteristics. This is probably very far from correct in practice.

A household's utility is a function of unobserved product characteristics and the interaction of observed product attributes with household level demographics. In our discrete choice model, we incorporate a simple version of a budget constraint. Household i is assumed only to be able to choose those products j for which the ratio $\frac{p_j}{income_i} < .5$. We work with household income net of taxes (assumed to be 26%). This cut-off point is roughly in line with practices by mortgage companies as well as it appears to be a reasonable cut-off point for a budget constraint since this represents the 90^{th} percentile of the empirical distribution of housing expenditure as a percentage of income.[4] Let $J(i)$ denote the set of products that are affordable for household i.

It is important to note that we have modeled a household's income without subscripting it by the product the household has chosen. This paper does not explicitly model a household head's choice of place of work. In our analysis, we take the place of work to be an exogenous variable. At first, this might seem very objectionable, since many households might choose a place of residence before a place of work or choose a place of work and residence simultaneously. We will argue, however, that our analysis is compatible with both of these cases.

First consider the case where a household simultaneously chooses a place of work and a place of residence. If the household is a utility maximizer, it must be the case that holding place of work fixed (at its maximized value!), the observed choice of place of residence must be utility maximizing. Therefore, an alternative interpretation of equation (2.1) is that the household is simultaneously choosing a place of work and a place of residence, but we are working only with the necessary condition for maximization that implies holding the utility maximizing place of work fixed, the place of residence must be maximizing. Second, consider the case that the household chooses a place of residence first and second chooses a place of work. If the household was endowed with perfect foresight, it would then be the case that the joint choice of residence and work is equivalent to a simultaneous choice of residence and work.

Unfortunately, our argument could break down if the household faces fixed adjustment cost and non-trivial uncertainty. Consider a scenario where the household chooses the place of residence first and the place of work second. However, before choosing the place of work, the household learns some new information about the community, for instance, whether the head of household likes his neighbors. If it is also the case that it is expensive for the household to move, it would no longer always be the case that holding the place of work fixed, the place of residence is utility maximizing. However, we see no feasible way to deal with this additional complication given the available data.

[4] Observations that do not satisfy this contraint are excluded in the estimation.

Also, we believe that labor markets and housing markets are bundled and it is important to consider this aspect of housing choice.

For identification purposes we normalized $\xi_1 = 0$ and we make an assumption that ε_{ij} comes from a Weibull distribution with cumulative distribution function $F(\varepsilon_{ij}) = \exp(e^{-\varepsilon_{ij}})$. In our model, we do not include an outside good, so we must make an alternative normalization of the utility function for identification.

Define $\widehat{u}_{ij}(x_j, \xi_j, p_j, d_i, \varepsilon_{ij}; \theta) = u_{ij}(x_j, \xi_j, p_j, d_i, \varepsilon_{ij}; \theta) - u_{i1}(x_1, \xi 1, p_1, d_i, \varepsilon_{ij}; \theta)$. Let $I(i,j)$ be an indicator variable for the event that household i chooses product j. The probability that household i chooses product j is $P(I(i,j) = 1|x, \zeta, p, d_i))$ is then:

$$P(I(i,j)) = \frac{\exp(\widehat{u}_{ij}(x_j, \xi_j, p_j, d_i, \varepsilon_{ij}; \theta))}{\sum_{k \in J(i)} \exp(\widehat{u}_{ik}(x_k, \xi_k, p_k, d_i, \varepsilon_{ij}; \theta))}$$

To form the full likelihood function, we will also incorporate the census weights associated with each household into the analysis. Let cen_i be the census weight associated with household i. Let $L(I; x, \zeta, p, d, cen)$ be the likelihood function for the observed choices, that is, I is the vector of all observed choices, x is the vector of observed product characteristics for all products, ζ is the vector of all product level fixed effects, p is a vector of all prices for all products and d is the vector of all household level demographics. The likelihood function then satisfies:

$$L(I; x, \zeta, p, d_i, cen) = \prod_i P(I(i,j))^{cen_i}$$

The model parameters are estimated using maximum likelihood.[5]

Our econometric framework is an extension of a standard multinomial logit model where we allow for interactions between housing, community and commute time with household level demographics. Unlike the multinomial logit model, however, the restrictive substitution patterns implied by the independence of irrelevant alternatives do not hold in the aggregate for our model.[6] In our econometric model, a home is a combination of six attributes: a value of $sindex$, mba, $mblack$, own and ξ as well as $price$. Unlike some previous studies which aggregate housing consumption into a single index, our model allows for multiple dimensions along which homes may differ. Since there is a full set of demographic interactions, our econometric model allows us to explore how different demographic groups match to heterogenous housing units. We use our structural estimates to predict locational patterns for white and black households under different counter-factuals.

[5] The estimation algorithm was coded by the researchers in Fortran. The researchers used the IMSL library's numerical optimization proceedures to find the parameter values used. The sources code is available from the authors upon request.

[6] This is because we include demographic interactions in our model. Therefore, the ratio of the probability that any two choices are made does depend on the set of available alternatives. Thus independence of irrelevant alternative fails.

3 Data

The raw data used in our empirical analysis comes from the 1990 Census of Population and Housing micro data (the 5% sample) for the Philadelphia metropolitan area. Philadelphia is an attractive area to study. It is one of the largest metropolitan areas in the nation (ranked 4th in population in 1990). The Philadelphia metropolitan area has an older housing stock. Only 12.9 percent of the housing stock was built between the years of 1980 and 1990. Thus, the stock of housing is largely predetermined. This greatly simplifies the econometric analysis because the supply of housing should be modeled together simultaneously with demand. Viewing the housing stock as exogenous is a less dangerous assumption in an area such as Philadelphia versus a sprawling area such as Phoenix or Las Vegas. Philadelphia is also an important area to study because like all older areas there has been great concern about center city decline, and continued high levels of racial segregation (Mieszkowski and Mills 1993, Massey and Denton 1993).

In Figure One, we document the spatial separation of blacks and whites in Philadelphia. Figure One shows that in 1990, the median black resident of the Philadelphia metropolitan area lived within 3 miles of this area's Central Business District while the median white resident and the median employee was located 12 miles from the CBD.[7]

Philadelphia is large enough such that public use Census data identifies 34 different communities and 14 different employment centers within the metropolitan area. Community is determined by Census geographic identifiers called Public Use Micro Areas (PUMAs). There are 34 PUMAs within the Philadelphia MSA and 11 PUMAs in the center city. In most cases, PUMA boundaries were defined for the Census by State government. While PUMAs generally are aggregations of census tracts and urban places, they do not reflect the boundaries of political jurisdictions. PUMAs are intended to be similar areas containing 100,000 people or more. Using the PUMA identifiers, we aggregate the micro data to form summary statistics such as a PUMA's percent college graduates, or the PUMA's share of residents who are black. A community's attributes are an emergent property of the set of households who choose to live within its borders. If all college graduates demand to live in a given PUMA, then this PUMA will feature high levels of college graduate rates. In our analysis we assume that migrants take as given such community attributes as "percent college graduate" and "percent black". Community attributes are based on the attributes of all households, not just migrants, within the PUMA.

There may be significant "community" variation within these PUMAs. To study this issue, we use census tract level data to study "within PUMA heterogeneity". Census tracts contain roughly 2000 people. Figure Two shows

[7] The data sources are the 1990 Census zip code and the 1996 Zip code employment data sets (see Glaeser and Kahn 2000).

a histogram of the racial composition of census tracts. Note that there are a larger number of census tracts where no blacks live and a relatively large number of census tracts whose population is over 90% black. The 34 PUMAs do explain a significant fraction of the variation across census tracts. Running a OLS regression of a census tract's percentage black for 992 census tracts in the Philadelphia MSA on the 34 PUMA fixed effects yields an R2=.59. A regression of tract median home price on these 34 PUMA fixed effects yields an R2=.52. PUMAs are clusters of "similar" areas.

One final reason for studying Philadelphia is that housing is cheap. The median 1990 home price in the metropolitan area was \$95,000 and the median prices in its center city and suburbs were \$47,500 and \$112,500 respectively. While Census data has many strengths, information on wealth and savings are not available. In a more expensive area, such as Los Angeles, downpayment constraints might reduce access to owner occupied housing for the young and minorities (Duca and Rosenthal 1994). There is considerably less top coding of housing prices in Philadelphia compared to more expensive cities such as Los Angeles or San Francisco. None of Philadelphia's apartments are rent controlled (AHS 1997). This is important because 1990 Census data does not indicate rent control status.[8]

This study focuses on the housing choices of households who switched homes between 1985 and 1990. These migrants represent 37% of the 1990 Philadelphia population. We choose to focus on the decisions of migrants for two reasons. First, incumbent households solve a decision problem that is distinct from the problem faced by recent movers. Incumbents must choose whether to incur the transaction cost of moving out of their current unit and sacrificing the social networks they have built up in their community. Second, including all residents in the same model would suffer from the reflection problem discussed by Manski (1993) because the utility of all of the residents depends on externalities generated through neighborhood effects. Recent movers, on the other hand, can take the production of local public goods as pre-determined.

In Table One, we present some sample average for all black and white heads of households and for black and white migrants who have switched homes in the last five years. Relative to the stock of all black households, black migrants are more educated, less likely to be home owners, younger and spending more on housing. Black migrants are 8 percentage points less likely to live in the center city and 3 percentage points less likely to work in the center city. White migrants spend more on housing than the average white household and white migrant owners spend much than black migrant owners in annual housing expenditure. Annual housing expenditure for owners is defined

[8] If a housing researcher wanted to estimate our model using New York City data, he would mistakenly infer that some apartments must have low unobserved quality because their prices are low. Such an equilibrium researcher would have ignored that New York City rent control laws lead to excess demand.

as one's reported home price multiplied by 7.5%. White migrants have household incomes that are $20,000 higher on average than black migrants. White migrants are twice as likely as black migrants to have a college education, and are much more likely to be married and to be a home owner. While white and black migrants are the same age, white migrants are much less likely to have children under the age of 18 present in the household. A large majority of white households and white migrants both live and work in the suburbs.

To provide some details about black migrant's structure and locational choices, in Table Two we report average consumption statistics broken out by household income levels. Household income is divided into three groups; poor (less than $25,000), middle class (between $25,000 and $40,000) and rich (greater than $40,000). Richer households are more likely to live in the suburbs (Margo 1992). The probability that a poor black household lives in the center city is 70% while the probability that a rich household chooses a center city location is 48%. Ownership is a normal good. The rich black migrant's probability of owning is 37 percentage points higher than the poor black migrant's probability. As would be expected, richer households purchase larger and newer housing structures. Richer households are also more likely to work in the suburbs but this slope is not steep. A majority of rich black migrant household heads work in the center city. The last three rows of Table Two report how community attribute consumption changes with household income. Richer black households move to communities that on average are 33% black while poor households move to communities that are 46% black. While exposure to college graduates rises within income, the slope is not steep. Average commute times actually rise with income. It is possible that as household income grows, more black migrants choose to live in the suburbs and commute longer to center city jobs.

Table Three is identical to Table Two except for in this case white migrant consumption patterns are reported. The rich/poor white home ownership differential of 49 percentage points is larger than the rich/poor black differential. The propensity to live in the center city falls sharply with income while the probability of working in the center city only falls slightly with income. Poor black and white migrants consume similar structures as measured by rooms and bedrooms but whites live in newer housing. The average poor white household lives in a community that is 13.8% black while the average rich white lives in a community that is 8.2% black. Unlike black households, white migrant commute times rise sharply with income such that the rich white households commute 5.5 minutes more each way than poor white households.

Measuring willingness to pay to avoid commuting is one goal of this paper. Both black and white migrants are more likely to live in the suburbs when they work in the suburbs. Table Four reports two place of residence, place of work cross-tabulations for white and black migrants. Over 50% of black migrants live and work in the center city while 30% of the black migrants live and work in the suburbs. 64% of white migrants live and work in the Philadelphia suburbs. Table Four also shows that over 50% of black migrants who work in the suburbs live in the suburbs.

The community attribute results reported in Tables Two and Three ignore that local public goods are bundled. In our analysis, there are 34 communities in Philadelphia. Some communities feature high levels of black population, high levels of human capital and long commutes, other communities feature low levels of black population and low levels of human capital. Since households must choose to live in one PUMA, they cannot independently construct their "dream bundle" of local public goods. To further investigate black and white migrant locational choice, we estimate conditional logit models where each household chooses which of the 34 PUMAs to move to. In these models reported in Table Five, a PUMAs attributes include a dummy variable indicating whether it is a suburban PUMA, its share of residents who are black, its share of residents who are college graduates and each migrant's commute time to work from that PUMA. A community's share of college graduates is a measure of access to role models and for the presence of good local schools (Rauch 1993).

To measure commute time for each household to each potential location, we use the detailed information provided in the Census data on the place of residence and the place of work for Philadelphia heads of households. The 1990 Census identifies places of work called "POWPUMAS". There are 14 POWPUMAs within the Philadelphia metropolitan area. Taking a working head of household's place of work as given, we calculate what is the sample mean one way commute from every PUMA to that POWPUMA.[9]

A commuter who works in a given POWPUMA will recognize that a PUMA near this POWPUMA offers a shorter commute to his job than other PUMAs while a commuter who works in another POWPUMA will recognize that the same residence features a long commute for him. If all employment was centralized at one Central Business District location, then average commuting times would be the same for all people who choose the same PUMA. Since employment is not fully centralized (see Figure One), two heads of households who are considering the same product in a given PUMA will face different commuting times from that PUMA if they work in different POWPUMAS. If a person does not work, we estimate the average commute time in the whole PUMA which represents a measure of access to the Central Business District.

Commute times differ greatly depending on whether a household lives and works in the center city or whether the household lives and works in the suburbs or if the household commutes between the city and suburbs. The average commute for a household which lives in the city and works in the city is 25.84 while if this household works in the

[9] Given that there are 14 POWPUMAS and 34 PUMAS, we calculate 476 means.

suburbs its average commute is 32.73 minutes. A commuter who lives in the suburbs and works in the city faces the longest average commute of 38.03 while a suburban resident who also works in the suburbs has the shortest average commute of 22.43 minutes.[10]

Table Five reports four separate conditional logit models. Models 1 and 2 are for black migrants and models 3 and 4 are for white migrants. Model 1 is based on all black migrants while model 2 is estimated for the subset of black migrants whose income is greater than $40,000. The coefficient estimates indicate that black migrants and rich black migrants value living in suburbia, living in black communities, and avoiding commuting. To ease the interpretation of the coefficients, the explanatory variables have been scaled by their standard deviations. As shown in model 1, black migrants are attracted to black communities, featuring fewer college graduates and shorter commutes. The magnitude of the coefficients varies greatly. Commute time's impact on locational choice is over 3 times greater than the community's racial composition and is over 20 time the impact of the community's human capital levels. The average white migrant's locational choice is presented in Model 3. Whites move to communities featuring less blacks, more college graduates and featuring shorter commutes. An extra standard deviation of commute time has a greater impact than a two standard deviation reduction in a PUMA percent black residents. Models 2 and 4 present the migration results for wealthy migrants. Both wealthy black and white migrants prefer short commutes and communities with college graduates. Richer black migrants prefer black communities while white migrants prefer white communities. Commuting has a stronger impact on black locational choice than on white locational choice.

To provide a visual display of our data, Maps 1 and 2 report the spatial distribution of where people live and where people work for blacks and whites. The unit of analysis is the census tract and PUMA boundaries are displayed. The distribution of employment is represented by dots such that there are a total of 2000 dots representing 100% of the jobs. An employment center is represented by a cluster of these dots. The maps highlight the concentration of black households and workers in the center city while white households and white workers are much more dispersed.

4 Constructing the 272 Housing Products

The Philadelphia housing market features millions of homes. There are "too many" products for households to choose from. To reduce the dimensionality of the problem, we aggregate similar homes into the same product. Intuitively, two homes located in the same PUMA that have the same tenure status and that feature similar prices and similar

[10] Spatial differences in housheold income by Philadelphia POWPUMA do not differ greatly. In a regression of log household income on household size, and household head's age, education, race, and sex we find that the coefficients on the 13 POWPUMA fixed effects only differ by 12 log points.

structure attributes will be grouped as the "same" product. To group different homes as having similar structure quality, we estimate standard hedonic rental and home price OLS regressions. These regression estimates allow us to predict housing structure consumption (measured in dollars) for each housing unit. If two housing units are located in the same PUMA, have the same tenure status and similar structure indices (measured in dollars), then we group them as the same housing product.

In the Census, rents and home prices are self reported as category variables. We take the midpoint of each category. There is very little top coding of the data in Philadelphia. For example, only 2.4% of apartments and homes in Philadelphia are top coded. The highest rent is $1,000 a month and the highest home price is $400,000. The dependent variable in the rental hedonic is annual rent for a given unit and the dependent variable in the home price regression is the home's reported price multiplied by 7.5% (see Blomquist, Berger and Hoehn 1988 and Gyourko and Tracy 1991 who also follow this convention). In these hedonic regressions, we control for structure attributes and community attributes.

We run separate home price and rental level regressions as a function of structure characteristics and PUMA fixed effects. The regression therefore has the form:

$$\text{Housing Expenditure} = B*\text{Structure} + \text{Puma} + U$$

The structure characteristics include; the type of structure (single detached, single attached, multi-unit dwelling etc.), the year the household moved into the structure, dummy variables to control for the age of the structure, the structure's number of rooms and bedrooms. and 33 PUMA fixed effects.

The hedonic estimates of the 1990 Philadelphia housing and rental regressions are presented in Table Six. The omitted category is a single detached home built after 1985. We have suppressed the estimates for the year the household moved into the unit. The marginal price of an extra room for owners is $1046 and for renters it is $335. Relative to rental rates, older owner occupied housing is much cheaper relative to new owner occupied housing.

The hedonic regression's structure estimates are used to assign each housing unit a structure index. Based on the hedonic estimates for renters and owners reported in Table Six, we can predict household expenditure on structure by taking the hedonic regression estimates for each structure attribute and multiplying this by a household's consumption of that attribute and then summing across the attributes.[11] For example, suppose that each housing structure is a

[11] In particular the renter structure index is defined as: constant + b(units in dwelling)*units in dwelling + b(age)*age + b(rooms)*rooms + b(bedrooms)*bedrooms.

bundle of bedrooms and rooms. If the hedonic price of a bedroom is $25 and the price of an extra room is $50, then a household who purchases a home with 2 bedrooms and 4 rooms would have a structure expenditure index equal to $250 per year.[12]

To aggregate similar homes into a smaller set of "housing products". We create 8 products per PUMA. For a given household, we know whether they rent or own, what PUMA they chose to live in, their annual housing expenditure, and their predicted structure expenditure. This Table explains how the eight products within a PUMA are constructed and how we assign a price and a structure level (sindex) to each product.

Product	Renter	SINDEX>	SINDEX Value	PRICE>	Product Price
		Puma Median		Puma Median	
1	yes	yes	75th quantile of	yes	75th quantile of
			PUMA SINDEX pdf		PUMA rental pdf
2	yes	yes	75th quantile of	no	25th quantile of
			PUMA SINDEX pdf		PUMA rental pdf
3	yes	no	75th quantile of	yes	75th quantile of
			PUMA SINDEX pdf		PUMA rental pdf
4	yes	no	75th quantile of	no	25th quantile of
			PUMA SINDEX pdf		PUMA rental pdf
5	no	yes	25th quantile of	yes	75th quantile of
			PUMA SINDEX pdf		PUMA home pdf
6	no	yes	25th quantile of	no	25th quantile of
			PUMA SINDEX pdf		PUMA home pdf
7	no	no	25th quantile of	yes	75th quantile of
			PUMA SINDEX pdf		PUMA home pdf
8	no	no	25th quantile of	no	25th quantile of
			PUMA SINDEX pdf		PUMA home pdf

For example, in a given PUMA assume that a home is owned and that its predicted structure index is greater than the PUMA's median structure index and that the home's annual price is greater than the PUMA's median home price, then we assign this home to be product number 5 and assign this product a price equal to the 75th percentile of the PUMA home price distribution.[13] Since there are 34 PUMAs in Philadelphia, this approach yields 272 products for households to choose between. It is important to note that even though each housing unit may be "unique", given that we have aggregated products, many individual households have chosen the same "product". Each of the 272 housing

12 The construction of this structure index mirrors the approach described by Rothenberg et. al (1991), King (1976), and has been used extensively in the quality of life literature to rank communities by their local public goods levels (Blomquist, Berger and Hoehn (1988), Gyourko and Tracy (1991), Roback (1982), DiPasquale and Kahn (1999)).

13 Since home prices are self reported it is possible that home prices would feature greater measurement error than rental products. To study this, we have compared the PUMA empirical distribution of reported home prices from 1990 Census data to 1990 data from the city of Philadelphia deeds office and find that the PUMA medians are extremely close in value.

products represents a bundle of tenure status, structure, community and commute time.

5 Structural Estimates

After allowing for a full set of fixed effects and demographic interactions, our model contains 294 parameters to estimate the demand for 272 products. Because of the wealth of demographic and commuting data (and the fact that there are 272 products!) we found that it takes roughly 2 to 3 days to compute our maximum likelihood estimates using a Sun Workstation. Our econometric framework was therefore motivated by what we felt were the main issues in correctly estimating housing demand.

Appendix One presents the structural estimates of the utility function. The estimated utility function parameters include a full set of demographic interactions with observed product attributes and the product fixed effects. For consumption of the outside good and for commuting we recover the level of marginal utility for each demographic group. Even though product level fixed effects are included, these parameters are identified because households differ with respect to income; and thus log(Income-price) varies "within product". Since household place of work differs, commute times differ "within product". For the other housing product attributes such as community % black, % college graduate, tenure status, and structure, these attributes do not vary within product and thus their value is captured in the product fixed effect ξ.

To begin to explore differences in housing choice between white and black migrants, we report optimal structure consumption and ownership propensities in Table Seven. For white and black households, we compute optimal housing expenditure and ownership rates and explore how optimal consumption changes with income growth. The top rows of the table report that based on the structural coefficient estimates, black migrants and white migrants have very similar structure income elasticities of .6. The table also reports how optimal ownership propensities change as household characteristics change. Remember that 136 of the 272 products are owner occupied. Given the estimates of the utility function, we calculate the probability that a household will choose one of these products and sum these probabilities. Both whites and blacks reveal that ownership is a normal good. Evaluated at the sample means, a 25% increase in black income increases the ownership rate by 15 percentage points. Increases in household size also sharply increase ownership.

Do blacks and whites reside in different communities because of differences in preferences over local public goods? To recover the baseline marginal utility for attributes such as "mba", "mblack" would require a second stage regression where we regress the product fixed effects ξ on product attributes. Such a second stage regression is presented in equation (4.1).

$$\xi_j = a_0 + a1 * \log(sindex_j) + a2 * \log(mba_j) + a3 * \log(mblack_j) + a4 * own_j + U \tag{4.1}$$

The econometric problem arises that an OLS estimate of this equation does not yield a consistent estimate. Communities with high levels of college graduates may also feature more golf courses. If this were the case, OLS estimates would over-estimate the coefficient a2. We are not confident that there are valid instruments available in the Census data.

We pursue an alternative strategy of bounding the difference between black and white willingness to pay for housing characteristics. Suppose we wish to compute a household's willingness to pay for an increase in the percentage of college graduates in the PUMA from mba to $\widetilde{mba}$ holding all other attributes of the housing bundle fixed. If we are to keep the household's utility constant, we must decrease its consumption of all other goods from c to $\widetilde{c}$. From the equation for utility in the appendix, it must be the case that (c, mba) and $(c, \widetilde{mba})$ satisfy:

$$\beta_{mba} \log(mba) + \beta_c \log(c/5000) = \beta_{mba} \log(\widetilde{mba}) + \beta_c \log(\widetilde{c}/5000) \tag{4.2}$$

where:

$$\begin{aligned} \beta_{mba} &= a2 + \pi_{13} * white_i + \pi_{14} * person_i + \pi_{15} * log(income_i/5,000) + \pi_{16} * log(age_i) \\ \beta_c &= \beta_1 + \pi_1 * white_i + \pi_2 * person_i + \pi_3 * log(income_i/5,000) + \pi_4 * log(age_i) \end{aligned} \tag{4.3}$$

where the demographic characteristics of the household are $(white_i, person_i, income_i, age_i)$.

We would like to use equations 4.2 and 4.3 to study how willingness to pay for housing attributes varies across demographic groups and use this information to assess what are the characteristics of center city housing that lead blacks to choose live in the cities and the characteristics of suburban housing that lead whites to choose to live in the suburbs. Consider two households that are identical in all respects except for race. Both housholds have initial consumption of all other goods c. Increase the level of college graduates in their PUMA from mba to $\widetilde{mba}$. Let c_{white} be the new level of consumption such that the white consumer is indifferent between the bundles (mba, c) and $(\widetilde{mba}, c_{white})$. Let c_{black} be the level of consumption such that the consumer is indifferent between the bundles (mba, c) and $(\widetilde{mba}, c_{black})$. One way to characterize the difference between white and black tastes for having college educated neighbors is to compute the difference $c_{white} - c_{black}$ holding all of the other demographic attributes of the household fixed at $(white_i, person_i, income_i, age_i)$.

It is straightforward using simple algebra to show that:

$$\log(c_{white}/5000) - \log(c_{black}/5000) = \frac{c1 + c2 + c3}{\beta_{c,white}} + (\frac{\beta_{c,black}}{\beta_{c,white}} - 1) * \log(c_{black}/5000) \tag{4.4}$$

where

$$\begin{aligned} c1 &= \pi_{13} * \log(mba) \\ c2 &= \pi_1 * \log(c) \\ c3 &= \pi_{13} * \log(\widetilde{mba}) \end{aligned}$$

From equation (4.4), if we knew the value of c_{black} it would be possible for us to compute $c_{white} - c_{black}$. While we do not know the exact value of c_{black}, it is possible for us to construct a set of bounds for c_{black}. An obvious upper bound for c_{black} is $c_{black} = c$. Since, according to our parameter estimates, having more college graduates in the neighborhood is a good, the consumer is at least as well off if consumption is held the same and the share of neighbors who are college graduates is increased. To find a lower bound we note that if we estimate equation (4.1) using ordinary least squares, the coefficient $a2$ will have positive bias if it is positively correlated with the error term. Therefore, if we estimate c_{black} using equations (4.1) and (4.2) we will tend to overestimate how much we will need to lower consumption in order to keep the black household indifferent between the bundles (mba, c) and $(\widetilde{mba}, c_{black})$. An appealing aspect of this approach is that we do not need to specify as set of instruments.

In Tables Eight, Nine and Ten, we compute upper and lower bounds for $c_{white} - c_{black}$ using the methodology described above. Table Eight reports willingness to pay differentials for housing structure for twelve different demographic groups. Each row of the matrix reports an upper and a lower bound on the willingness to pay differential for a particular demographic group. In our simulations, there are two household sizes (2 and 4 people), two ages for the head of household (age 30 and age 45) and three household income levels based on the 25th, median and 75th percentiles of the empirical household income distribution. Consider a four person household, where the head is age 45 and the household's income is \$54,000. The bounds indicate that a black migrant household is willing to pay between \$518 and \$808 per year more than an observationally identical white household for a 50% increase in structure over the baseline value. Table Nine reports willingness to pay bounds for community college graduate rates. Unlike structure, whites are willing to pay more than blacks for access to role models. A white houshold with four people, where the head is age 45 and the household's income is $54,000 is willing to pay between $322 and $367 more per year than an identical black household to live in a community with 50% more college graduates than the baseline level. Table Ten shows that blacks are willing to pay more than whites to live in black communities. Perhaps surprisingly, the black/white differential in willingness to pay to live in black communities are quite small. Across the demographic groups, the average black household is willing to pay between $150 and $200 per year more than the same white housheold to live in a community where a larger percentage of residents are black.

6 Why Do Blacks Live in Cities?

In the previous section, we showed that blacks are willing to pay more than whites for structure, less for role models and more for living near other blacks. We are struck by the fact that these differentials in willingness to pay are small. To explain why blacks live in cities requires a different mechanism. Commuting differences between whites and blacks is our prime suspect.

The commuting hypothesis states that racial residential separation occurs because households are willing to pay to avoid commuting and blacks tend to work in occupations and industries that are over-represented in the center city. Commuting is the one housing product attribute where we can consistently estimate how much different demographic groups are willing to pay without using an instrumental variables approach to decompose the product fixed effects. Since households differ with respect to income and place of work, we can identify the coefficients β_1 and π_{25} even though product fixed effects are also estimated. To measure willingness to pay to avoid commuting, we use the utility function parameter estimates to calculate an expenditure function for different demographic groups. Holding all other housing attributes at their sample means, we evaluate how much of the composite commodity a given demographic group would be willing to give up to avoid a doubling of commute time. In Table Eleven we construct willingness to pay measures for 24 types of households (black or white, poor or middle class or rich, young or middle aged, small family or large family).

Both blacks and whites are willing to pay to avoid commuting. We simulate how much of the consumption good a household would be willing to give up to avoid a doubling of a one way commute from 25 minutes to 50 minutes is very high. Assuming that workers commute for 200 hours per year, our estimates show that across the 24 groups, the median pre-tax value of time is $7.38 per hour with a mean of $7.78. These summary statistics are intuitively plausible. Our income elasticities of the cost of commuting for blacks are larger than the income elasticities we estimate for whites and are larger than those estimated in a recent contingent valuation study (Calfee and Whinston 1998). Comparing hosuehold type #1 to household type #17, the income elasticity of avoiding commuting for blacks is 1.42.

By embedding commuting as just one of a housing product's characteristics, our approach helps to explain the "wasteful commuting paradox" (see Small and Song 1992, Hamilton 1982,1991). Urban economists have noted that average commuting times are much higher than what commuting times would be if all households lived near their jobs. As shown in Figure One, the spatial distribution of jobs is almost identical to the spatial distribution of white households. If white households choose the house that is closest to their job, then their average commute times would be quite low. Our discrete choice model provides an explanation for why households do not live next to their jobs. "Wasteful commuting" takes place because of the matching of heterogeneous households to heterogenous structures. While households are willing to pay not to commute, preferred homes are often not located next to the household's place of work. Only in a world with homogenous preferences and a homogenous housing stock, would we be surprised if we observed households not living as close as possible to their jobs.

If disutility from commuting had been low, then there would be no reason why place of work would influence place of residence and help to explain differences in white/black locational patterns. Since commuting is costly, it is relevant to investigate racial differences in place of work. Blacks are much more likely to work in occupations and industries that are concentrated in center cities (Ihlanfeldt and Sjoquist 1991). Perhaps related to skill acquisition, blacks and whites differ with respect to industry and occupational choice. While 20.3% of black migrant households work in service occupations, only 6.7% of white migrants work in service occupations. Service occupation jobs are over-represented in the center city. Whites are much more likely to work in repair, professional and managerial occupations relative to blacks while black household heads are more likely to work in operator occupations. Blacks are much more likely to work in the public sector and these jobs are concentrated in the center city. In addition, blacks are over-represented in the professional and related service industries and these industries represent a much larger share of center city jobs (38.6%) than suburban jobs (23.7%).

National level data can be used to partition all industries into those where black workers are over-represented and those industries where black workers are under-represented. Figure Three graphs the empirical CDF for employment for these two sets of industries with respect to distance from the Philadelphia Central Business District. Industies where blacks are over-represented in the national workforce are much closer to the Philadephia city center. Figure Three shows that all else equal, commute minimizing black households have an incentive to live in the center city. We showed in Table Four that blacks who work in the suburbs are much more likely to live in the suburbs.

The ideal test of the commuting hypothesis would be to observe what share of center city black residents would suburbanize if their center city employer suburbanized due to some exogenous factor. While this "natural experiment" is not available to us, we can simulate our model's structural estimates to measure how the probability of urbanizing changes as commuting times from center city housing products gets longer. The top row of Table 12 reports that our model predicts that for 65% of black migrants that their optimal housing product is in the center city. The next row of the table simulates how this probability changes if center city housing products featured a 50% longer commute. Thus, we are studying how residential urbanization would be affected if more blacks worked in the suburbs. Under this scenario, 49.1% of black migrants, down from 65%, would now choose to live in the center city. This 15.9 percentage point decline is quite large. White migrants would also significantly reduce their urbanization rates. The results in the right column of Table Twelve show that white urbanization rates would fall from 45.4% to 20.6%. Whites and blacks are both much more likely to live in the center city when they have found work there. The size of this probability change can be better judged by comparing it to how changes in income affect suburbanization rates. In the second row of Table Twelve, taking place of work as fixed, we simulate the new urbanization rate as the household's income increases by 25%. Black households are .6 percentage points less likely to urbanize and white households are 7 percentage points less likely to urbanize. Increases in household income have a much smaller effect than place of work on the propensity to suburbanize. The last row of the table shows that changes in household size also have a small effect on black migrant urbanization rates.

6.1 Caveats

In estimating black housing preferences we have assumed that the only constraint these households face is a budget constraint. Racism would reduce black access to enter certain white communities. If blacks could only choose among a handful of products which are concentrated in black communities, then our structural approach would yield estimates that black households greatly desire living in cities when in fact they were $forced$ to live in these urban communities. While we have no doubt that minorities often experience differential treatment than whites in the search process and in the mortgage process (see Yinger 1986), the growth in the black middle-class provides the opportunity to sketch out this group's preferences, especially in a metropolitan area such as Philadelphia where prices are low.

A limitation of our model is that households face a static maximization problem. Since housing is a durable good and moving is costly, the consumer must evaluate trade-offs intertemporally. To properly form a structural model of the dynamics of decision making, detailed panel data on individual level choices is typically required. Fortunately, the type of model we estimate can be correctly interpreted as the value function of a household's dynamic program (see Rust (1994) for a more complete discussion). All of our demographic variables would be natural state variables in a dynamic model of housing and location choice. For example, current income and race are important indicators of future income. These considerations are important when interpreting the results from our analysis. Consider, for instance, a positive coefficient on the interaction between $white$ and own (as it is in our estimates). This could reflect higher marginal valuation of home ownership in each period among whites. An alternative explanation, however, is that holding current household income constant, whites have higher expected permanent income and thus they are more likely to choose to own than non-whites. It is not clear how we can resolve these issues without panel data on households. Since our demographic variables would be natural state variables in almost any dynamic model of housing consumption, to interpret the results we must bear in mind that households face not only static trade-offs, but also make their decisions in light of expectations about the future.

7 Conclusion

To explain why blacks live in cities while whites live in the suburbs, this paper estimated a high dimensional discrete choice model of housing demand. Our structural demand estimates point to commuting as the primary reason for the patterns we observe. Place of work has been underinvestigated in analyses of locational choice because to study place of work requires micro data. Aggregate data cannot provide information on where people live and where they work. In a metropolitan area featuring dispersed employment accounting for such gross flows is crucial for explaining differentials in residential suburbanization propensities.

Future research could explore locational patterns in other cities. While this paper's empirical work has focused on Philadelphia, black segregation in major center cities is a general phenomena (see Cutler, Glaeser, Vigdor 1999). Figure Four documents that residential racial segregation is higher in metropolitan areas where most of the employment is suburbanized. Job sprawl is highest in the most segregated metropolitan areas such as Detroit, Chicago and Philadelphia. In these metropolitan areas, white households live in the suburbs and work in the suburbs. Figure Four is consistent with the hypothesis that there would be a greater level of white urbanization if employment were concentrated downtown.

Employment suburbanization helps to explain black/white separation at a point in time and changes in white/black suburbanization over time. In 1950, whites and blacks both worked in the center city and lived in the center city.

As predicted by the monocentric model, richer households who demanded land tolerated a longer commute and lived in the suburbs (Wheaton 1977). Over time industries that employed these workers began to suburbanize offering suburban residents shorter commutes. A spatial “separating equilibrium” took place as “white jobs” suburbanized and white workers seeking nice structures, short commutes, and mainly white communities outbid blacks for these properties. Over time as black education levels have increased and racial tensions have diminished, black households have increased access to professional jobs at suburban corporate industrial parks. Minority households who work in such jobs are increasingly likely to suburbanize.

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8 Appendix.

The utility function used in this research is of the form:

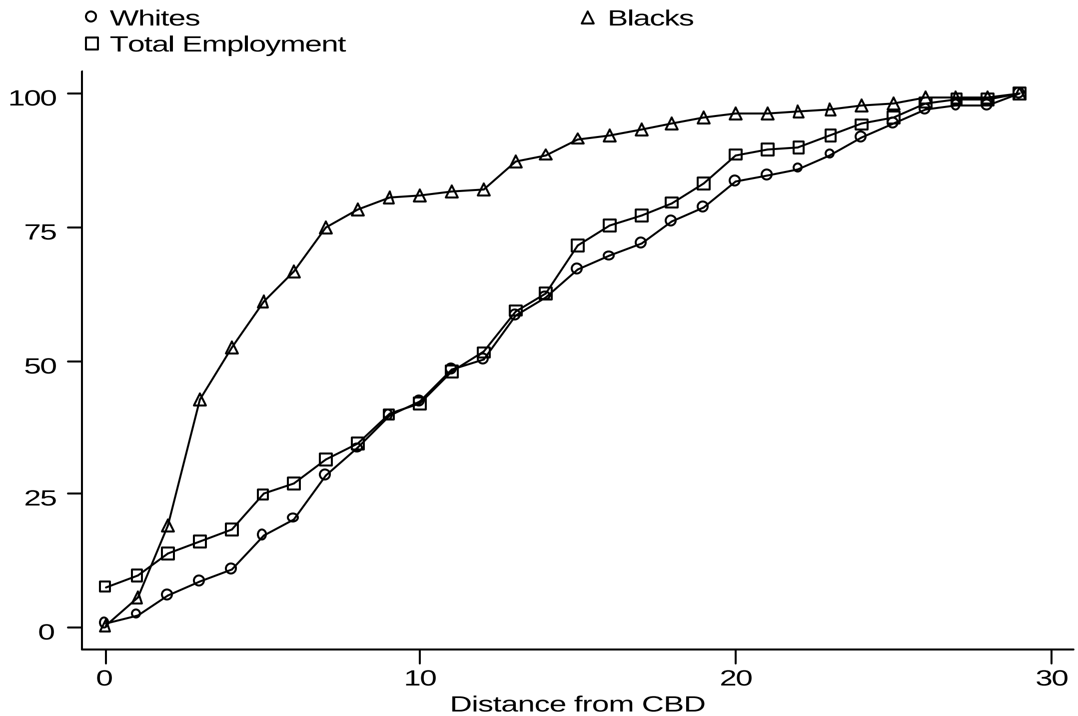
$$\begin{aligned}
u_{ij} \quad = \quad & \xi_j + \beta_1 \log((income_i - price_j)/1,000) + \pi_1 \log((income_i - \\
& price_j)/1,000) * white_i + \pi_2 * \log((income_i - price_j)/10,000) * \\
& person_i + \pi_3 * \log((income_i - price_j)/10,000) * \log(income_i/ \\
& 10,000) + \pi_4 \log((income_i - price_j)/10,000) * \log(age_i) + \pi_5 * \\
& \log((sindex_j + 85)/1,000)) * white_i + \pi_6 * \log((sindex_j + 85)/1,000)) \\
& *person_i + \pi_7 * \log((sindex_j + 85)/1,000)) * \log(income_i/1,000) + \\
& \pi_8 * \log((sindex_j + 85)/1,000)) * \log(age_i) + \pi_9 * \log(mblack_j) * \\
& white_i + \pi_{10} * \log(mblack_j) * person_i + \pi_{11} * \log(mblack_j) * \\
& \log(income_i/10,000) + \pi_{12} * \log(mblack_j) * \log(age_i) + \pi_{13} * \\
& \log(mba_j) * white_i + \pi_{14} * \log(mba_j) * person_i + \pi_{15} * \log(mba_j) * \\
& \log(income_i/1,000) + \pi_{16} * \log(mba_j) * \log(age_i) + \pi_{17} * own_j * \\
& white_i + \pi_{18} * own_j * person_i + \pi_{19} * own_j * \log(income_i/1,000) \\
& +\pi_{20} * own_j * \log(age_j) + \pi_{21} * \log(comm_{ij}) * \log(income_i/1,000) + \varepsilon_{ij}
\end{aligned}$$

Parameter Estimates

Parameter	MLE	S.E.
$\beta_1 : log((income_i - price_j)/5,000)$	11.14	0.9940
$\pi_1 : log((income_i - price_j)/5,000) * white_i$	-7.588	0.8726
$\pi_2 : log((income_i - price_j)/5,000) * person_i$	-0.5589	0.03296
$\pi_3 : log((income_i - price_j)/5,000) * log(income_i/5,000)$	14.79	0.5782
$\pi_4 : log((income_i - price_j)/5,000) * log(age_i)$	-2.004	0.06597
$\pi_5 : log((sindex_j + 85)/5,000)) * white_i$	-1.248	0.5153
$\pi_6 : log((sindex_j + 85)/5,000)) * person_i$	1.126	0.02735
$\pi_7 : log((sindex_j + 85)/5,000)) * log(income_i/5,000)$	0.8309	0.2457
$\pi_8 : log((sindex_j + 85)/5,000)) * log(age_i)$	0.05467	0.05792
$\pi_9 : log(mblack_j) * white_i$	-0.2933	0.01945
$\pi_{10} : log(mblack_j) * person_i$	0.02586	0.001306

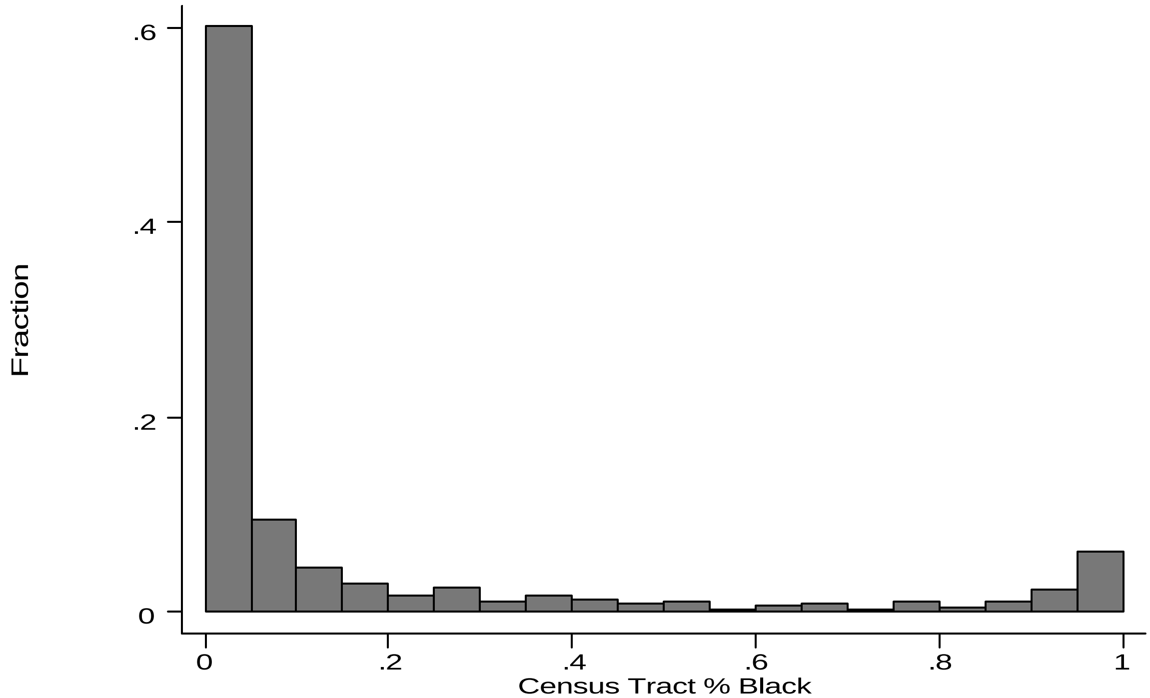
Parameter	M.L.E.	S.E.
$\pi_{11} : log(mblack_j) * log(income_i/5,000)$	0.03949	0.009798
$\pi_{12} : log(mblack_j) * log(age_i)$	0.1364	0.001414
$\pi_{13} : log(mba_j) * white_i$	0.5043	0.01279
$\pi_{14} : log(mba_j) * person_i$	-0.3730	0.0001904
$\pi_{15} : log(mba_j) * log(income_i/5,000)$	0.7319	0.003208
$\pi_{16} : log(mba_j) * log(age_i)$	0.3958	0.002808
$\pi_{17} : own_j * white_i$	1.2509	0.1679
$\pi_{18} : own_j * person_i$	-0.2736	0.01052
$\pi_{19} : own_j * log(income_i/5,000)$	0.7956	0.07519
$\pi_{20} : own_j * log(age_i)$	0.1376	0.01868
$\pi_{25} : log(comm_{ij}) * log(income_i/5,000)$	-1.098	0.002798

Figure One



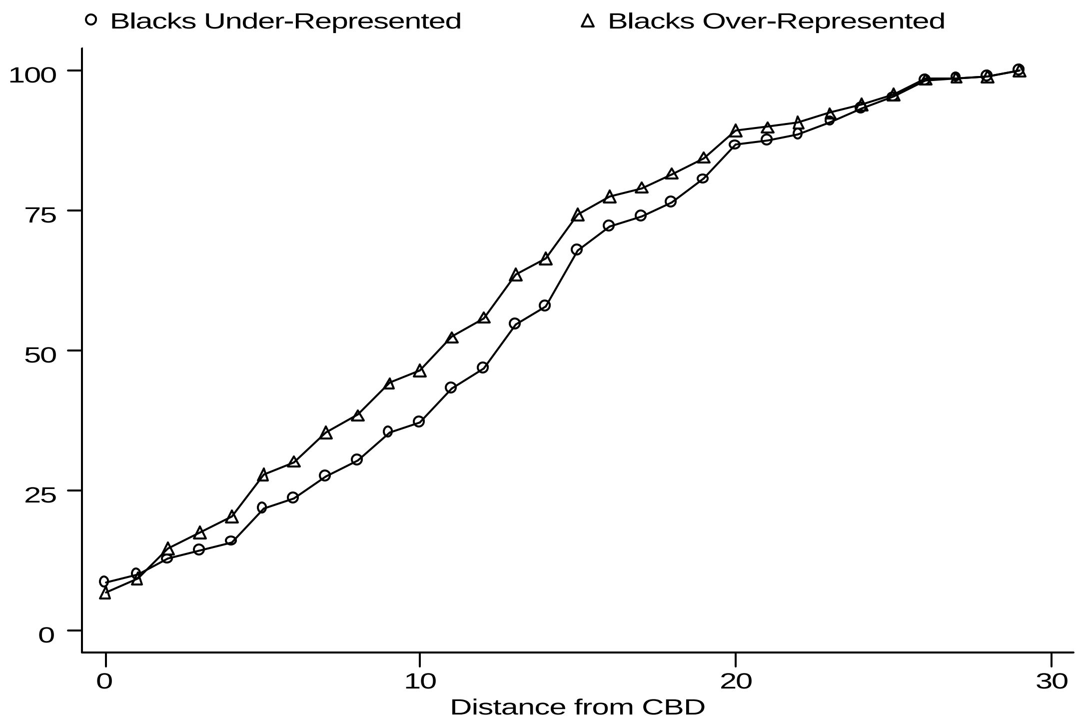
CDF of Population and Employment in 1996 Philadelphia

Figure Two



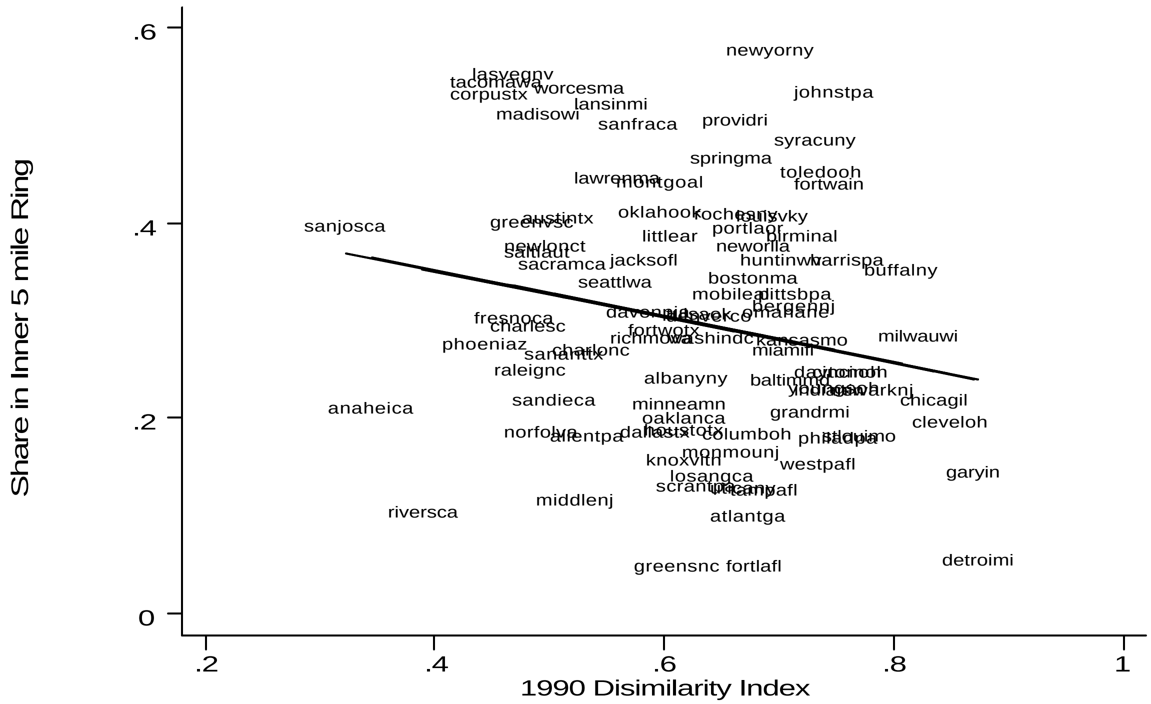
1990 Philadelphia MSA

Figure Three

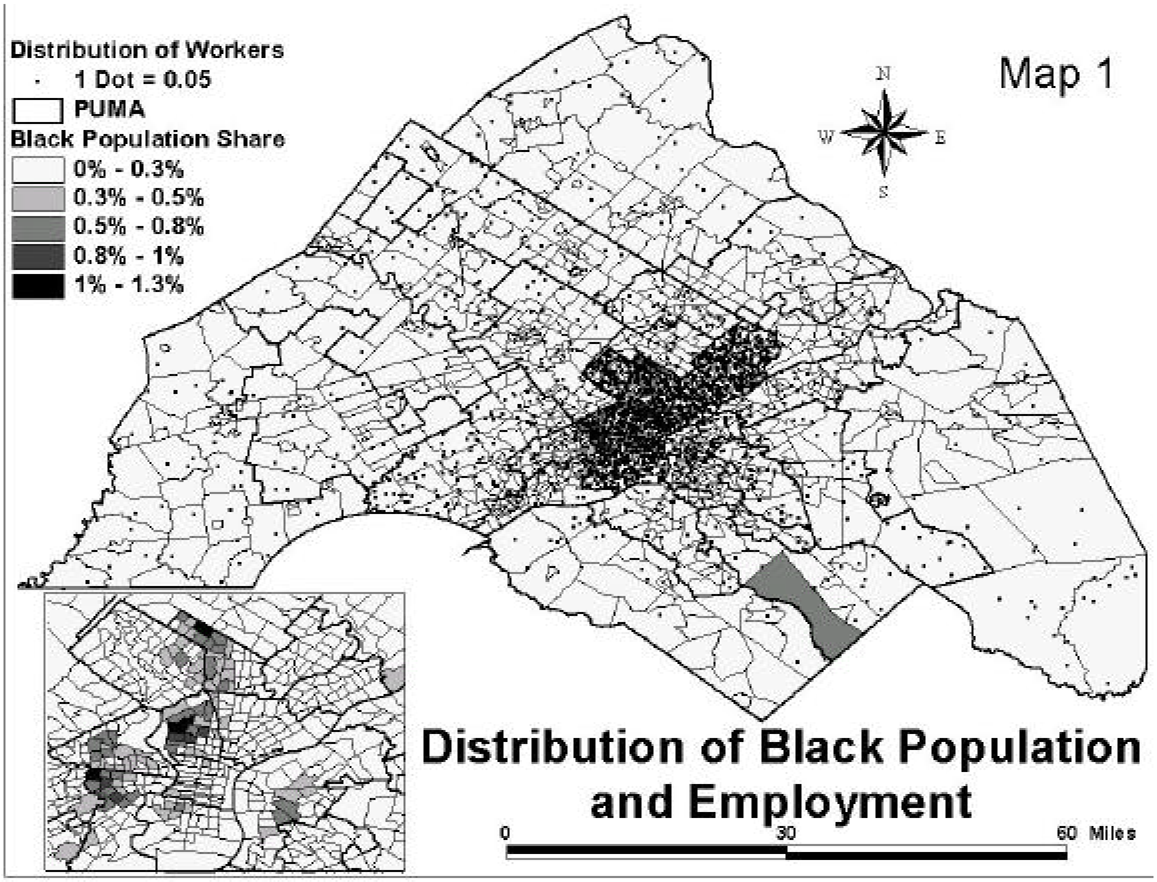


Philadelphia Employment CDF by National Worker Shares

Figure Four



Differences in MSA Job Centralization by Segregation


Distribution of Workers
1 Dot = 0.05
PUMA
Black Population Share
0% - 0.3%
0.3% - 0.5%
0.5% - 0.8%
0.8% - 1%
1% - 1.3%
Map 1
N
W
E
S
Distribution of Black Population and Employment
0
30
60 Miles

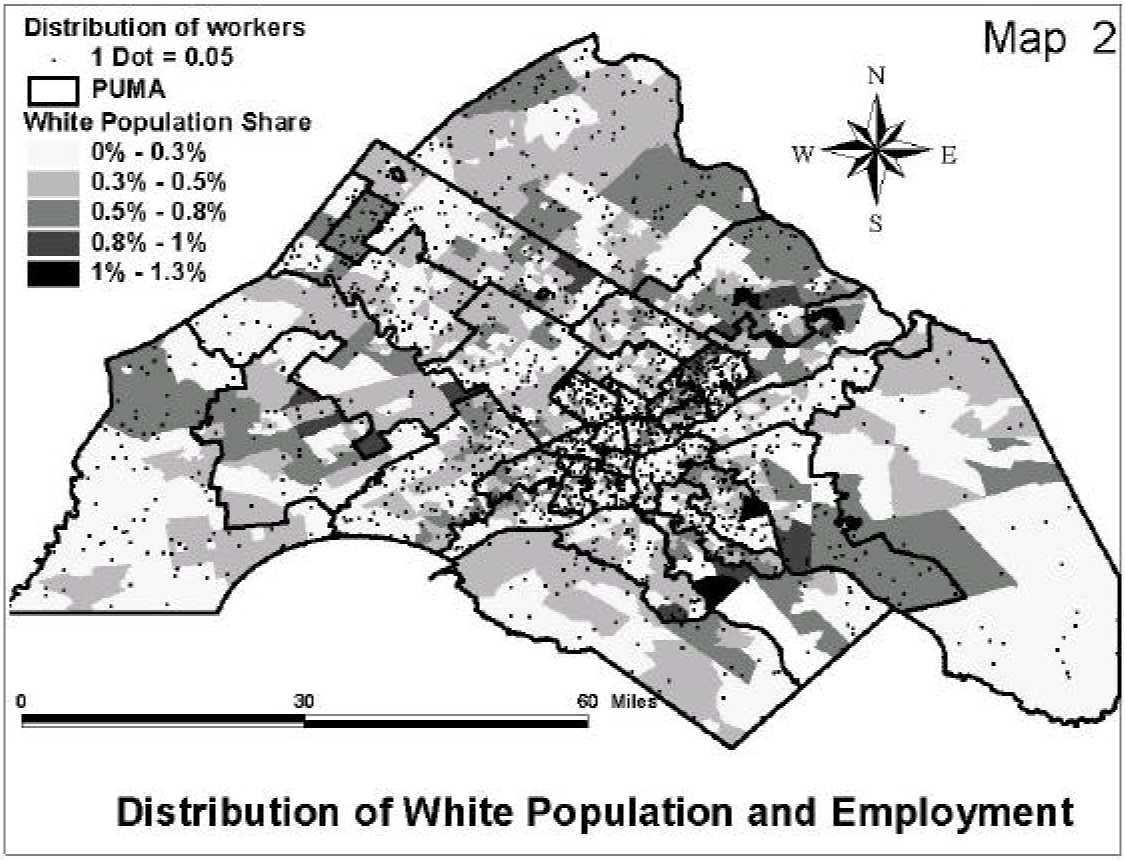

Distribution of workers
1 Dot = 0.05
PUMA
White Population Share
0% - 0.3%
0.3% - 0.5%
0.5% - 0.8%
0.8% - 1%
1% - 1.3%
Map 2
N
W
E
S
0
30
60 Miles
Distribution of White Population and Employment

Table One

Summary Statistics for the 1990 Philadelphia Sample

	all black households	black migrants	all white households	white migrants
Variable	Mean	Mean	Mean	Mean
Annual Housing Expenditure for Owners	3758.864	4846.251	9910.548	11220.280
Annual Housing Expenditure for Renters	3959.536	4432.481	5942.020	6278.840
Changed home between 1985 and 1990	0.345	1.000	0.375	1.000
College graduate	0.114	0.155	0.282	0.377
Persons in the household	2.844	2.787	2.583	2.524
Female head of household	0.557	0.559	0.311	0.309
Married	0.336	0.297	0.593	0.547
Home Owner	0.559	0.293	0.739	0.542
Household Income	27696.820	26469.860	46477.680	46578.710
Head of Household age	49.139	40.014	50.240	39.644
Children under age 18 present	0.432	0.502	0.324	0.387
Center city resident	0.702	0.624	0.253	0.228
Center city worker	0.598	0.564	0.290	0.284
Live and Work in the Suburbs	0.290	0.340	0.661	0.669
One way travel time to work	30.181	30.652	25.992	26.253
Not own a car	42.1	45.3	12.4	10.8
Observations	9497	3271	57953	21275
Migrants are households who switched homes between 1985 and 1990.				

Table Two

Black Migrant Choices by Household Income Level

	Household Income		
	Less than $25000	greater than $25000 less than $40000	greater than $40000
Annual Housing Expenditure	3660.641	4944.884	6596.623
Home Owner	0.183	0.342	0.547
Center City Resident	0.699	0.557	0.480
Center City Worker	0.604	0.569	0.502
Rooms	4.294	4.898	5.882
Bedrooms	1.952	2.265	2.802
Home Built after 1970	0.175	0.212	0.269
PUMA % black	0.461	0.384	0.331
PUMA % college graduate	0.178	0.201	0.219
Travel Time	30.240	30.579	31.329
observations	1754	711	806
Black migrants are partitioned into three groups based on household income. The table reports average consumption by income level.			

Table Three

White Migrant Choices by Household Income Level

	Household Income		
	Less than $25000	greater than $25000 less than $40000	greater than $40000
Annual Housing Expenditure	5935.557	7294.524	11543.710
Home Owner	0.253	0.465	0.746
Center City Resident	0.356	0.248	0.145
Center City Worker	0.312	0.294	0.269
Rooms	4.179	5.083	6.527
Bedrooms	1.813	2.274	3.013
Home Built after 1970	0.321	0.376	0.499
PUMA % black	0.138	0.105	0.082
PUMA % college graduate	0.256	0.276	0.314
Travel Time	22.537	25.018	28.193
observations	5340	5005	10930
White migrants are partitioned into three groups based on household income. The table reports average consumption by income level.			

Table Four

Migrant Place of Work and Place of Residence

White Migrants			
	place of work		
place of residence	suburbs	center city	Total
suburbs	240892	52606	293498
center city	17051	63331	80382
Total	257943	115937	373880

Black Migrants			
	place of work		
place of residence	suburbs	center city	Total
suburbs	18491	6611	25102
center city	5867	30914	36781
Total	24358	37525	61883

Table Five

Conditional Logit Models of Migrant Locational Choice

	Black Migrants	Black Migrants with Income >= 40,000	White Migrants	White Migrants with Income >= 40,000
Model	1	2	3	4
PUMA % Black	0.488 (0.009)	0.382 (0.017)	-0.632 (0.008)	-0.832 (0.012)
commute time	-1.578 (0.020)	-1.142 (0.032)	-1.483 (0.006)	-1.322 (0.008)
PUMA % BA	-0.072 (0.012)	0.115 (0.020)	0.159 (0.004)	0.287 (0.005)
pseudo R2	0.189	0.115	0.189	0.186

Each column reports a separate estimate of a 34 dimensional conditional logit model. Each migrant household chooses one of 34 PUMAs to live in. A PUMA's attributes are its share of residents who are black and its share of residents who are college graduates. Commute time is the one way average commute time measured in minutes from the migrant's place of work to the PUMA. Standard errors are presented in parentheses. Each explanatory variable has been standardized by dividing subtracting off its mean and dividing by its standard deviation.

Table Six

Housing Hedonic Regressions

	owner		renter	
	Coef.	Std. Err.	Coef.	Std. Err.
single unit attached	-3658.77	54.34	-493.85	66.28
2 units	-564.20	149.20	-241.76	72.83
3-4 units	-157.27	241.58	-137.93	73.55
5-9 units	-3190.90	248.66	202.65	77.31
10-19	-3654.48	252.76	303.65	74.10
20-49	-2189.80	357.04	491.10	77.99
50+ units	-568.41	233.48	1214.45	78.36
Built 1980-1985	-644.70	185.69	-439.75	169.21
Built 1975-1979	-1916.22	192.12	-1396.48	166.55
Built 1970-1974	-3190.42	179.68	-1223.06	159.06
Built 1960-1969	-3993.78	180.12	-1175.63	159.22
Built 1950-1959	-4485.20	178.09	-1475.68	161.11
Built 1940-1949	-4749.89	182.28	-1660.17	162.28
Built pre-1940	-4662.59	177.82	-1619.78	158.58
rooms	1046.53	20.17	334.60	20.31
bedrooms	623.85	35.69	276.58	33.56
constant	5745.35	189.44	5259.04	176.85
observations	51879		17545	
R2	0.585		0.394	

Note: Two hedonic specifications are presented where the dependent variable is annual housing expenditure as a function of structure attributes and community attributes. PUMA fixed effects are included but their estimates are suppressed. The omitted category is a single detached unit built after 1980. The dummies for the year that the household moved into the unit are suppressed.

Table Seven

Structural Estimates of Optimal Housing Attribute Consumption

Policy Experiment	Black Migrant Head of Household	White Migrant Head of Household
Housing expenditure ($)	3733.97	6850.14
Housing expenditure if income is 25% higher	4305.32	7879.44
structure income elasticity	0.61	0.60
Housing expenditure if household size doubles	3751.75	7344.24
Ownership rate	0.589	0.725
Ownership rate if income is 25% higher	0.798	0.958
ownership rate if household size doubles	0.730	0.877
ownership rate if the head of household is 10 years older	0.595	0.726
This table's entries are based on the parameter estimates of the utility function reported in the Appendix.		

Table Eight

Racial Differences in Willingness to Pay for Structure

persons in household	age	income	income - price	baseline value	upper and lower bound on willingness to pay differential
2	30	18700	13200	5574	281,449
4	30	18700	13200	5574	178,485
2	45	18700	13200	5574	276,474
4	45	18700	13200	5574	179,515
2	30	34253	27562	6466	429,585
4	30	34253	27562	6466	354,614
2	45	34253	27562	6466	437,606
4	45	34253	27562	6466	356,636
2	30	54000	45756	9233	585,767
4	30	54000	45756	9233	512,786
2	45	54000	45756	9233	595,778
4	45	54000	45756	9233	518,808

The method for calculating the bounds is described in the text. The bounds are measured in annual 1989 dollars. The bounds represent how much more a black household is willing to pay relative to a white household.

Table Nine

Racial Differences in Willingness to Pay for Community Percent College Graduate

persons in household	age	income	income - price	baseline value	Upper bound on willingness to pay differential	lower bound on willingness to pay differential
2	30	18700	13200	0.15	-177	-216
4	30	18700	13200	0.15	-191	-202
2	45	18700	13200	0.15	-187	-237
4	45	18700	13200	0.15	-202	-223
2	30	34253	27562	0.21	-233	-280
4	30	34253	27562	0.21	-244	-269
2	45	34253	27562	0.21	-241	-297
4	45	34253	27562	0.21	-253	-286
2	30	54000	45756	0.37	-302	-361
4	30	54000	45756	0.37	-313	-350
2	45	54000	45756	0.37	-310	-378
4	45	54000	45756	0.37	-322	-367

The method for calculating the bounds is described in the text. The bounds are measured in annual 1989 dollars. The bounds represent how much more a black household is willing to pay relative to a white household.

Table Ten

Racial Differences in Willingness to Pay for Community Percent Black

persons in household	age	income	income - price	baseline value	Upper bound on willingness to pay differential	lower bound on willingness to pay differential
2	30	18700	13200	0.2	104	179
4	30	18700	13200	0.2	112	197
2	45	18700	13200	0.2	110	191
4	45	18700	13200	0.2	119	212
2	30	34253	27562	0.08	136	197
4	30	34253	27562	0.08	143	207
2	45	34253	27562	0.08	141	204
4	45	34253	27562	0.08	148	215
2	30	54000	45756	0.03	176	237
4	30	54000	45756	0.03	183	246
2	45	54000	45756	0.03	181	243
4	45	54000	45756	0.03	188	253

The method for calculating the bounds is described in the text. The bounds are measured in annual 1989 dollars. The bounds represent how much more a black household is willing to pay relative to a white household.

Table Eleven

Philadelphia Migrant Willingness To Pay Avoid Commuting by Demographic Group

Demographic Group						
type	white	person	age	income	income - price	commute time increased from 25 minutes to 50 minutes
1	0	2	30	18700	13200	-570
2	1	2	30	18700	13200	-847
3	0	4	30	18700	13200	-599
4	1	4	30	18700	13200	-912
5	0	2	45	18700	13200	-591
6	1	2	45	18700	13200	-894
7	0	4	45	18700	13200	-622
8	1	4	45	18700	13200	-966
9	0	2	30	34253	27562	-1245
10	1	2	30	34253	27562	-1626
11	0	4	30	34253	27562	-1290
12	1	4	30	34253	27562	-1703
13	0	2	45	34253	27562	-1277
14	1	2	45	34253	27562	-1681
15	0	4	45	34253	27562	-1324
16	1	4	45	34253	27562	-1763
17	0	2	30	54000	45756	-2107
18	1	2	30	54000	45756	-2611
19	0	4	30	54000	45756	-2169
20	1	4	30	54000	45756	-2707
21	0	2	45	54000	45756	-2152
22	1	2	45	54000	45756	-2680
23	0	4	45	54000	45756	-2216
24	1	4	45	54000	45756	-2781

Based on the structural estimates presented in the appendix, we simulate willingness to pay to avoid an extra 25 minutes of one way commuting attributes for 24 different demographic groups. Migrant willingness to pay is measured in $1989 and represents an annual flow. Unlike in Tables Eight, Nine, and Ten, this is not a bound.

Table Twelve

Structural Estimates of The Probability of Choosing a Center City Housing Product

Policy Experiment	Black Migrant Head of Household	White Migrant Head of Household
Baseline	0.650	0.454
Increase commute by 50% for Center City housing products	0.491	0.206
Increase suburban PUMAs % black by 10 percentage points	0.601	0.392
Increase center city PUMA % college graduate by 10 percentage points	0.804	0.681
Increase center city housing product's structure by 25%	0.896	0.681
Increase income by 25%	0.644	0.386
Double family size	0.693	0.653
Using the estimates reported in the Appendix, we estimate for each household its probability of choosing one of the 88 center city housing products. Summing these probabilities yields the probability that it is optimal for the household to live in the center city. The top row reports the baseline. We then simulate several policy changes.		