RESIDENTIAL MOBILITY, INCOME INEQUALITY, AND RACE/ETHNIC SEGREGATION IN LOS ANGELES

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Abstract. Sociology has a long history of studies that use cross-sectional data to describe patterns of segregation in large American cities. While descriptively valuable, this work has not revealed the causal mechanisms that drive neighborhood change. Insofar as change occurs through residential and social mobility, a dynamic approach is required. I develop a model that links the residential mobility of individuals to aggregate patterns of neighborhood change, and use this model to understand how income inequality and mobility behavior interact to produce and maintain segregated neighborhoods in Los Angeles. Preliminary findings suggest that, given existing levels of income inequality in Los Angeles, racial and economic factors that govern residential mobility have offsetting effects on racial segregation. Given a number of unresolved modeling issues, however, these findings should be viewed as an illustration of this approach rather than as a substantive result.

1. INTRODUCTION

This paper is concerned with how racial and economic factors contribute to neighborhood stability and change. Over the past 20 years, economic inequality has grown and may be a source of widening inequalities in other realms as well (Reich 1991; Durlauf 1996). The concentration of neighborhood poverty increased dramatically from the 1970s through 1990, and then declined moderately between 1990 and 2000 (Jargowsky 1996a; Jargowsky 1996b; Jargowsky 1994; Jargowsky 2003). Numerous studies have focused on the possible effects of residential neighborhoods on social and economic outcomes (e.g., Brewster 1994; Brooks-Gunn et al. 1997). Persistent economic and racial residential segregation is implicated in enduring racial and ethnic inequality (e.g., Massey and Eggers 1993). Yet we have only limited understanding of the dynamics of how neighborhoods are formed and how they change. A long tradition of research has used cross-sectional data to document trends in economic and racial segregation in American cities (e.g, Duncan and Duncan 1957; Taueber and Taeuber 1969; Frey and Farley 1996; Massey and Eggers 1993; Jargowsky 1996a).

Date: August 25, 2005.
The author gratefully acknowledges financial support from the National Science Foundation. Robert Mare and Christine Schwartz provided comments and suggestions that improved this paper.

While descriptively valuable, this work has not revealed the causal mechanisms that drive neighborhood change. Insofar as change occurs through residential and social mobility, a dynamic approach is required.

One promising line of research has been to use panel survey data on geographic mobility to measure movement among neighborhoods of varying economic and racial composition (e.g., Massey and Eggers 1990; Quillian 1999, Quillian 2002; South and Crowder 1998; Gramlich et al. 1992). Even with panel data it is difficult to model the interplay between individuals' migration decisions and their changing environments. While providing valuable information on individuals' choices about where to live, this work has not yielded plausible models of neighborhood dynamics. The neighborhood changes implied by the turnover rates estimated in these studies are unrealistic because they assume fixed mobility rates across neighborhood types. This assumption ignores a crucial feature of residential mobility, namely that changes in the characteristics of neighborhoods bring about changes in rates of movement in and out of these neighborhoods.

Agent-based (computational) modeling is a tool for studying the relationship between individual decisions and collective outcomes. Researchers have used agent-based models to explore a host of behaviors in which aggregate features of the environment result from the behavior of individual actors. These models are particularly useful for understanding dynamic phenomena in which there is feedback between the characteristics of the environment and the behavior of the individuals who constitute that environment (Durlauf 2001). For example, individuals who move out of a neighborhood because they cannot tolerate its racial composition are simultaneously adapting to shifts in neighborhood composition and affecting neighborhood composition.

One of the first agent-based models was Schelling's (1978, 1972, 1971) model of residential tipping which showed how the preferences of autonomous individuals about where to live give rise to (unanticipated) aggregate patterns of residential segregation. These patterns, moreover, are often at odds with the preferences of the majority of individuals. In Schelling's model, neighborhoods change through the mobility of agents who are reacting to the composition of their own neighborhood and of other potential neighborhood destinations. As agents move, they alter the neighborhoods of other agents in the system, engendering further moves by individuals who are trying to satisfy their preferences.

Despite the significance of Schelling's contribution, it raises questions that also arise in other applications of agent-based models. First, the model is only weakly linked to empirical research on individual behavior and real populations. Second, the space in which individuals move about bears little resemblance to real geography. As a result, it is unclear whether the neighborhood dynamics observed in Schelling's agent-based model can explain actual patterns of neighborhood change. Although Schelling's ideas are well known to students of residential mobility and segregation (e.g., Clark 1991), they are seldom used to analyze neighborhood change in real populations. Instead, most of our knowledge about changes in segregation comes from careful description of segregation patterns in successive Census cross sections without adequate attention to the underlying behavioral dynamics. As a result, we still lack strong tools for understanding what mechanisms generate existing patterns of segregation.

1.1. **A Dynamic Model of Neighborhood Change in Los Angeles.** This study blends agent-based modeling with empirically based choice models and a realistic neighborhood context in an effort to understand the interdependence of racial and economic factors in the formation and maintenance of segregated neighborhoods. I develop a dynamic model of residential mobility by race and income, and use this model to examine how overall trends in inequality and households' mobility behavior interact to produce and maintain segregated neighborhoods in Los Angeles. This strategy allows me to evaluate different explanations for persistent segregation by comparing neighborhood turnover expected under a given behavioral model to actual neighborhood change.

The model consists of two interrelated parts: statistical analyses of residential mobility in Los Angeles, and a realistic agent-based model that connects the movement of individuals to patterns of residential segregation. I estimate individual-level models of neighborhood choice using residential mobility histories taken from the first wave of the Los Angeles Family and Neighborhood Survey (hereafter LA FANS) and 2000 Census data. These models describe the probability that a person of a given race and income moves into a neighborhood of a given racial and economic composition. I then use an agent-based model to simulate neighborhood turnover assuming that individuals behave according to the models estimated from the LA FANS data, and that the distribution of housing units and individuals in the simulated city follows the distribution of the people and housing units in LA County in 1990. I examine what segregation outcomes occur assuming: (1) individuals choose neighborhoods on the basis of economic factors alone; (2) individuals choose neighborhoods on the basis of neighborhood racial composition alone; and (3) individuals choose neighborhoods on the basis of both economic factors and neighborhood racial composition.

As discussed further below, my models and analyses incorporate a number of simplifying assumptions. I address many of these in on-going research (Bruch 2005). The main goal of this paper is to present the basic features of my approach and to illustrate them with empirical data. The balance of this paper is as follows. First I describe my data sources. Second, I present a discrete choice model for the effects of race-ethnic and economic characteristics of neighborhoods on residential mobility decisions. Third, I present estimates of the parameters from this model, which reveal the neighborhood preferences of individuals and how they vary across income and race groups. Fourth, I present a realistic and dynamic agent-based model of neighborhood change that incorporates the mobility probabilities estimated from the discrete choice model. Fifth, I use the aggregate model to simulate changes in residential segregation in Los Angeles. Finally, I conclude with a discussion of the strengths and weaknesses of the present analysis and my agenda for future research.

2. ANALYZING RESIDENTIAL CHOICE DATA

2.1. **Data.**

LA FANS. The LA FANS is a multi-stage probability sample of 65 census tracts in Los Angeles County. The survey makes it possible to study the mobility of families, households, and/or individuals. For a randomly selected adult in each sampled household, the first wave of the survey contains a two-year retrospective geographic mobility history (derived from addresses of places of residence) as well as detailed information about demographic characteristics, labor force participation, schooling, income and wealth. Subsequent waves of the survey will update this information and follow these individuals wherever they move.

The mobility history information in the LA FANS enables me to examine the processes by which individuals choose to move or remain in their places of residence and, if they move, the specific destinations that they choose. The main strength of the LA FANS data is that they allow me to test whether individuals evaluate their current neighborhood differently from all other possible destinations. At any given moment, people are more likely to remain in their current residence than move to a new location. In other words, there is a "cost of moving" from one's current place of residence to a new neighborhood. Because the LA FANS residential histories are longitudinal, I can estimate this "cost of moving," and how it varies by neighborhood and individual characteristics. These data also include a wide range of measures of individual, household, and family characteristics that may affect residential mobility behavior. However, the LA FANS also has two key weaknesses. First, the small sample size means that I can only include a limited number of parameters in the model. Second, the survey oversamples poor neighborhoods. Because I am studying residential choice, this is tantamount to sampling on the dependent variable. There is a correction for this bias (detailed below), but I compare the LA FANS estimates to those based on an unbiased sample (the 2000 Census) to determine the extent to which my solution to the oversampling corrects the bias. I also use the Census data to estimate models that include parameters which cannot be included in the LA FANS models due to its small sample size.

2000 Census Data. The 2000 Census public use files contain tables documenting the distribution of households across tracts by race, (categorical) income and (categorical) housing price. I treat each cell in each table as an aggregated observation (characterized by household race, tenure, and income, and the price and neighborhood composition of each choice), and estimate the probability of moving into a housing unit of a given price and neighborhood composition, based on both characteristics of that unit as well as all other possible destination units.

The Census data have the desirable properties of unbiased sampling and a large sample size. The large sample size allows me to estimate models of residential choice that are more complex than those estimated using the LA FANS. On the other hand, the Census data have a couple of disadvantages. First, household income and rent are categorical variables in the Census data, which leads to a loss of precision in the estimates. Also the Census data are a cross-sectional distribution of the population, which means that I cannot estimate the "cost of moving" from one's current residence to a new neighborhood. But taken together, the Census and LA FANS data provide a reasonably comprehensive set of estimates of residential mobility behavior in Los Angeles.

To simplify the analysis, I restrict my sample to households that were renting their housing units at the time of the survey. Table 1 summarizes the residential information available on renters in the Census data and the LA FANS. The 1,366 LA FANS respondents provide information on 2,605 annual mobility decisions. As indicated by the comparison with the 2000 population data for Los Angeles County, the LA FANS data overrepresent Hispanics and underrepresent non-Hispanic whites and Asians. The LA FANS sample also overrepresents low-income households. I define neighborhood boundaries as Census tracts. Despite the relatively large number of mobility decisions faced by LA FANS respondents, they report only 307 between-tract annual moves during the two years prior to the interview date, few enough to limit the complexity of the statistical models that can be estimated. Note that Asian respondents report a total of 13 between-tract moves over the two year period, which is not enough information to estimate Asian-specific mobility. Thus, in the LA FANS analyses, I combine Asian and white respondents into a single group. On average, approximately 10 percent of LA FANS respondents move per year, approximately half the annual mobility rate typically observed in national data.[1]

[1]It is likely that this is because residentially stable persons are easier to locate and more likely to yield completed interviews.

To measure the race-ethnic, tenure, and economic composition of Los Angeles neighborhoods, I use 1990-2000 tract information for Los Angeles County. These data include the number of persons in each tract in each of the four race-ethnic groups (non-Hispanic whites, non-Hispanic blacks, Hispanics, and Asians), the (categorical) distribution of income and housing prices in each tract, and the proportion of households in the tract who own (or rent) their housing unit. Given that many neighborhoods changed between 1990 and 2000, and given that the LA FANS retrospective mobility histories span the years 1998-2000, I use linear interpolation between the decennial Censuses to predict the composition of neighborhoods experienced by the LA FANS respondents in years between Censuses.

I use the 20th percentile rent in each tract as a measure of neighborhood prices. I chose the 20th percentile rent because it is one indicator of the lower bound of affordability in the neighborhood, and correspond to the idea of an economic threshold that individuals must meet in order to enter the neighborhood. If individuals have a nonzero probability of moving into a neighborhood with a given 20th percentile rent, this implies that the individual can afford at least 20 percent of the housing units there.[2]

Given the limited number of parameters that can be estimated with the LA FANS discrete choice models, I collapse neighborhood proportion Asian and neighborhood proportion white into a single measure of neighborhood proportion white and Asian. In the Census models, I allow for separate effects of proportion white and proportion Asian.

2.2. **Identifying Price Thresholds.** One idea motivating this study is that economic factors may create thresholds in individuals' ability to purchase or rent in certain neighborhoods. I want to test whether, conditional on household income, the probability of moving into a given neighborhood is discontinuous at a given threshold housing unit price. In other words, I want to see if, conditional on income, certain households are barred from entering certain neighborhoods because they cannot pay the rents.

[2]Admittedly, this modeling strategy is somewhat awkward, as individuals do not need to afford 20% of all neighborhood housing units, but only the one housing unit that they are considering. A more natural modeling strategy is to use housing units as possible destinations (with associated unit price and neighborhood composition). Revisions of this paper will contain these estimates.

Figure 1 describes one possible relationship between housing costs and the probability of choosing a housing unit, for an individual with a given set of resources (e.g., household income and/or assets). The x-axis is the price of housing units, and the y-axis is the probability of residential choice. The point c^* denotes an (unknown) threshold ratio of housing costs to resources; threshold c^* will vary by individuals' race, income, and/or wealth. For an individual with a given economic status, the probability of moving into a given housing unit increases with the unit price up to the point c^*. In other words, people want to live in the best housing they can afford. But once housing becomes unaffordable, the probability of moving into a unit drops off sharply and levels off. In other words, individuals distinguish among affordable units, but are indifferent over all unaffordable (unattainable) units. Note that this choice function assumes that price is an indicator of quality (and that individuals try to maximize their housing quality subject to price constraints). The function shown in Figure 1 is only one of any number of ways of representing the relationship between housing costs and the probability of choice. The fundamental issue is whether or not the critical point c^* exists, and how this point varies across race and income groups. I construct a variable that is the ratio of monthly income to monthly rent, and use this measure to see if the data support the existence of these income thresholds.[3]

2.3. **Models of Residential Choice.** A first step in developing an empirically grounded computational model of residential mobility and neighborhood change is to examine how people actually evaluate neighborhoods. Mare and Bruch (2001) investigate the shape of individuals' preference functions using retrospective mobility histories of LA County residents taken from the LA FANS. They estimate discrete choice (conditional logit) models (McFadden 1973, 1978) for how the probability of choosing a residential location depends on the race/ethnic composition of that location, and that of all other possible destinations.

[3]In results not shown, I use a non-parametric approach to determine the empirical shape of these choice functions. These results show that no LA FANS household earning more than $17,000 per year spends more than 40% of its income on rent, and very few households spend more than 30% of income on rent. These results suggest that a nonlinear continuous function describes the relationship between income, 20th percentile rent, and the probability of choosing a housing unit.

The models incorporate the effects of individuals' own race as well as their opportunities for mobility; that is, the racial composition of all neighborhoods to which they might move.

I build on the work of Mare and Bruch (2001) to estimate models of housing choice that incorporate other characteristics of individuals (race, income, and tenure) and neighborhoods (racial composition and housing prices). I treat both household income and housing tenure as fixed characteristics of people that do not change over time.[4] Mobility decisions are modeled as a discrete time process, and each individual makes up to two decisions.[5] The estimated parameters of these models, combined with census data on the characteristics of actual neighborhoods, enable me to estimate mobility rates between specific neighborhoods. In the next section of this paper, these mobility rates are incorporated into an agent-based model to study the implication of individuals' preferences and associated mobility rates for neighborhood composition and segregation.

The discrete choice models used in this paper assume that Los Angeles residents choose among destination neighborhoods located in Los Angeles County.[6] Thus, for the lth individual who is considering the jth neighborhood destination in the tth period, neighborhood utility is a function of one or more of the following neighborhood and individual traits:

$\mathrm{U}_{jt} = \mathrm{F}(\text{Race/Ethnicity}_{l}, \text{Income}_{l}, \text{Housing Costs}_{jt}, \text{Race/Ethnic Composition of Potential Destinations}_{jt}, \mathrm{D}_{ljt})$, where D_{ljt} equals 1 if potential destination j is the tract of origin for individual l in year t and equals 0 otherwise.

[4] In the first wave of the LA FANS, I only observe a household's tenure status and income at the time of the survey. But the LA FANS residential mobility data are retrospective. Of course it is possible that households may have experienced upward or downward income mobility or changed tenure status prior to the time of the survey. Once subsequent waves of the LA FANS data have been collected, I will have measures of income and tenure status at least two points in time, and thus will be able to relax these restrictions and allow for both income and tenure mobility.

[5] In this analysis, LA FANS respondents can move up to once per year for a total of two possible moves over the two year period. Modeling mobility behavior in discrete years raises the issue that some LA FANS respondents may move more than once within a given year. For the sake of simplicity, I treat mobility decisions as a discrete time (annual) process in the current analysis. While most LA FANS respondents move at most only once in a given year, a small subset of respondents move two or more times within a year. In future work I will investigate modeling mobility behavior in continuous time.

[6] This is a simplifying assumption. Future work will allow for the possibility that people enter and exit LA County.

I can write the utility function as the probability that a respondent of race/ethnicty R and income I moves to jth neighborhood at time t as:

$$p_{jt}^{RI} = \frac{e^{F_{RI}(p_{jt1},...,p_{jtm},rat_{Ijt},r_{jt},o_{jt})}}{\sum_{k=1}^{K} e^{F_{RI}(p_{kt1},...,p_{ktm},rat_{Ikt},r_{kt},o_{kt})}}, \tag{1}$$

where the denominator sums over tracts, p_{jt1},...,p_{jtm} denote the racial composition in the jth neighborhood at time t, rat_{Ijt} is the ratio of respondent's income I to the 20th percentile rent in the jth neighborhood at time t, and o_{jt} and r_{jt} denote the logged number of owners and renters in the neighborhood.[7]

Sampling the Neighborhood Alternatives. One problem is the extraordinary computational burden imposed on estimating choice probabilities for each possible destination for each individual in the sample. Table 1 shows that, given that each individual faces 1652 possible alternatives in each move opportunity, the total number of person-year-options is 4,289,668. However, it is possible to obtain consistent estimates of the coefficients by drawing a sample of possible destinations for each respondent (McFadden 1978; Ben-Akiva and Lerman 1985). If I subsample the alternatives, it is possible to estimate a modified version of the discrete choice model in 1, which is:

$$p_{jt}^{RI} = \frac{e^{F_{RI}(p_{jt1},...,p_{jtm},rat_{Ijt},r_{jt},o_{jt})-lnq_{ijt}}}{\sum_{k=1}^{K} e^{F_{RI}(p_{kt1},...,p_{ktm},rat_{Ikt},r_{kt},o_{kt})-lnq_{hkt}}}, \tag{2}$$

where q_{ijt} denotes the (known) probability of sampling the jth census tract for the ith individual in the tth year and the remaining notation is as defined above. In practice, I draw a stratified sample of alternatives within each of the person years in the LA FANS and Census samples.

Choice Based Sampling. As mentioned above, another problem that affects the LA FANS analysis is that it is a biased sample of destinations. The LA FANS survey is a stratified probability sample in which the sampling strata are partially defined by neighborhood

[7] I include the logged number of owners and renters because neighborhoods with more housing units have, all things being equal, a higher probability of being chosen.

poverty rate. Thus, at the time of the survey, the 65 tracts sampled over-represent the poor neighborhoods of Los Angeles. The sampling strata in the LA FANS design correspond to Los Angeles County Census tracts that are very poor, poor, and non-poor. The total Los Angeles population distribution of tracts at the time of the survey was: very poor: 9%, poor: 34%, non-poor: 56%. The distribution of the tracts sampled for inclusion in the LA FANS was: very poor: 27%, poor: 37%, non-poor: 36%.

Given that the ultimate interest is neighborhood choice, the stratified sampling methods used to select tracts for inclusion in the survey is tantamount to sampling on the dependent variable, and therefore biases estimated coefficients. While the retrospective mobility histories may include moves from any potential destination in Los Angeles, the sample of moves for LA FANS respondents are conditional on the respondents ending up in one of the 65 tracts sampled at the time of the survey. Since households tend to move among similar neighborhoods, the characteristics of previous residences will be correlated with the characteristics of current residence. Therefore, I must adjust the coefficients to account for the non-random sample of destinations at the time of the survey.

Manski and Lerman (1977) demonstrate that unbiased coefficient estimates can be obtained using the following weighting scheme. The Manski-Lerman estimator relies on weights of the following form (where, for example, i indexes the LA FANS poverty sampling strata):

$$W(i) = \frac{\text{population proportion in stratum } i}{\text{sampled proportion in stratum } i}$$

However, the LA FANS data have the additional wrinkle that while a biased sample of neighborhoods was drawn at the time of the survey, households were free to move anywhere prior to the time of the survey (conditional on ending up in one of the sampled neighborhoods at the time of the survey). Thus the tracts that households occupied prior to the time of the survey are neither an purely choice-based sample nor are they are random sample of all neighborhoods in Los Angeles. I compute a separate set of weights for each month of the two-year mobility window in order to reflect the fact that the sampled proportion in the three strata will change over months.[8] The Manski-Lerman weights are then the population proportion for the appropriate stratum divided by the sample proportion for the appropriate stratum and month.[9]

2.4. **Results.** Table 2 summarizes models estimated using the LA FANS and Census data and reports their log-likelihoods. Both the Census and the LA FANS models include information on the proportions white, black, Asian, and Hispanic in each census tract. In the LA FANS models Asians and whites are combined into a single category, while the Census models allow separate white and Asian effects. The models also include the 20th percentile rent in each tract, which may affect its attractiveness or affordability to potential movers. The effect of 20th percentile rent on neighborhood attractiveness is represented in the model as the ratio of monthly income to monthly rent. The models allow for the possibility that neighborhood traits influence residential choice in a nonlinear way. For example, neighborhoods that have almost no black residents may be very unattractive to blacks, neighborhoods in which blacks have significant representation may be very attractive, and neighborhoods that are almost 100 percent black may also be unattractive. Similarly, individuals may select the most expensive housing they can afford.

The LA FANS models allow for the possibility that the composition of a neighborhood affects individuals differently depending on whether they are evaluating their current place of residence or evaluating other possible destination neighborhoods.

Both the Census and the LA FANS models allow individuals to respond to their own race group differently from others. That is, these models allow for blacks to respond to neighborhood proportion black differently from other race groups, Hispanics to respond to

[8] I compute the sample proportions in each category by month of the residential calendar in the following way: for each month j, I compute the number of sampled (chosen) neighborhoods for month j and the number of sampled (chosen) neighborhoods in stratum i in month j. To compute the sample proportion in stratum i for month j, I divide the number of sampled neighborhoods in stratum i in month j by the number of sampled neighborhoods in month j. Within months, the sample proportions in the three strata sum to 1. If a selected tract falls into stratum i in month j, it receives the weight associated with stratum i and month j.

[9] I can provide a Stata program that will calculate the conditional logit model with Manski-Lerman weights and corrected standard errors to interested readers.

neighborhood proportion Hispanic differently from other race groups, and whites and Asians to respond to neighborhood proportion white and Asian differently from other race groups.

The Census models allow for the possibility of group-specific tendencies to be drawn to or avoid neighborhoods in which other groups are well represented. In other words, the models allow blacks to evaluate neighborhood proportion Hispanic differently from whites and Asians, and Hispanics to evaluate neighborhood proportion black differently from whites and Asians. Similarly, these models allow whites to respond to neighborhood proportion Asian differently from blacks and Hispanics, and Asians to respond to neighborhood proportion white differently from blacks and Hispanics.

Finally, the Census models allow the effects of neighborhood housing prices conditional on income to vary across race groups. For example, these models allow for the fact that, even after controlling for income, blacks may end up in poorer neighborhoods than whites.

For each data source, I estimate three models: (1) models that include only income effects; (2) models that include only race effects; and (3) models that include both race and income effects. These coefficients and their associated z-statistics are reported in Tables 3 and 4.

LA FANS. The model coefficients from the LA FANS models are shown in Table 3. The parameter estimates indicate that, over the course of a year, individuals are much more likely to remain in their own neighborhoods than to move. We also see that the race and income estimates are fairly stable across models. Beyond these observations, it is difficult to interpret the models from the parameters alone. Further insights can be obtained from predicted probabilities of neighborhood choice as a function of racial composition and 20th percentile rent. These probabilities are predicted from the parameter estimates for Models 1.1-1.3 shown in Table 3, and are presented separately for the choice of a new neighborhood and the decision to remain in one's own neighborhood.

Figures 2 and 3 show the probabilities predicted from Model 1.1 (race effects only). Figure 2 displays the probability of moving into a new neighborhood. In selecting new neighborhoods, whites and Asians prefer to enter areas with low to moderate levels of Hispanics and blacks. Not surprisingly, Hispanics are more likely to live in areas that have a high concentration of Hispanics. Both blacks and Hispanics tend to end up choosing areas with low concentrations of whites and Asians.

The corresponding predicted probabilities for remaining in one's own neighborhood, shown in Figure 3, follow similar patterns to the in-migration probabilities in Figure 2, albeit at much higher overall levels. We see that whites tend to avoid Hispanics, while blacks typically remain in areas with moderate proportions Hispanic. On the other hand, the higher the proportion Hispanic, the more likely it is that Hispanics will choose to remain in the current tract. This may be because high proportion Hispanic tracts tend to be poor; and people who end up in these tracts may not have the resources to leave them. As in Figure 2, whites are more likely to choose to remain in the current tract when the proportion white or Asian is high, while blacks and Hispanics have lower probabilities of remaining in the current tract as the proportion white or Asian increases. We also see that whites and Asians, and to a lesser extent Hispanics, are more likely to leave a neighborhood when it has a high concentration of blacks. Blacks, on the other hand, are more likely to remain in the current neighborhood as the black representation increases.[10]

These estimates demonstrate that individuals take account of the race-ethnic composition of neighborhoods when deciding if and where to move. These patterns may result from a number of underlying social processes. While race-ethnic prejudice may govern residential choices to some degree, the ethnic composition of neighborhoods is also correlated with other factors that determine neighborhood attractiveness (Harris 1997). For example, neighborhoods vary in levels of crime, quality housing, and poverty. These factors are captured (crudely) with a measure of neighborhood 20th percentile rent. We now turn to a model that examine how individuals respond to neighborhood prices (1.2 in Table 3).

Figure 4 below shows the probability of moving into a neighborhood as a function of neighborhood 20th percentile rent. The first thing to observe is that this response function is not monotonically decreasing; individuals prefer to live in more expensive neighborhoods up to a certain point. This is probably because the price differences capture unmeasured

[10]But keep in mind that in 2000 less than 5 percent of the Census tracts in LA County were more than 50 percent black.

neighborhood desirability. These plots provide modest support for the threshold hypothesis illustrated in Figure 1. Low-income individuals (i.e., family incomes of around $20,000) do have what appears to be a threshold-shaped response to housing prices, although not as pronounced as that shown in Figure 1. For higher income individuals, these thresholds disappear.

Figure 5 shows the probability of choosing to remain in the current neighborhood as a function of neighborhood 20th percentile rent. Here we see a much flatter response to prices than in the previous graph. This makes sense because the vast majority of people who choose to remain in their current neighborhood are in fact choosing not to move at all, and if someone can afford to live in a housing unit in one year it is very likely that he or she can afford to live there in the next year. However, we can see that if the individual is living in a neighborhood where 20th percentile rents are extremely high relative to one's income, the probability of choosing to remain in the neighborhood drops off.

Finally, we examine residential choice when individuals take account of both racial and economic factors in evaluating neighborhood desirability. Predicted probabilities from Model 1.3 are reported in Figures 6-9. The income plots are shown in Figures 6 and 7. The main thing to notice is that these income plots look quite similar to those for the model where individuals do not take racial factors into consideration when evaluating a neighborhood (Figures 4 and 5). Thus, accounting for neighborhood racial composition does not have a marked effect on response to neighborhood 20th percentile rent.

Figure 8 shows the probability of moving into a neighborhood for the three race-ethnic groups by neighborhood racial composition. We see that, after accounting for neighborhood prices, whites and Asians appear more tolerant of blacks and Hispanics. This suggests that at least part of the reason that whites and Asians avoid predominantly Hispanic and/or black neighborhoods is because of economic factors and/or neighborhood characteristics correlated with prices (e.g., crime rate). Similarly, after conditioning on 20th percentile rent and respondents' incomes, we see that both blacks and Hispanics are more likely to choose areas with a higher proportion of whites. The same patterns are also shown in Figure 9.

These estimates provide evidence to suggest that, after conditioning on the relationship between individual income and housing prices, individuals are more willing to tolerate some level of integration (although the level of tolerance varies by race group). We also see some support for the idea that that low income households may experience income thresholds such that they cannot move into certain neighborhoods due to price constraints.

2000 Census. We now turn to the residential choice models estimated using the 2000 Census data. Recall that these models are based on a cross-section of the population of Los Angeles in 2000, and do not distinguish neighborhood choices in which individuals changed neighborhoods from decisions in which individuals remained in their current neighborhood. Unlike the LA FANS models, the Census estimates allow for a variety of cross-race effects and do not combine Asians and whites into a single race category. They also allow different race groups to respond differently to neighborhood prices conditional on income.[11]

Figure 10 shows the probability of choosing a neighborhood by neighborhood racial composition (model 2.1). I compare the response probabilities in this figure with Figures 2 and 3. Notice that Asians and whites do not respond in the same way to neighborhood proportion white, Hispanic, or Asian. Whites tend to avoid areas with large numbers of blacks and Hispanics, and they tend to choose neighborhoods with only a few Asians. Asians, however, prefer areas that are approximately half white and half Asian; they avoid blacks but tend to choose areas with a moderate Hispanic presence.

Figure 11 shows the response profiles from a model that assumes individuals only care about neighborhood rents (model 2.2). Because the Census model allows each race group to have a different response to neighborhood 20th percentile rent, this plot shows how individuals of varying race-ethnicity with an income of $20,000 respond to 20th percentile rent. We see that blacks and Hispanics have a negative response to prices; conditional on income, the higher the neighborhood price, the less likely blacks and Hispanics are to live there. In

[11] One role of the Census data in this analysis is to confirm that my correction for the biased sample of neighborhoods in the LA FANS is working. In work not shown, I estimated the same models using the LA FANS (with Manski-Lerman weights) and Census data, and found that these data sources produced similar estimates.

contrast, both Asians and Whites have a low probability of moving into the least expensive neighborhoods, and tend to choose somewhat more expensive areas. This may be because whites and Asians have more wealth on average than blacks and Hispanics (and therefore even conditional on income whites and Asians can afford to live in more expensive housing), or it may be that whites and Asians are paying a premium to avoid Hispanics and/or blacks. Another possible explanation is that whites and Asians pay more in order to avoid poor residential areas, whereas blacks and Hispanics do not.

Figure 12 shows the probabilities predicted from model 2.3, which allows individuals to respond to both the racial and economic composition of neighborhoods. We see some support for the idea that whites and Asians pay a premium to avoid poor (presumably minority) neighborhoods. After controlling for racial factors, whites and Asians are more likely to choose less expensive areas. Also, once I control for neighborhood racial composition, blacks and Hispanics have a flatter response to neighborhood rent. It's possible that racial factors sort blacks and Hispanics into poorer neighborhoods than they could otherwise afford. This is consistent with Bayer et al. (2004), who argues that the scarcity of middle-class black neighborhoods forces the black middle class to choose between white middle-class neighborhoods and poorer black neighborhoods. Should the size of the black middle class increase it would be possible for new middle-class black areas to form, thereby relieving the prior supply constraint and leading to an increase in race segregation.

Finally we turn to Figure 13, which shows how blacks, whites, Asians and Hispanics respond to neighborhood race composition conditional on 20th percentile neighborhood housing price. After controlling for prices, blacks and Hispanics have a slightly higher probability of living in areas with white representation. Conditional on prices, Hispanics are also more willing to live among blacks. However, controlling for prices does not change whites' and Asians' tendency to avoid black neighborhoods.

The Census models suggest that certain key features of neighborhood choice may be omitted from or incorrectly specified in the LA FANS models. For example, the Census models show that whites and Asians have different neighborhood mobility patterns, and it seems unwise to combine them into one group. Also, the Census models show that different race groups respond differently to neighborhood housing prices, even after conditioning on income. This may be because whites and Asians pay a premium to avoid living in predominantly Hispanic or black areas.[12]

Overall, these results show that individuals appear more willing (or able) to live among other race groups after conditioning on economic factors. We also see some evidence that price thresholds may limit poor people from entering more expensive areas. Recall that my approach consists of two parts: statistical estimation of residential choice models, and a realistic agent-based model that demonstrates the implications of these choices for aggregate patterns of residential change. The primary goal of this paper is to demonstrate the power of this method of linking individual behaviors and collective outcomes. In the next section I incorporate the LA FANS models into the agent-based model of neighborhood change.

3. A DYNAMIC MODEL OF NEIGHBORHOOD CHANGE IN LOS ANGELES

In this section, I describe the agent-model of residential mobility in Los Angeles. This model reveals the aggregate implications of the behavioral models presented in the previous section, that is, how individuals' choices about where to live collectively generate segregation outcomes. My aim for designing this computational model is to make it correspond closely to real-world space and time so that eventually the neighborhood change predicted in the model can be compared to observed neighborhood change in Los Angeles.

3.1. **The City.** The model uses map (Geographic Information Systems, or GIS) data for Los Angeles County at the block, block group, and tract level to create the realistic space in which the agents move about. Agents, the artificial "people" of agent-based models, live in housing units within Census blocks, and their neighborhoods are their current block plus

[12]The main advantage of the LA FANS data is that I can allow individuals to evaluate their own neighborhood differently from all other possible destinations. But I would also like to preserve the ability to estimate a more flexible model of neighborhood choice. In the next stages of this work, I will combine these two data sources to estimate one set of discrete choice models that incorporate the strengths of both the LA FANS and the Census.

all contiguous blocks.[13] The structure of these data is hierarchical: agents live in housing units, which are nested within Census blocks, which are nested within block groups, which are nested within tracts in Los Angeles County.

Agents are characterized by their race and income. Housing units can be vacant or occupied by an agent, and are characterized by their price and the race composition of the neighborhood. Eventually the model will include both owners and renters (and owned and rented housing units), but for now the model only includes rented housing units and a population of renters. The socioeconomic characteristics of agents and housing units in this model are a 10 percent sample of the rented units and households documented in the 1990 Los Angeles County decennial Census data.[14] Thus, at the beginning of the simulation, the agents are arranged on the simulated city such that the distribution of agents across tracts in the model matches the distribution of renting households across LA County Census tracts in 1990.[15] In other words, if in 1990 LA County tract 10100 is 30% Hispanic and has a median income of $35,000 and a 5% vacancy rate, then tract 10100 in the agent-based model is expected to be 30% Hispanic, and has a median income of $35,000 and a 5% vacancy rate.

3.2. **How It Works.** After the model has been initialized with a sample of the renter population in Los Angeles County, agents are given opportunities to move. In each time step, 5% of agents and 50% of vacant housing units are sampled using simple random sampling with replacement.[16] Using the appropriate LA FANS neighborhood choice model described above, the selected agents calculate transition probabilities for their current neighborhoods and the neighborhoods surrounding all available vacancies. Based on these probabilities, each sampled agent moves into another neighborhood in the city or remains in its current

[13] Neighborhoods are parameters in the model that can be adjusted. For example, neighborhoods can include second order contiguous blocks, block groups, or pedestrian-friendly areas bounded by major streets.

[14] However, given the extremely low vacancy rate documented in the decennial Census (less than 5%), I artificially inflate the vacancy rate to 10% in order to allow agents more mobility opportunities. I assume that vacancies are evenly spread across the county.

[15] I initialize the agent model at the tract level because the smallest geographic unit of analysis available in the STF4 public use files is the tract. Conditional on living in a given tract, agents are allocated randomly to blocks within tracts.

[16] Agents are sampled in these 5% clumps in order to make the model run faster. Neighborhood composition is not updated until all of the sampled agents have completed their moves.

residence. Any agent who moves leaves its previous cell vacant for another agent to move into. In the next time period, a second 5% sample of agents is randomly drawn; these agents evaluate their options, and decide whether and where to move based on their vector of transition probabilities. In the third period, yet another sample is drawn, and the process continues. Obviously, the opportunity structure for each agent changes over subsequent moves. Thus, the economic and race/ethnic composition of neighborhoods available to agents as they make their mobility decisions is a function of all previous moves by other agents.[17]

Updating Housing Prices. As the composition of neighborhoods change, we expect that housing prices will change as well. I initialize prices using the decennial Census data, but allow prices to change as a function of neighborhood turnover. In the simulation runs reported below, I assume that higher income and higher cost areas are more desirable. Thus, the distribution of rents in a neighborhood to follow the income distribution in that neighborhood. I divide the income distribution into quantiles, and specify that a given quantile of rents in that neighborhood is 0.3 of the corresponding income quantile. I choose the 30 percent benchmark since this is a standard measure of housing affordability (Quigley and Raphael 2004).[18] In the simulations reported below, rents are updated every 5 time steps (after 25% of the agents have had the opportunity to move).

3.3. **Neighborhood Turnover Predicted by the Model.** Figure 14 shows the index of dissimilarity computed over 300 runs for the three behavioral models. The top panel shows the Hispanic-White/Asian, Black-Hispanic, and Black-White/Asian indices of dissimilarity for the model assuming that individuals behave according to Model 1.1 (race effects only).

[17]It is possible to calibrate the model to real time by linking the simulated mobility rate to annual mobility rates reported in survey or Census data, although this link is not made for the analyses reported in this paper.

[18]There are other ways of updating housing prices. For example, Bayer's (2002) technique for updating prices in a simulation model uses a market mechanism to set prices. Prices are computed such that the market "clears." In other words, I compute the aggregate demand for each housing unit, and set prices such that (at most) only 1 agent can move into each housing unit. Thus, prices in more attractive areas are set high enough (and prices in less attractive areas are set low enough) to offset the relative differences in neighborhood quality. Market prices imply that people are indifferent among neighborhoods. The agent-based model allows prices to be updated using this method. But because the LA FANS residential choice functions are nonlinear in price, there is not a unique set of prices that will clear the market when agents behave according to these functions. I am still trying to figure out how to get around this.

Under this model, we see that all measures of segregation increase over time.[19] The segregation of both whites/Asians and Hispanics from blacks appear to increase most rapidly. In sharp contrast, the middle panel of Figure 14 shows the indices of dissimilarity that result from a simulation assuming that agents behave according to Model 1.2 (income effects only). Here we see that all three measures of segregation decrease sharply over the 300 time steps; they also appear to decrease at more or less the same rate. Finally, the bottom panel of Figure 14 shows the segregation that results assuming that agents consider both the racial composition and the prices in their destination neighborhoods (Model 1.3). Under this model, Hispanic-White/Asian segregation declines quite sharply, but Black-Hispanic and Black-White/Asian segregation levels decline slightly but stay fairly stable over time.

These simulation results suggest that, under the behavioral models estimated from the LA FANS applied to the population of LA County in 1990, sorting on the basis of income will decrease segregation, while sorting on the basis of race will increase segregation. For black-Hispanic and black-white/Asian segregation, racial and economic factors have offsetting effects. While there is lukewarm evidence for income thresholds in the behavioral models, the level of income inequality in the Los Angeles population is not sufficient to generate high levels of segregation as a result of these thresholds.

4. CONCLUSIONS AND NEXT STEPS

These results illustrate the ways in which individual-level preferences for neighborhoods generate patterns of neighborhood change. Changing residential patterns, in turn, alter the relative attractiveness of neighborhoods for future potential movers. The results presented here are mainly to demonstrate the feasibility of this dynamic model. The simulations in their current form do not constitute a complete or even credible forecast of neighborhood

[19] Readers familiar with Bruch and Mare (2005) will note that, in that agent-model, realistic neighborhood choice models did not generate segregated neighborhoods. This is because when residential choice functions are continuous we observe scale effects. In other words, whether or not racial tolerances/preferences produce high levels of segregation depends on size and organization of space in which individuals move about. This means that it's not enough to look at differences in residential preferences and behavior across cities; the same behaviors will produce different expected patterns of neighborhood turnover in different areas. Thus, realistic choice functions that generate integration on an artificial lattice can generate segregation on a realistic urban space. See pages 38-9 in Bruch and Mare (2005) for a more detailed discussion of scale effects.

change in Los Angeles. At the very least, the model assumes a population with a static socioeconomic distribution and closed to growth through immigration and natural increase.

At the same time, these results are useful for isolating the effects of racial and economic factors on residential mobility and subsequent neighborhood change. The discrete choice models suggest that, after conditioning on economic factors, individuals are more willing to tolerate racially integrated neighborhoods. We also observe from the Census models that, even after conditioning on income differences among race groups, blacks and Hispanics choose poorer neighborhoods than their white and Asian counterparts. If the results presented here are to be believed, residential sorting by income alone would lead to a marked decrease in neighborhood race segregation. Residential choice on the basis of racial factors alone, on the other hand, would lead to an increase in existing patterns of racial segregation. For black-Hispanic and black-white/Asian segregation, these two factors appear to offset one-another.

While the descriptions of individuals' mobility behavior detailed in Section 2 are useful in their own right, the contributions of this paper are primarily conceptual and methodological. I have developed a realistic agent-based model that links individual level mobility behavior to changes in neighborhood composition. This model provides a dynamic mechanisms for changes in neighborhood segregation between cross-sectional observations and for linking observations on individual behavior to aggregate patterns of segregation. This work is an improvement over previous empirical work in that I allow both neighborhoods and rates of mobility between them to be endogenous to the model.

This model is similar to Schelling's original dynamic models of segregation. But I go beyond Schelling in a number of important ways. First, I estimate individual-level choice functions from mobility behavior in real populations. Second, I demonstrate how to combine behavioral functions based on sample data with population data on real world neighborhoods in an agent-based model. This enables me to combine the analytical advantages of agent-based modeling with the ability to compare the simulation results with neighborhood change in real populations. Thus, my approach blends Schelling's models of population dynamics with the descriptive demography of residential segregation. Finally, this model allows for the possibility that individuals consider factors other than race in their evaluations of neighborhoods. This allows me to examine how different characteristics of individuals and neighborhoods may offset or exacerbate the effects of one another in generating patterns of segregation.

While the possibility that racial and economic sorting have offsetting effects on race segregation is provocative and interesting, it is not yet clear the extent to which these results can help us understand segregation in Los Angeles county. There are a number of unresolved issues at hand, some of which are substantive and some of which relate to how the microsimulation model is constructed. In my current work, I am extending the present analysis in several different directions (Bruch 2005).

(1) I am currently combining the Census and LA FANS data sources in a single model of residential choice. This model allows me to utilize the strengths of the LA FANS (which permit me to estimate the "cost of moving" parameter and its interactions with neighborhood and individual characteristics) and the Census data (which can be used to estimate more complex and nuanced models of neighborhood choice).

(2) The choice functions reported in this paper assume that individuals choose neighborhoods (not housing units within neighborhoods), and they use the 20th percentile rent as a measure of housing affordability. This is a fairly crude measure of price effects. A better measure would be the actual price of the unit chosen. I will estimate models of housing choice to see if this affects my estimates of individuals' responses to prices conditional on income.

(3) In addition to studying how actual levels of income inequality affect segregation outcomes, I will also examine what segregation outcomes occur under alternative assumptions about income inequality within and among race groups. These simulations will explore how overall trends in income inequality interact with sorting processes to produce observed segregation patterns.

(4) The model presented in this paper assumes a world in which there are only renters. It is plausible that some proportion of race segregation may be accounted for by differences in

homeowner status by race group, and the segregation of owned and rented housing in space. Moreover, if the market for housing is bifurcated (that is, owners search in one market, and renters search in another) and rented and owned housing is unevenly distributed across neighborhoods, we would expect inequalities in homeownership to contribute to observed patterns of race segregation since owners and renters are effectively searching for housing in different neighborhoods. Future work will examine how tenure differences affect residential mobility and segregation outcomes.

(5) In this paper I use a simple mechanical method for updating housing prices in the agent-based model. Future work will include more market-based mechanisms for updating prices. I am currently experimenting with two different methods for updating housing prices. One fairly simple way of updating housing prices in the model is to use hedonic regressions. Using 2000 Census data, I regress logged housing prices on tract race and income composition, to determine the relationship between neighborhood characteristics and expected rent. I then use these regression equations in the agent-based model to update prices. A more explicitly market based approach, adapted from Bayer's (2002), uses a market mechanism to set prices. Prices are computed such that the market "clears." In other words, I compute the aggregate demand for each housing unit, and set prices such that (at most) only 1 agent can move into each housing unit. Thus, prices in more attractive areas are set high enough (and prices in less attractive areas are set low enough) to offset the relative differences in neighborhood quality.

(6) One advantage of an agent-model that incorporates real data is that the model output can be compared with real-world neighborhood change. In future work, I will determine the extent to which the model can explain observed patterns of residential turnover in Los Angeles. This evaluation produces, not only an overall assessment of goodness-of-fit for the computational model, but also information about specific areas or neighborhood types where the model cannot capture broad trends. This information provides clues as to what key determinants of neighborhood change are missing from the model, or incorrectly specified.

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Table 1. Summary of Observations in L.A. FANS and Race-Ethnic and Income Composition of L.A. County

Census Tracts (1990 Census): 1639
Respondents in LA FANS Data: 1366

	Total	White	Black	Hispanic	Asian
Mobility Decisions					
Year 1	1,243	197	144	827	75
Year 2	1,362	217	153	905	87
Total	2,605	414	297	1,732	162
Race-Ethnic Composition					
L.A. FANS	100.00	15.89	11.40	66.49	6.22
2000 Census	100.00	35.21	13.44	40.12	11.20
Median Income					
L.A. Fans	$20,000	$35,227	$20,636	$17,775	$36,002
2000 Census	$42,189	$53,978	$31,885	$33,820	$47,656
Moves Between Tracts					
Year 1	119	18	24	71	6
Year 2	188	29	27	125	7
Total	307	47	51	196	13
Person-Year-Options (Total)					
Year 1	2041006	323474	236448	1357934	123150
Year 2	2248662	358267	252603	1494155	143637
Total	4289668	681741	489051	2852089	266787
Person-Year-Options (Choice-Based Sample)					
Year 1	21,216	3,356	2,615	14,091	1,273
Year 2	23,295	3,708	2,462	15,458	1,480
Total	44,511	7,064	5,077	29,549	2,753

Note: This sample is restricted to households who rent.

Table 2. Models of the Effects of Respondent and Tract Characteristics on Residential Choice

Model	Data Source	Own-Tract Effect	Separate Asian and White Effects	Response to Price differes by Race	Own-Group Preferences	Cross-Group Preferences	Racial Composition	Economic Composition	Number of Parameters	Log Likelihood
1.1	Census	No	Yes	No	Yes	Yes	Yes	No	16	1535
1.2	Census	No	Yes	Yes	Yes	Yes	No	Yes	5	1575
1.3	Census	No	Yes	Yes	Yes	Yes	Yes	Yes	21	1525
2.1	LA FANS	Yes	No	No	Yes	No	Yes	No	21	-18883956
2.2	LA FANS	Yes	No	No	Yes	No	No	Yes	8	-16753195
2.3	LA FANS	Yes	No	No	Yes	No	Yes	Yes	29	-15700041

Table 3. Effects of Respondent and Tract Characteristics on Residential Choice, LA FANS data

Variable	Beta	|z(B)|	Beta	|z(B)|	Beta	|z(B)|
	Model 1.1 (Race Effects Only)		Model 1.2 (Income Effects Only)		Model 1.3 (Race and Income Effects)	
Dij	15.923	6.68	10.215	22.22	17.011	6.88
Ratio			13.880	2.95	17.101	3.65
Dij * Ratio			-10.727	2.47	-9.311	2.11
$Ratio^2$			-33.020	3.54	-32.993	3.62
Dij * $Ratio^2$			24.597	2.62	19.946	2.06
%black	11.019	4.45			11.182	4.58
Dij * %black	-15.779	5.83			-15.865	5.94
$\%black^2$	-17.464	5.01			-17.228	4.96
Dij * $\%black^2$	15.112	3.93			14.896	3.92
black * %black	-7.113	3.72			-6.196	3.27
black * $\%black^2$	16.845	4.58			16.033	4.4
%Hispanic	7.700	1.48			7.92	1.51
Dij * %Hispanic	-12.432	2.19			-12.756	2.21
$\%Hispanic^2$	-8.500	2.28			-8.487	2.25
Dij * $\%Hispanic^2$	7.095	1.74			7.282	1.77
Hispanic * %Hispanic	-5.843	3.44			-5.314	3.12
Hispanic * $\%Hispanic^2$	8.031	4.37			7.599	4.12
$(\%White + \%Asian)^2$	-0.629	0.28			-0.061	0.03
Dij * $(\%White + \%Asian)^2$	-6.547	2.65			-6.924	2.76
(White or Asian) * $(\%White + \%Asian)^2$	3.601	11.46			3.108	9.03
Log Likelihood	-1535		-1575		-1525	
N	23352		23352		23352	

Note : Models also include logged numbers of owners and renters, and correction for sampling that is the natural logarithm of the sampling fraction, and the estimates are computed using Manski-Lerman weights. Coefficients for logged number of owners and renters and not shown.

Table 4. Effects of Respondent and Tract Characteristics on Residential Choice, 2000 Census data

Variable	Beta	|z(B)|	Beta	|z(B)|	Beta	|z(B)|
	Model 2.1 (Race Effects Only)		Model 2.2 (Income Effects Only)		Model 2.3 (Race and Income Effects)	
Ratio			18.737	442.12	2.423	53.68
$Ratio^2$			-22.565	316.33	-6.889	103.89
black * Ratio			-23.669	171.28	19.134	91.49
black * $Ratio^2$			13.412	46.69	-38.4565	89.97
Hispanic * Ratio			-17.491	228.71	7.398	78.64
Hispanic * $Ratio^2$			7.743	52.95	-15.988	94.79
Asian * Ratio			-4.462	41.65	-1.886	15.52
Asian * $Ratio^2$			1.347	7.05	-1.167	6.03
%black	-3.069	84.09			-4.046	101.74
$\%black^2$	-7.438	104.75			-6.334	84.17
black * %black	17.102	297.08			17.727	264.25
black * $\%black^2$	-3.681	42.64			-4.778	49.92
Hispanic * %black	0.993	21.87			1.000	19.83
Hispanic * $\%black^2$	6.573	80.49			5.845	66.93
%Hispanic	-3.667	110.83			-4.912	134.21
$\%Hispanic^2$	-2.610	114.02			-1.801	71.58
Hispanic * %Hispanic	5.968	115.94			6.120	106.56
Hispanic * $\%Hispanic^2$	0.372	11.12			-0.167	4.53
black * %Hispanic	1.727	25.79			0.842	10.58
black * $\%Hispanic^2$	2.665	44.58			2.979	41.80
%Asian	-1.965	59.76			-2.809	75.84
$\%Asian^2$	-0.842	17.71			-0.487	9.29
Asian * %Asian	8.581	153.66			9.654	154.13
Asian * $\%Asian^2$	-8.499	117.66			-9.295	116.19
White * %Asian	-1.640	33.31			-1.171	21.40
White * $\%Asian^2$	-2.442	35.79			-2.576	34.85
$\%White^2$	-3.609	134.25			-4.312	143.26
White * $\%White^2$	1.082	32.29			1.479	39.63
Asian * $\%White^2$	-3.133	80.76			-2.315	54.03
Log Likelihood	-18883956		-16753195		-15700041	
N	56492630		56492630		56492630	

FIGURE 1. One Possible Relationship between Housing Costs and an Individual's Resources

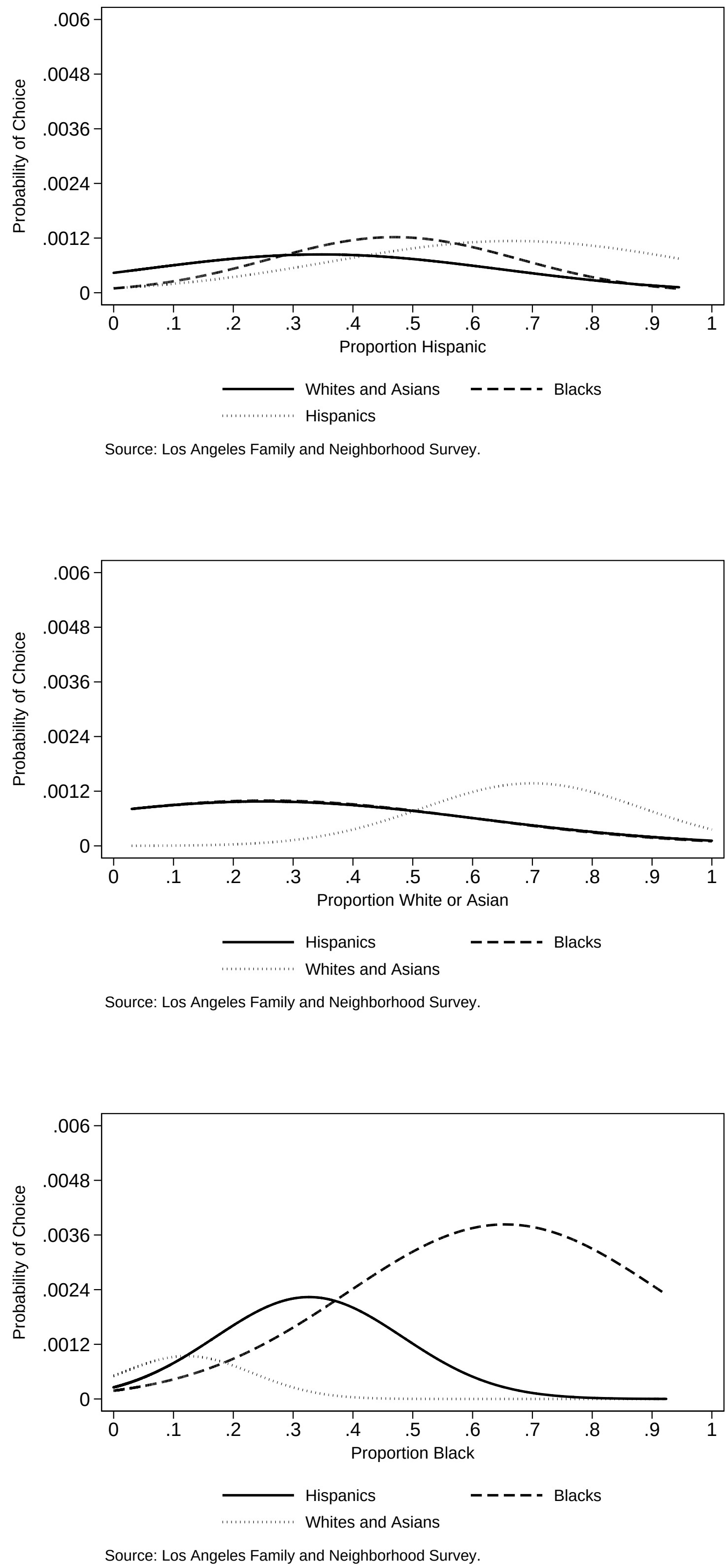
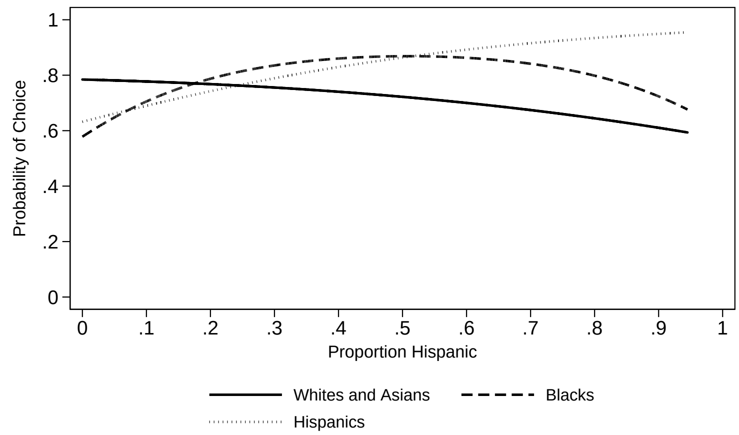
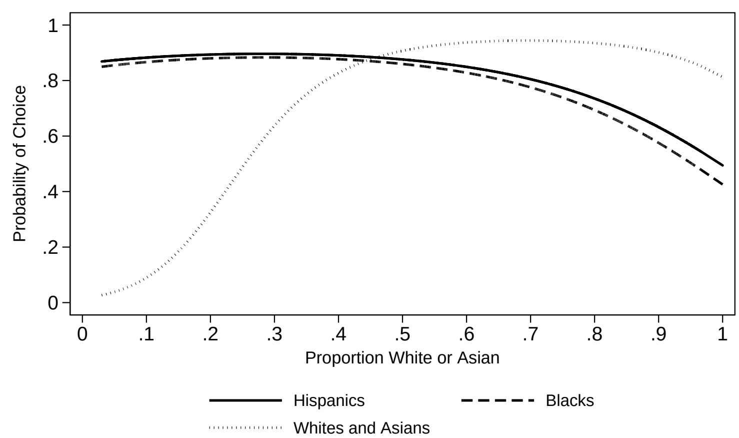


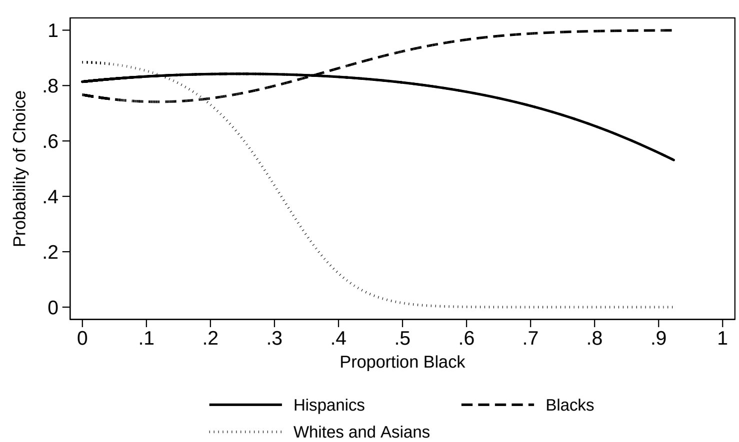
Figure 2. Probability of Moving into a Neighborhood, Conditional on Neighborhood Race Composition, Model with only Race Effects



Source: Los Angeles Family and Neighborhood Survey.



Source: Los Angeles Family and Neighborhood Survey.



Source: Los Angeles Family and Neighborhood Survey.

FIGURE 3. Probability of Staying in Current Neighborhood, Conditional on Neighborhood Race Composition, Model with only Race Effects

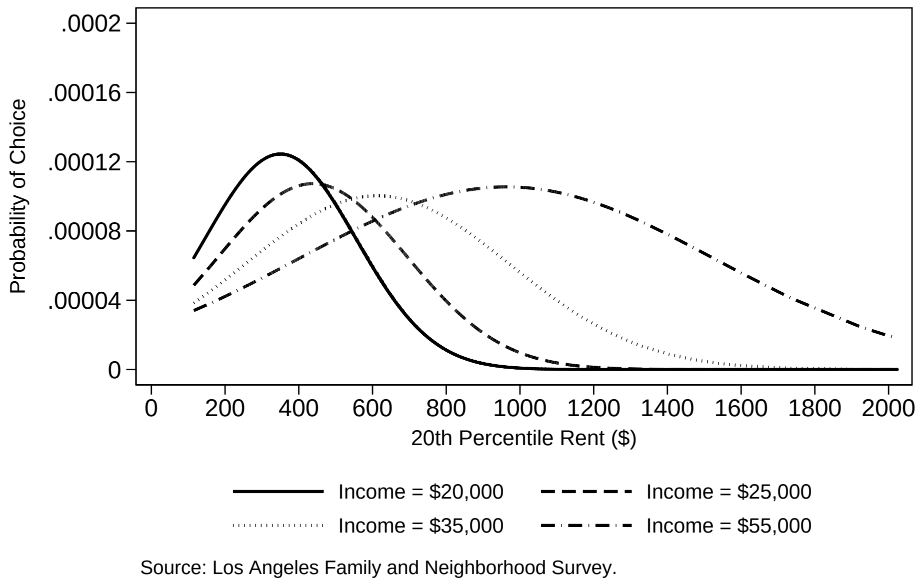


FIGURE 4. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Moving to a New Neighborhood, Model with only Income Effects

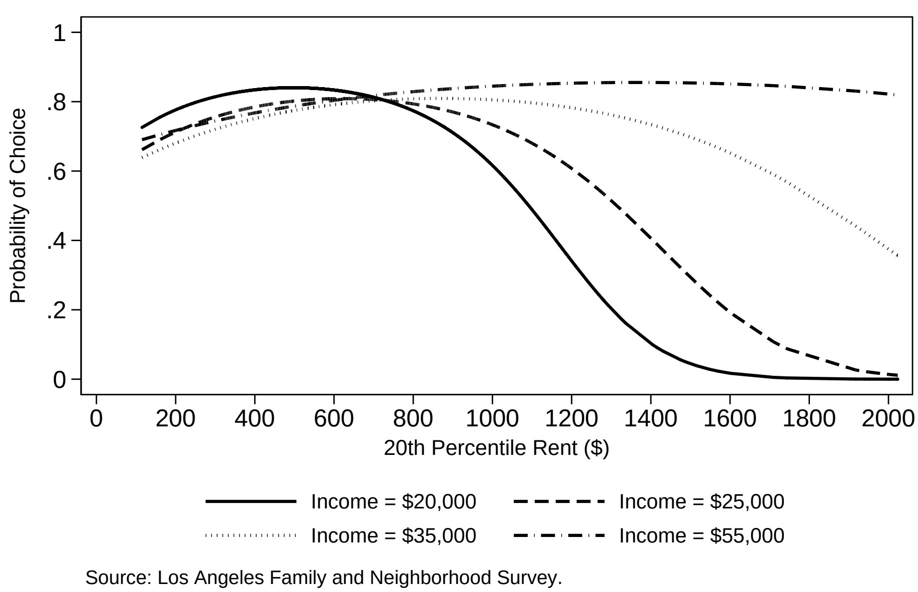


FIGURE 5. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Staying in Current Neighborhood, Model with only Income Effects

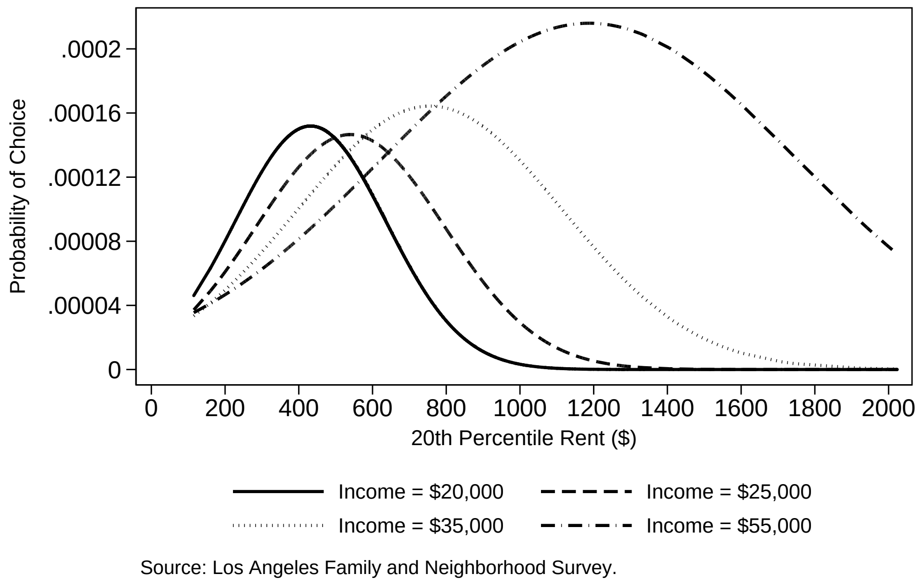


Figure 6. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Moving to a New Neighborhood, Model with Race and Income Effects

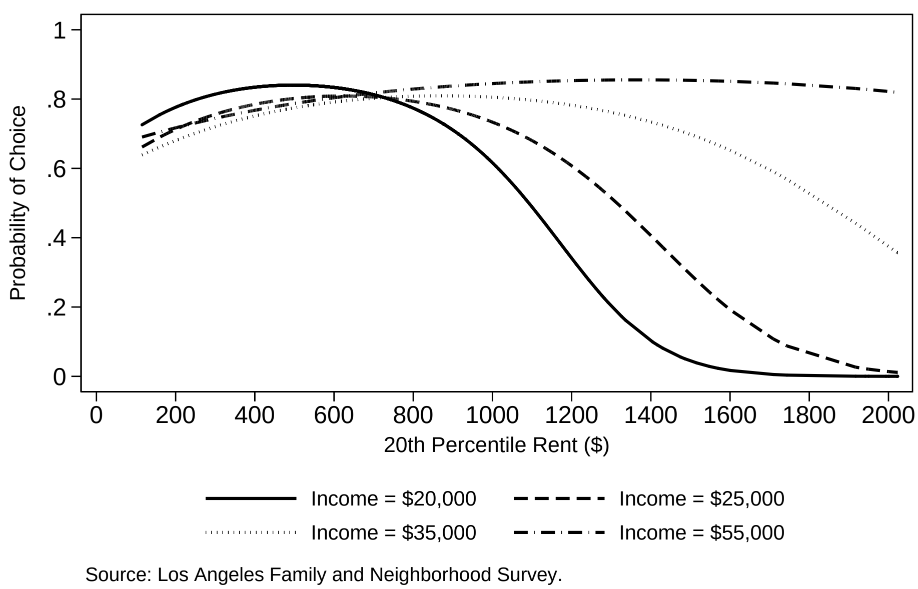


Figure 7. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Staying in Current Neighborhood, Model with Race and Income Effects

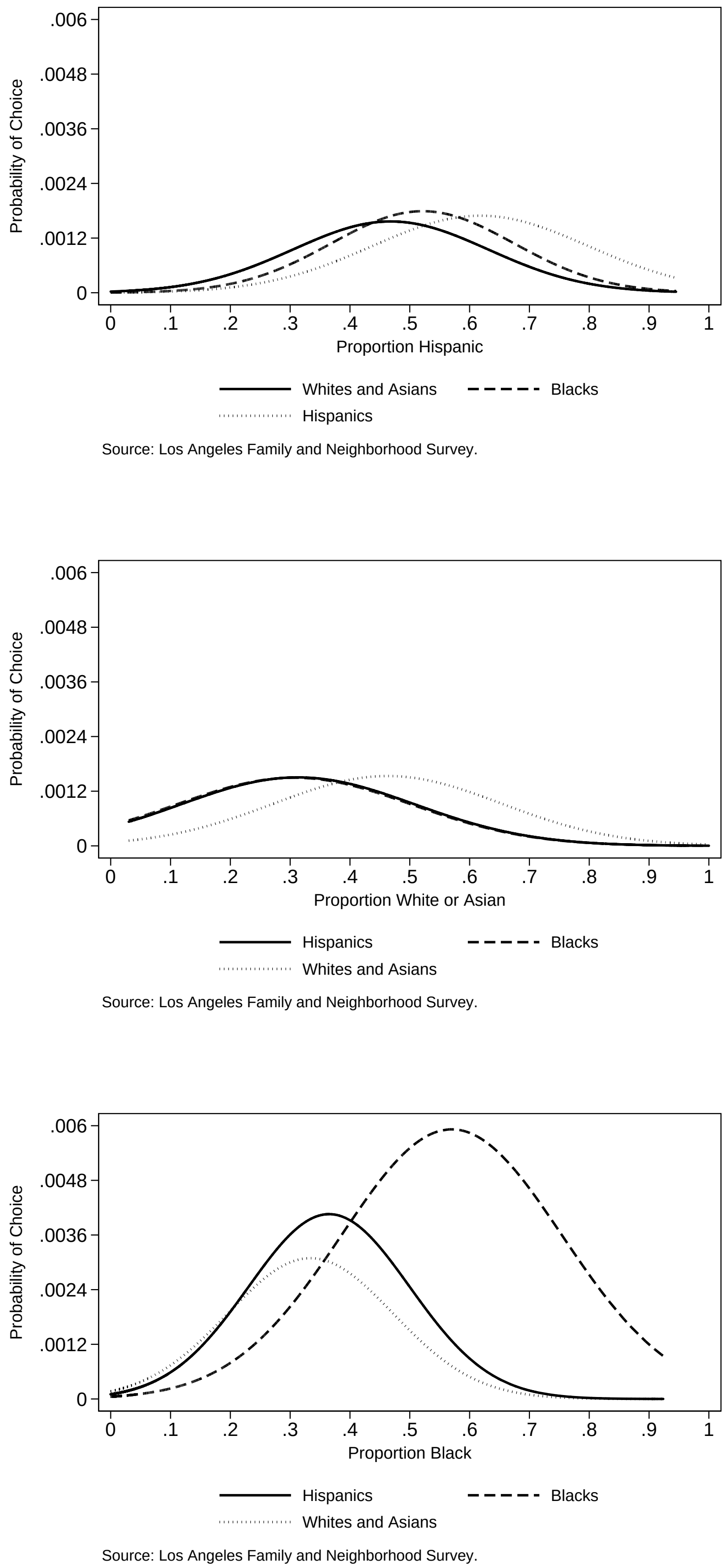
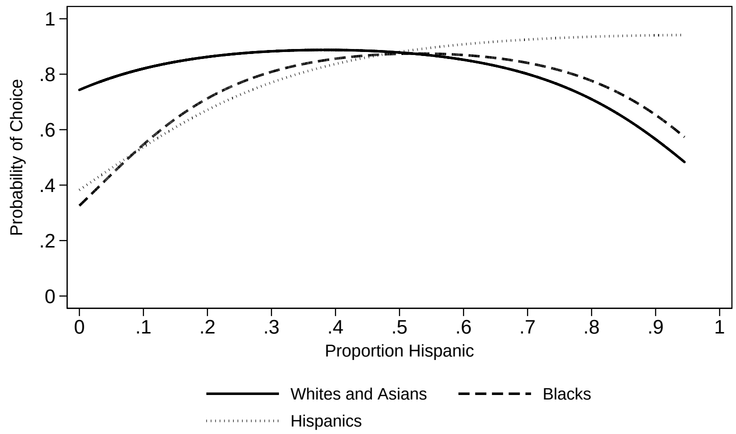
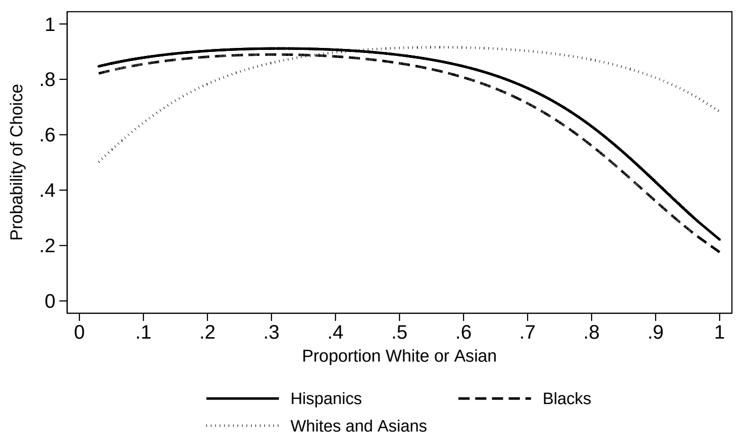


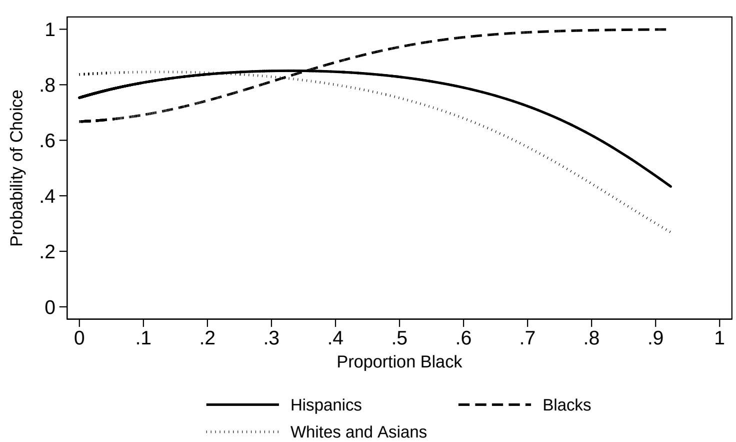
FIGURE 8. Probability of Moving into a Neighborhood, Conditional on Neighborhood Race Composition, Model with Race and Income Effects



Source: Los Angeles Family and Neighborhood Survey.



Source: Los Angeles Family and Neighborhood Survey.



Source: Los Angeles Family and Neighborhood Survey.

FIGURE 9. Probability of Staying in Current Neighborhood, Conditional on Neighborhood Race Composition, Model with Race and Income Effects

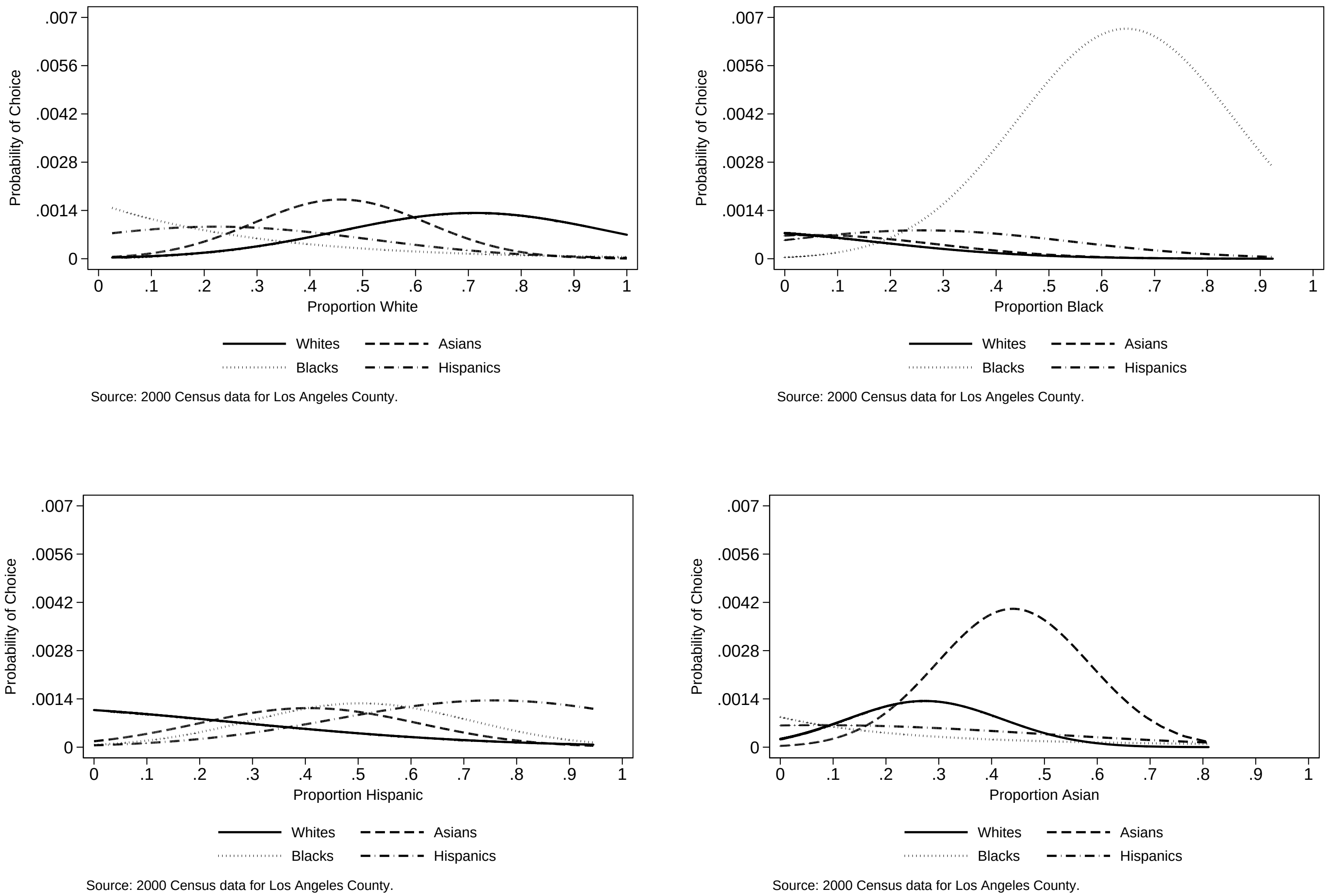


FIGURE 10. Probability of Moving into a Neighborhood Conditional on Neighborhood Race Composition, Model using Census Data with only Race Effects

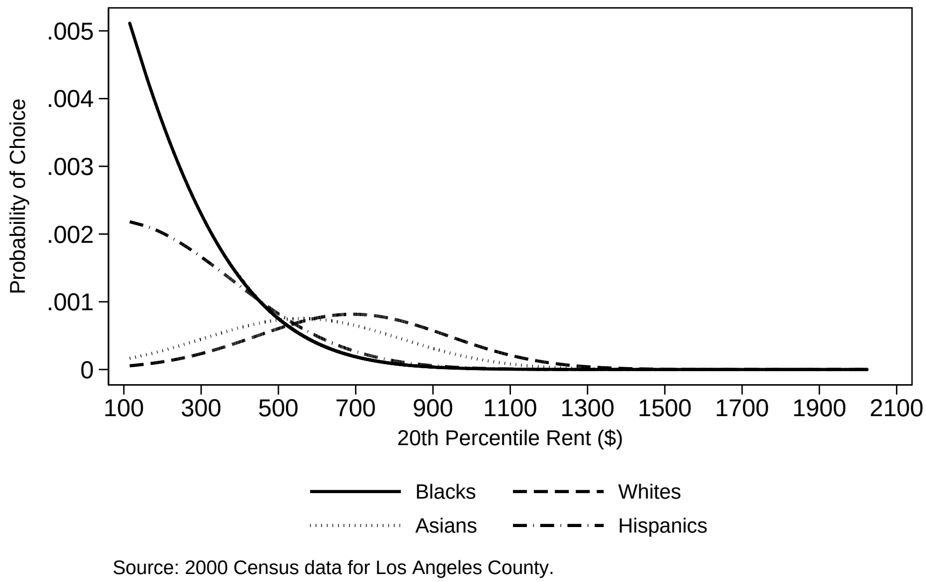


Figure 11. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Moving to a New Neighborhood, Model Using Census Data with only Income Effects

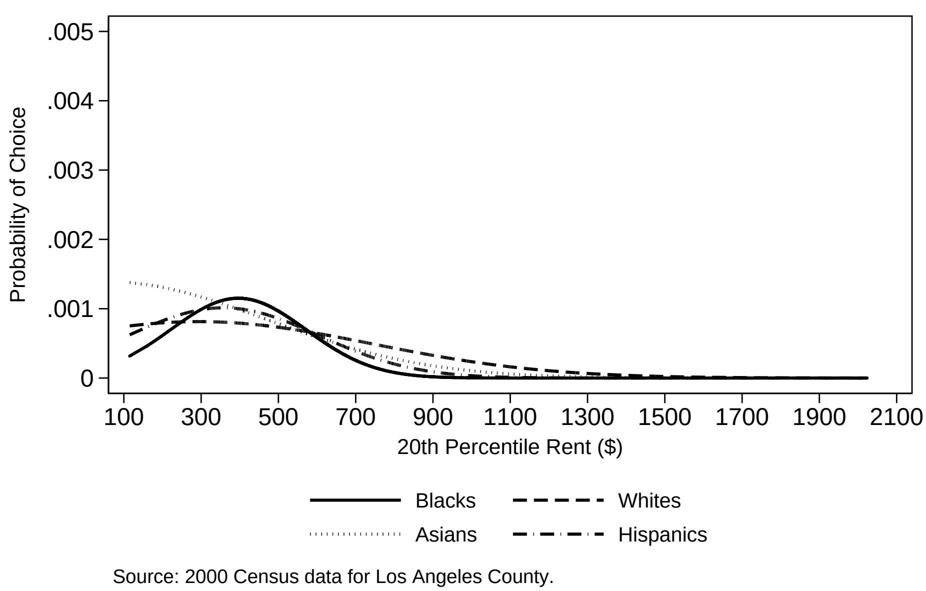


Figure 12. Relationship between Ratio of Income to 20th Percentile Rent and Probability of Moving to a New Neighborhood, Model Using Census Data with Race and Income Effects

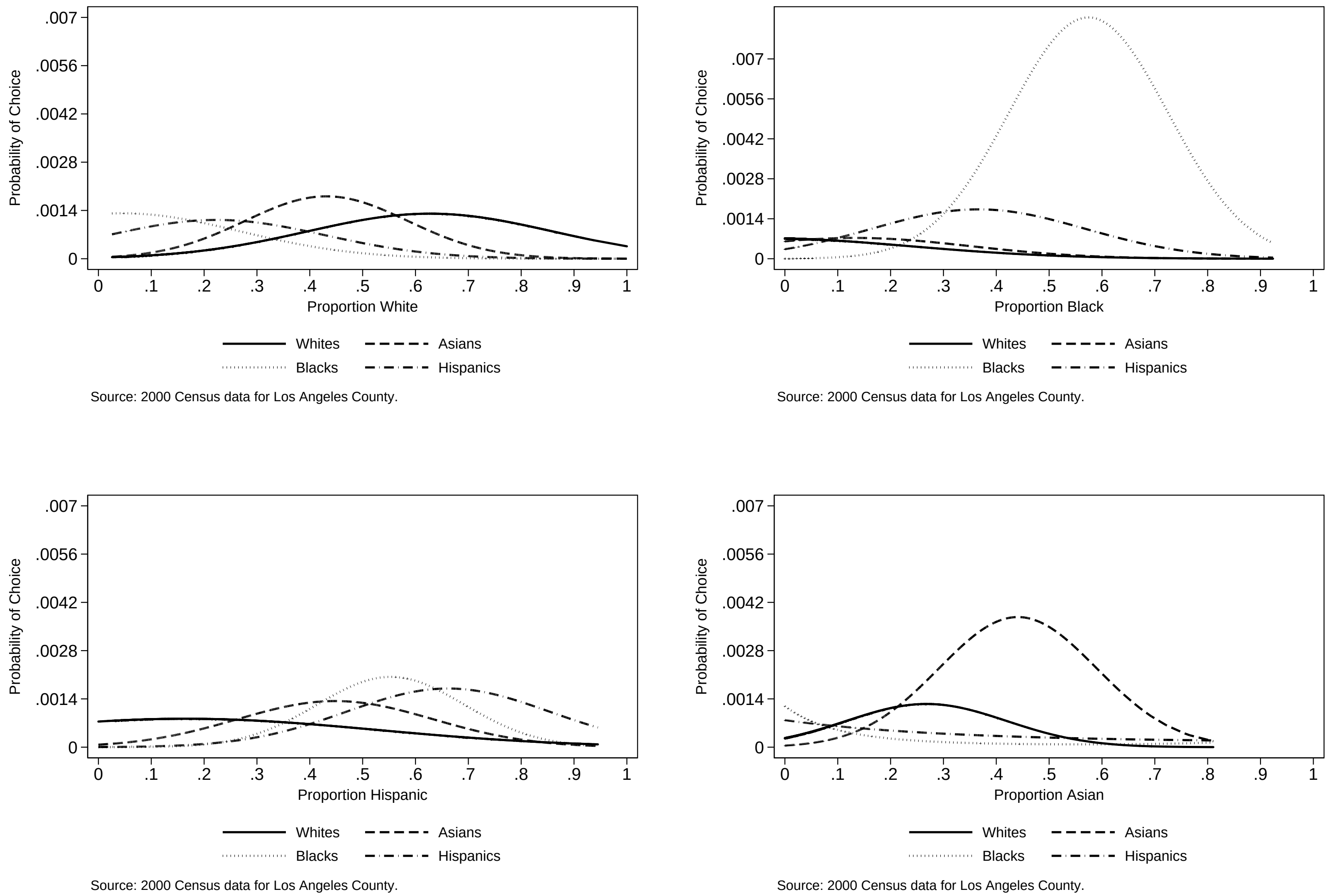


Figure 13. Probability of Moving into a Neighborhood, Conditional on Neighborhood Race Composition, Model Using Census Data with Race and Income Effects

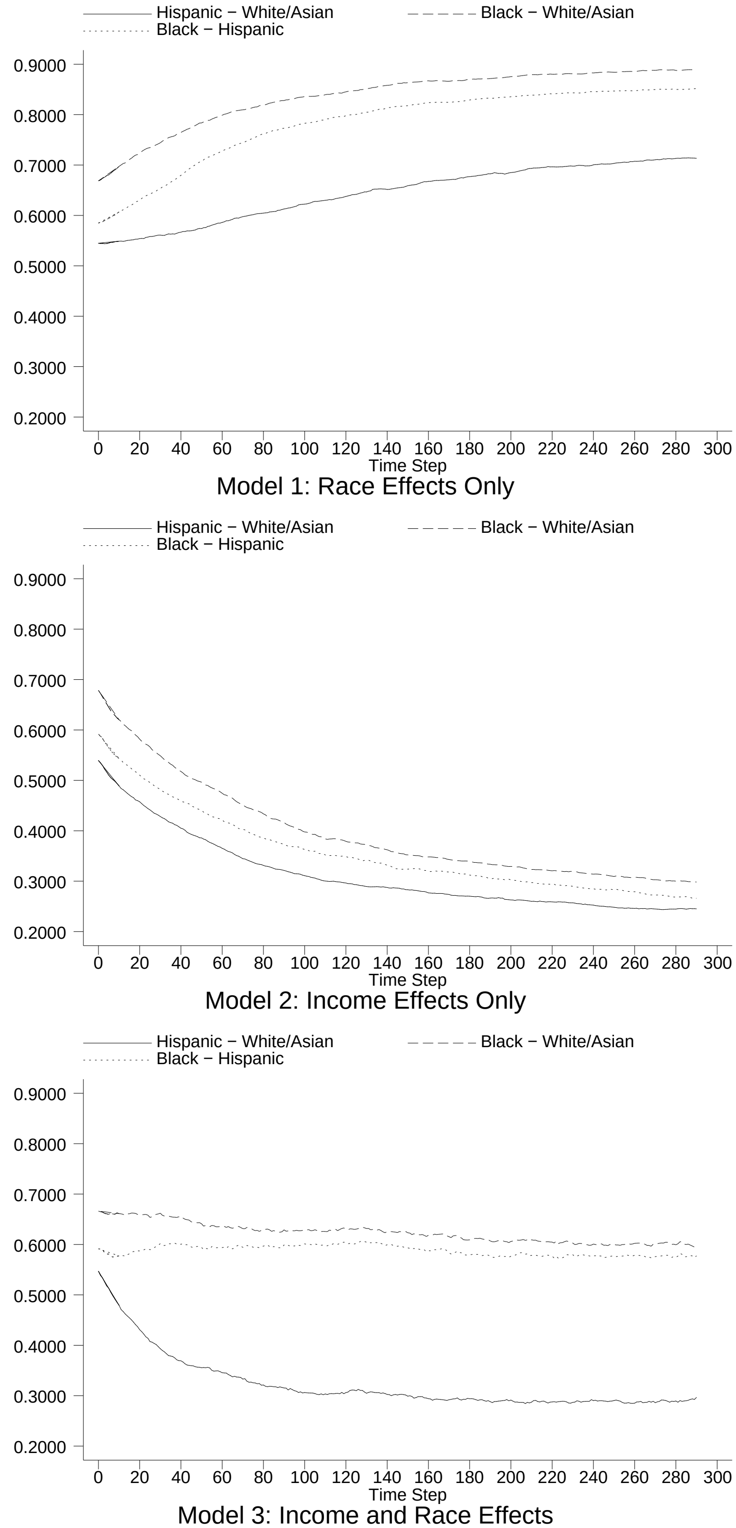


Figure 14. Indices of Dissimilarity from Simulation Models