Spatial Inequality, Neighborhood Mobility, and Residential Segregation

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AND RESIDENTIAL SEGREGATION*

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This paper is concerned with stability and change in neighborhoods in large
metropolitan areas. During the past 20 years, economic inequality among neighborhoods
has grown and may be a source of widening inequality in other realms as well (e.g.,
Reich 1991; Jargowsky 1996). Numerous studies have focused on the possible effects of
residential neighborhoods on a variety of social and economic outcomes (e.g., Brewster
1994; Brooks-Gunn, Duncan, and Aber 1997). Likewise, persistent residential
segregation among racial and ethnic groups is implicated in enduring racial and ethnic
inequality (e.g., Massey and Denton 1993). Yet our understanding of the dynamics of
how neighborhoods are formed and how they change remains limited. A long tradition of
research has documented trends in economic and racial segregation in American cities,
relying on cross section census data (e.g., Duncan and Duncan 1957, Taeuber and
Taeuber, Frey and Farley 1996, Massey and Denton 1993, Jargowsky 1996; 1997).
While descriptively valuable, these studies have not revealed the causal mechanisms
behind neighborhood change. Inasmuch as change occurs through residential and
socioeconomic *mobility*, a dynamic approach is required. More recently, others have
examined survey data on residential preferences in an effort to understand the attitudinal
underpinnings of residential segregation (e.g., Farley, Fielding, and Krysan 1997; Frey
and Farley 1996; Charles 2000). The rationale for these studies is that segregation is, at
root, the result of individual choices about where to live which are determined in part by

individuals' attitudes and preferences about the characteristics of neighborhoods.

Although these studies are informative, lacking a model of how individual attitudes lead

to residential mobility and how mobility leads to neighborhood change, they provide

limited insight into how change occurs. As Schelling (1971; 1972) observed 30 years

ago, the dynamic links between individual preferences and residential segregation are by

no means intuitive. Another promising line of research has been to use panel survey data

on geographic mobility to measure mobility among neighborhoods of varying economic

and racial composition (e.g., Gramlich, Laren, and Sealand 1992; Massey, Gross, and

Shibuya 1993; Quillian 1999a; 1999b). While providing valuable information on patterns

of neighborhood turnover, this work has not yet 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 is unsatisfactory because it 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. In sum, the study of residential segregation and inequality remains a

lively area of research in which many of the core analytic issues are unresolved.

Schelling (1971; 1972; 1978) laid the conceptual groundwork for understanding

the links between individual preferences and behavior on the one hand and the evolution

of neighborhoods on the others. Using rudimentary computational models applied to

artificial agents, he showed how the preferences of autonomous individuals about where

to live give rise to (often unanticipated) aggregate patterns of residential segregation.

These patterns, moreover, are often at variance 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 they agents move, they alter the neighborhoods of other

agents in the system, engendering further moves by individuals who are trying to satisfy

their preferences.

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 understanding of changes in residential segregation

derives from careful description of segregation in successive census cross sections

without adequate attention to the underlying behavioral dynamics.   As a result we still

strong tools for answering such questions as: What are the respective effects of economic

and residential mobility on changing economic segregation? If race-based preferences

for residential location were eliminated, how long would it take for racial residential

segregation to be eliminated?   To what degree are the same race-ethnic groups

competing for the same neighborhoods and how does this affect segregation? What are

the likely future trends in segregation in large American cities? To address these

questions will require the development of models that incorporate the mechanisms of

neighborhood change identified by Schelling but that can be estimated from and used

with data on actual populations.

We address these issues in our research on recent neighborhood change in Los

Angeles. In this paper, we (1) develop and report estimates of a discrete choice model of

residential preferences and mobility; (2) use the parameters and predicted probabilities

from the discrete choice model to parameterize rates of mobility between neighborhoods;

(3) develop an aggregate model of neighborhood change in which, as in Schelling's model, neighborhood characteristics and rates of transition into neighborhoods are endogenous to individual preferences; and (4) present illustrative simulations of future trends in residential segregation that can be predicted from recent neighborhood conditions and the individual and aggregate models developed here.

Our discrete choice model for residential location can be estimated from individual-level panel data on mobility and aggregate neighborhood characteristics for a well-defined geographic region (such as a metropolitan area). A key feature of the discrete choice model is that it explicitly incorporates the effect of an individual's entire opportunity structure ("choice set") for mobility. That is, residential mobility is a function of the characteristics of individuals, in interaction with the characteristics of all possible neighborhoods to which they may move (including their own neighborhood). This is in contrast to the geographic mobility models in widespread use that focus exclusively on the characteristics of individuals or, at best, the characteristics of individuals' places of orgin (e.g., South and Crowder 1997; 1998). Such models cannot represent the key feature of a geographic mobility system, namely that each individual's mobility decisions are affected by the characteristics and past mobility decisions of every other individual in the system. Discrete choice models of the effects of residential opportunity structure enable one to capture this important set of mechanisms that govern geographic mobility.

In this paper we focus on the effects on residential mobility of the race-ethnic characteristics of individuals and the corresponding race-ethnic composition of neighborhoods, although our approach can also be extended to other dimensions of

socioeconomic segregation, such as income or educational attainment.   As discussed

further below, our models and analyses incorporate a number of other simplifying

assumptions as well. We address many of these in our ongoing research (Mare 2000).

The main goal of this paper is to present the basic features of our approach and to

illustrate them with realistic albeit incomplete data.

The balance of this paper is as follows. First, we describe our data sources.

Second, we present a discrete choice model for the effects of the race-ethnic

characteristics of neighborhoods on residential mobility decisions. Third, we present

estimates of the parameters of this model, which reveal the race-ethnic preferences of

individuals and how they vary across race-ethnic groups. Fourth, we present an

aggregate model of neighborhood change that incorporates the race-ethnic specific

mobility probabilities estimated from the discrete choice model. Fifth, we use the

aggregate model to simulate future changes in neighborhood composition and residential

segregation in Los Angeles. Finally, we conclude with a discussion of the strengths and

weaknesses of the present analysis and our agenda for future research.

Data

The analyses reported in this paper are based on two sources of data, preliminary

microdata from the Los Angeles Survey of Families and Neighborhoods (L.A.FANS) and

1997 census tract summary data for Los Angeles County.

L.A.FANS. The L.A.FANS is a panel study of approximately 3500 households in

65 neighborhoods (census tracts) within Los Angeles County. The first wave of the

survey has been conducted in 2000-01 and still remains in the field. It is expected that

subsequent waves will be conducted at approximately two-year intervals. 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.

Replenishment samples will be drawn to ensure that the survey continues to be

representative of the originally sampled neighborhoods. Over time, therefore, the survey

will continue to provide representative samples of (1) the original L.A.FANS cohort,

irrespective of its places of residence and (2) the 65 sample neighborhoods. For further

details, see Sastry *et al*. (2000).

        At the present time, the L.A.FANS is still in the field but data from 1270

completed interviews are available. Although these observations are not a random

subsample of the full L.A.FANS sample, they provide data of the form that we will use in

our ongoing research and that can illustrate our effort to understand neighborhood

change. The two-year mobility histories provide data on all changes of residence

experienced by respondents prior to their survey date. To simplify the present analysis,

we take a discrete time approach and focus only on the two one-year intervals prior to the

survey date. This approach omits a small number of moves by a few respondents who

move several times within a year, but results in the loss of only a small amount of

information.

        For the purposes of the present analysis, we assume that "neighborhoods" are

simply census tracts as defined in the 1990 Census. This is a crude approximation to the

areas that individuals define as their own neighborhoods or think about when considering

alternative places to move. Because the L.A.FANS obtains information about exact

addresses in each respondent's residential history, in future work it will be possible to use

more refined definitions of neighborhood, an approach that we will pursue once all of the

data for wave 1 are available.

Table 1 summarizes the information available for the analysis of residential

mobility using the preliminary L.A.FANS data. The 1270 respondents provide

information on 2423 annual mobility decisions.[1] As indicated by the comparison with the

1997 and 2000 population data for Los Angeles County, which are based primarily on

Census sources, our data overrepresent Hispanics and underrepresent non-Hispanic

whites and Asians. This reflects the nonrandom order in which the L.A.FANS interviews

have been completed. Despite the relatively large number of mobility decisions faced by

L.A.FANS respondents, they report only 210 annual moves during the two years prior to

the interview date, few enough number to limit the complexity of the statistical models

that we can estimate.   On average approximately 10 percent of L.A.FANS early

respondents move per year, approximately half the annual mobility rate typically

observed in national data. It is likely that this also reflects the unrepresentativeness of the

preliminary data inasmuch as residentially stable persons are easier to locate and more

likely to yield completed interviews early in the fieldwork period.

The mobility history information in the L.A.FANS enables us to examine the

processes by which individuals choose to move or remain in their places of residence

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[1] Respondents who failed to provide valid information about their location 12 months prior to the interview
date are omitted from our sample. Respondents who provided valid information about their location 12
months prior to their interview but failed to provide valid information about their location 24 months prior
to their interview are included in the data for the second year but excluded from the data for the first year.

and, if they move, the specific destinations that they choose. Although the sample is not

large enough to provide reliable estimates of mobility rates between specific

neighborhoods in Los Angeles, it provides a large enough sample of moves between

identifiable neighborhoods that we can estimate models of the effects of neighborhood

characteristics that attract and repel individuals and thus govern their mobility decisions.

The estimated parameters of these models, combined with census data on the

characteristics of actual neighborhoods, enable us to estimate mobility rates between

specific neighborhoods. As discussed further below, these mobility rates enable us to

examine the implication of mobility preferences and rates for neighborhood composition

and segregation.

    CENSUS SUMMARY DATA.   To measure the race-ethnic composition of Los

Angeles neighborhoods, we use census tract information for Los Angeles County in

1997. This information consists of data for 1997 for tracts defined by 1990 Census tract

boundaries. It consists of intercensal estimates, based on 1990 Census data updated with

information from vital statistics, Current Population Surveys, and administrative school

enrollment data.[2] The data include numbers of persons in each tract in each of four race-

ethnic groups (non-Hispanic whites, non-Hispanic Blacks, Hispanics, and Asians). We

also use these data when we examine the longer run implications of mobility patterns

observed in the L.A.FANS data by combining the estimated parameters from discrete

choice models based on the L.A.FANS (see below) with Census data on neighborhood

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[2] These estimates were prepared by the Los Angeles County Urban Research Division. The authors are
grateful to John Hedderson for giving us the estimates.

characteristics. The Census data provide the initial conditions for our simulations of the

effects of residential preferences on residential mobility and neighborhood formation.[3]

Models of Residential Choice

Our analyses of the determinants of residential preferences are based on discrete

choice (conditional logit) models for residential location (McFadden 1973; 1978). The

models incorporate the effects of individuals' personal characteristics as well as their

opportunities for mobility; that is, characteristics of all neighborhoods to which they

might move. In the analyses presented here, we examine only mobility within Los

Angeles County, although in further work we will extend the choice set to include all

census tracts in the Los Angeles Metropolitan Area plus residual categories for other

California, other U.S., and non-U.S. destinations. The models include attributes of

neighborhoods such as the proportion of residents in a given race-ethnic group, attributes

that do not vary across individuals, as well as possible interactions with individual level

characteristics such as race-ethnicity.

The model for residential choice is as follows. In this model the potential utility

that an individual expects from each potential destination (including the decision not to

move) is a function of his/her own ethnic group membership, the ethnic composition of

each potential destination, and whether a given destination would require that the

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[3] Data from the 2000 Census are available for Los Angeles census tracts and would provide a more representative picture of the city during the period that the L.A.FANS data were collected than the 1990 Census. However, census tracts in Los Angeles changed considerably in both numbers and boundaries between 1990 and 2000. The L.A.FANS sample design is based on 1990 and, thus far, the residential mobility histories have been coded only to 1990 tract locations. Once all of the wave 1 data are available, we will code the mobility data into 2000 tract locations as well as other geographic units.

individual move or stay. That is, for the ith individual who is considering the jth

neighborhood destination in the tth period,

(1) $U_{ijt} = F$(Ethnicity$_i$, Ethnic Composition of Potential Destinations$_{jt}$, D_{ijt}),

where D_{ijt} equals 1 if potential destination j is the tract of origin for individual i in year t

and equals 0 otherwise.

We can estimate the effects of these factors using a random utility model that is

specified as a conditional logit model for discrete choice (McFadden 1978). In particular,

if p_{ijt} denotes the probability of choosing the jth neighborhood in the tth period by the ith

individual, then the model can be written:

(2) $p_{ijt}(x_{ijt}) = [\exp(\beta x_{ijt})]/[\Sigma_{k \in C(i)} \exp(\beta x_{ikt})]$

where x_{ijt} and x_{ikt} denote vectors of attributes of tracts j and k (possibly interacted with

traits of individual i, β denotes a vector of parameters to be estimated, and C(i) denotes

the set of potential destinations of individual i. In principle, this model allows for the

possibility that individuals differ in the set of possible neighborhoods into which they can

move. In the present application, however, we assume that each individual has the

potential of moving to every neighborhood (census tract) within Los Angeles County.

Thus C(i) = C for all i.

A potential problem with this type of model is the extraordinary burden of

computing the choice probabilities for each possible destination neighborhood for each

individual in the sample. In the present case, we have 1639 census tracts, each of which

is a possible destination for the 2,423 individual mobility decisions in our sample,

resulting in an effective sample size of 1,639 x 2,423 = 3,971,297 "tract-decisions," far

too large for efficient computation. It is possible, however, to obtain consistent estimates

of the discrete choice model by drawing a choice-based sample from the set of possible

destinations (McFadden 1978; Ben-Akiva and Lerman 1985). If we subsample the

alternatives, it is possible to estimate a modified version of the discrete choice model,

which is

$$(3) \qquad p_{ijt}(x_{ijt}) = [\exp(\beta x_{ijt} - \ln q_{ijt}]/[\Sigma_{k \in C(i)} \exp(\beta x_{ikt} - \ln q_{ijt})],$$

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, we

draw a stratified sample within each of the 2,423 person years in our preliminary sample.

Thus, each person year is represented at least once in the sample. We design the

stratification according to the following rules:

  (a) if the alternative tract is the one in fact chosen, $q_{ijt} = 1.0$;

  (b) if the alternative tract is the origin tract, $q_{ijt} = 1.0$;

  (c) if the tract is neither the one chosen nor the origin tract, select at random with

    $q_{ijt} = 0.1$.[4]

This procedure yields an estimation sample of 42,531, which is computationally

manageable. Table 1 summarizes the information available in the L.A.FANS for this

type of analysis, including the number of decisions, number of moves, and the number of

options faced by respondents in both the total sample and the choice-based subsample.

We estimate the discrete choice model using software for a standard conditional logit

model in which the coefficient of $\ln q_{ijt}$ is constrained to equal 1.0.[5] McFadden (1978) and

Ben-Akiva and Lerman (1985) provide extensive discussions of this procedure.

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[4] In fact, since most mobility decisions result in the choice of the origin tract (that is, most decisions are to
stay), typically conditions (a) and (b) are either both met or both not met.
[5] We estimated the models reported in this paper using Stata (StataCorp 2001) and treating -$\ln q_{ijt}$ as an
"offset" in the model.

Residential Choice and Race-Ethnic Preferences

Our discrete choice models focus on the effects of the race-ethnic composition of

neighborhoods on residential choice. In each period, individuals face the probability of

staying within their neighborhood or moving to another neighborhood within Los

Angeles County.[6] Our models allow for the following types of effects. First, we

recognize that individuals face a cost to moving and thus are, all things being equal, more

likely to choose their current place of residence than to move. As shown in equation (1),

this is represented as the effect of a dummy variable that equals 1 if the tract in question

is the current tract of residence and 0 if the tract is a different tract from the current tract

of residence. Second, we include information on the race-ethnic composition of each

census tract, which may affect its attractiveness to potential movers.   Our models allow

for the possibility that this effect is nonlinear. 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. To incorporate these effects we

include the linear and quadratic terms for the proportions in each of four race-ethnic

groups (non-Hispanic whites, Hispanics, non-Hispanic blacks, non-Hispanic Asians) as

separate variables in the discrete choice models.[7] Third, we allow the effects of

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[6] In a more realistic model, individuals may also opt to leave Los Angeles and thus face a much larger
residential choice set than we allow for. Mobility out of Los Angeles, however, cannot be observed in the
retrospective mobility history data used in the present analysis. Subsequent waves of the L.A.FANS data
will provide prospective data on mobility both within and out of Los Angeles County. We are also
planning analysis of mobility data from the 2000 Census, which show moves between all pairs of zip codes
between 1995 and 2000.
[7] We investigated race-ethnic differences in the probability of immobility (that is, selecting one's current
neighborhood), but found no systematic effects. Although a more flexible functional form that allows for

neighborhood race-ethnic composition to vary with the race-ethnicity of the individual

decision-makers. Individuals are likely to prefer neighborhoods in which their own

groups are well represented and may display group-specific tendencies to be drawn to or

avoid neighborhoods in which other groups are well represented. Fourth, we allow for

the possibility that the race-ethnic composition of a neighborhood affects individuals

differently depending on whether they are evaluating their current place of residence or

evaluating neighborhoods to which they may move. We estimate a variety of

specifications of the discrete choice model that include alternative combinations of these

effects.[8]

Table 2 lists several of the specifications that we estimated and their associated

log likelihood statistics. Table 3 presents the estimated parameters of these models.

Although the nonrandom nature of our sample precludes rigorous tests of statistical

significance, the z statistics for the estimated coefficients and the contrasts among the

model log likelihood statistics provide evidence for the five types of effects mentioned

above. Model 1 incorporates all of these effects on the probability of choosing a

neighborhood, including a stayer-mover parameter; linear and quadratic effects of the

percent black, Hispanic, and Asian in a neighborhood; interactions between the mover-

stayer choice and percent black and percent Hispanic; interactions between an

individual's own race-ethnicity and the percentage of a neighborhood that is made up of

her/his own group; and interactions between whether or not a respondent is Hispanic and

neighborhood percent black and between whether or not a respondent is black and

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more complex nonlinearity would be desirable, the sample of moves in the preliminary L.A.FANS data is
too small to provide reliable estimates of these effects.

neighborhood percent Hispanic. The parameters corresponding to these effects are

shown in the first column of Table 3. Model 1 will be used for most of the interpretations

and illustrations presented in the balance of this paper.[9]

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. They also suggest

that Hispanics prefer neighborhoods in which members of their own group are already

highly represented, whereas blacks respond positively to the level of black representation

in their neighborhoods only over a low to moderate range. The estimates also suggest

that Hispanics and non-Hispanic blacks are each attracted to neighborhoods in which the

other group has a relatively high representation. Beyond these qualitative observations,

however, 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 the

race-ethnic composition of neighborhoods for each of the race-ethnic groups. These

probabilities are predicted from the parameter estimates for Model 1 in Table 3 and are

presented separately for the choice of a new neighborhood and the decision to remain in

one's own neighborhood in Figures 1 and 2 respectively. Although the model provides

estimates of the residential preferences of all four race-ethnic groups, estimates for

Asians are not reliable because they are based on a very small number of moves (see

Table 1). Thus we confine our discussion to the other three groups. In selecting new

neighborhoods, blacks and Hispanics are more responsive to the race-ethnic makeup of

those neighborhoods than are whites. In-migration probabilities for both groups vary

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[8] A further logical possibility is a three-way interaction among an individual's race-ethnicity, preference for
moving vs. staying in one's own neighborhood, and race-ethnic composition. We found no evidence for
interactions that are this complex in the preliminary L.A.FANS data.
[9] Only terms that were at least 1.4 times their estimated standard errors were retained in Model 1.

inversely with the proportion of the neighborhood made up by non-Hispanic whites. For

example, as shown in the first panel of Figure 1, the expected rate at which either blacks

or Hispanics move into neighborhood with no whites is more than twice the rate at which

they will move into a neighborhood that is 50 percent white. Both black and Hispanic in-

migration probabilities vary directly with neighborhood percent Hispanic, suggesting that

these two groups are socioeconomically more similar to each other than either is to

whites and they are, to some degree, "competing" for the same neighborhoods. Blacks

respond much more strongly than other groups to the percent black in a neighborhood,

but this effect is curvilinear. For low to moderate degrees of black representation, blacks

choice probabilities vary directly with percent black. Above that point, however, black

choice probabilities vary inversely with percent black. All things being equal, blacks

may try to avoid neighborhoods in which they are highly represented and which have

traditionally suffered from high rates of poverty and crime and poor services. It must be

remembered, however, that blacks are a small minority in Los Angeles and very few

neighborhoods are more than 50 percent black.[10]

The corresponding predicted probabilities of remaining in one's own

neighborhood, shown in Figure 2, follow a similar pattern to the in-migration

probabilities in Figure 1, albeit at much higher overall levels. The probabilities that

either blacks or Hispanics remain in their neighborhoods vary inversely with

neighborhood percent white and directly with percent Hispanic. All nonblack groups are

more likely to move the higher the proportion black in their neighborhoods, and, when

percent black is very high, black out-migration is more likely to occur as well. Again,

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[10] In 1997, less than six percent of the 1639 census tracts in Los Angeles County were more than 50 percent
black.

however, we note that these patterns are based on extrapolations from small numbers of

moves and small numbers of tracts in Los Angeles in which the majority of residents are

black.

These estimates suggest that individuals take the race-ethnic composition of

neighborhoods into account when deciding whether and where to move. These patterns

may result from several underlying processes. Although race-ethnic prejudice may

govern residential choices to some degree, the ethnic composition of neighborhoods may

be highly correlated with other neighborhood characteristics that affect their

attractiveness, even in a color-blind world (e.g., Harris 1997; 1999). For example,

neighborhoods vary in levels of crime, poverty, and substandard housing, factors to

which race-ethnic groups are not equally exposed. Further multivariate analysis on a

larger sample is needed to see whether other neighborhood characteristics can explain the

apparent affects of race-ethnicity shown here. For our purposes, however, it suffices to

demonstrate the associations between race-ethnic composition and mobility. In the

balance of this paper, we examine the implications of these associations for aggregate

mobility patterns and neighborhood change.

A Model of Residential Mobility and Neighborhood Change

To examine the effects of residential mobility on residential segregation, we use a

model that links individual-level preferences and aggregate mobility rates. We combine

the estimated coefficients and predicted mobility probabilities from our discrete choice

model and tract level data on race-ethnic composition in Los Angeles County in 1997.

Using the tract-specific summary data as initial conditions, we predict subsequent

neighborhood composition from the individual-level mobility probabilities implied by the

discrete choice model. A key feature of this procedure is that it allows the predicted

changes in neighborhood composition to affect subsequent mobility and thus the race-

ethnic composition of neighborhoods is treated an endogenous outcome of the model.

More important, the transition probabilities that govern movement among specific

neighborhoods are endogenous as well. Each move in Los Angeles that occurs between

times t and $t + 1$ changes the opportunity structure for all L.A. residents who are

contemplating a move between $t + 1$ and $t + 2$. Thus, the model explicitly incorporates

not only the aggregate implications of individual preferences, but also the (nonlinear)

feedback effects of aggregate change on the mobility behavior of individuals. In the

approach described here, individuals' preferences for alternative neighborhood

characteristics are assumed fixed over time. The characteristics of neighborhoods,

however, change over time as a result of mobility. Changes in the residential

composition of neighborhoods, combined with fixed individual preferences, result in

changes in transition rates between neighborhoods. In this model, the behavior of each

individual affects the opportunity structure of every other individual in the region. The

model incorporates both the aggregate implications of individual preferences, and also

the feedback effects of neighborhood change on the mobility of individuals. Thus the

residential composition (and segregation) of neighborhoods and the mobility rates

between neighborhoods are endogenous to individual preferences.   This represents an

advance over previous efforts to project the residential composition of neighborhoods

that unrealistically assume fixed mobility rates (Gramlich, Laren, and Sealand 1992;

Massey, Gross, and Shibuya 1993; Quillian 1999a; 1999b).

This analysis will be based on estimated mobility probabilities between neighborhoods with varying race-ethnic composition and expected distributions of neighborhood types that are implied by the mobility probabilities. In our analysis the parameter estimates from the discrete choice model will be used to estimate the probability that an individual with given characteristics chooses a particular neighborhood. We estimate the expected race-ethnic distributions of the population across tracts areas and compute summary statistics for the expected residential distributions measuring the degree of residential segregation among race-ethnic groups. The parameters of the discrete choice model plus the distributions of race-ethnic and economic groups within tracts or zip code areas (as observed in 1997) enable one to estimate an initial SK x SK matrix of mobility probabilities, P_t, between all tracts in Los Angeles County, where K is the number of tracts and S is the number of race-ethnic categories that are distinguished in the analysis. Given estimates of the transition probabilities, it is possible to estimate the distribution of race-ethnic groups across the K areas implied by the discrete choice model. Based on the expected distributions, summary statistics for residential segregation among race-ethnic groups will be computed. These summary statistics indicate what level of segregation is implied by the mobility pattern. Expected distributions are computed for each period.

If C_0 is the SK x 1 vector of population counts distributed across K tracts and S sociodemographic categories in year 0, then $C_1 = P_0\, C_0$ is the expected population distribution after one year. Because C changes over time, P changes as well (because, given fixed individual preferences for types of neighborhoods, the changing characteristics of actual neighborhoods changes their attractiveness). Thus $C_\infty = P_\infty =$

$\Pi_t P_t C_t$ is the expected stable distribution if the process continues indefinitely. Given

estimated values of C_t, it is possible to compute the expected pattern of residential

segregation under the mobility regime summarized in mobility matrices P_t using the

standard measures of residential segregation.

Effects of Residential Mobility on Segregation: Illustrative Results

The estimates reported in this section are based on the parameters and predicted

probabilities of Model 1 (see Tables 2 and 3). To examine the effects of residential

preferences and mobility on residential segregation, we first report the expected trend in

indices of dissimilarity among pairs of race-ethnic groups over the next five decades.

This index indicates the proportion of persons who would have to move to effect an even

distribution of race-ethnic groups within Los Angeles County. Then we provide more

disaggregated estimates of the effects of mobility on neighborhood race-ethnic

composition.

The first panel of Figure 3 reports expected trends in the index of dissimilarity

over the 10 year period from 1997 to 2007 for three pairs of race-ethnic groups: whites

and Hispanics, whites and blacks, and blacks and Hispanics.[11] These trends indicate that

if the race-ethnic preferences estimated in Model 1 remain constant, residential

segregation will change substantially in the following decade. White-black segregation

declines by approximately 15 percent, from an index of dissimilarity of more that .7 to

approximately .6. Black-Hispanic segregation, already substantially lower than white-

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[11] As noted above, our sample of moves for Asians is too small to provide information about the likely
trajectory of the Asian population.

black segregation in Los Angeles, declines by about 15 percent in the first five years, but

appears to stabilize after that. In contrast, segregation between whites and Hispanics

grows over the decade from an index of dissimilarity of slightly less than .6 to nearly .7.

Although the assumption of stable residential preferences becomes less realistic

as the time horizon extends further into the future, it is useful to extend the simulation

several more decades for to show the dynamic behavior of segregation that is implied by

the discrete choice model of residential location. Whereas the trends in black-Hispanic

and white-black residential segregation in the first panel of Figure 1 suggest that

segregation levels rapidly approach an asymptote, examination of a longer period,

illustrated in the second panel, indicates a much different pattern. Rather, the index of

dissimilarity is expected to fluctuate considerably over several decades and, in the case of

white-black segregation return to a higher segregation level than in 1997 following a

period of substantial decline. White-Hispanic segregation, in contrast, grows steadily

over 50 years, concluding the period more than one third higher than the 1997 level.

These estimates, of course, are simply extrapolations of the estimated parameters given

the 1997 initial conditions and it is unrealistic to think that the preferences observed in a

single cross section survey will persist for decades. They nonetheless show that

residential preferences can have very large effects on levels of segregation and these

aggregate effects cannot be straightforwardly intuited from a simple examination of

individual preference patterns.

The index of dissimilarity is a standard tool for summarizing residential

segregation. Yet it may conceal substantial variation in how race-ethnic groups are

exposed to each other and how these exposures change over time. The dissimilarity

index, moreover, is somewhat removed from the actual behavior of our discrete choice

model in which individuals respond not to an expected level of segregation *per se*, but

rather to the race-ethnic composition of the neighborhood. Figures 4a, 4b, and 4c display

the expected neighborhood composition that the four race-ethnic groups will experience

over the decade from 1997 to 2007 under discrete choice Model 1. These figures show

the proportions of each race-ethnic group that will be living in neighborhoods with

varying representations of each group. The lower left panel of Figure 4a, for example,

shows that the increase in residential segregation between whites and Hispanics shown in

Figure 3 will occur in part because a much greater proportion of whites in Los Angeles

will be living in neighborhoods with fewer than 10 percent Hispanics. At the same time,

a progressively smaller proportion of whites will be living in neighborhoods with small

to moderate percentages Hispanic (10 to 40 percent). Over the decade, the proportion of

whites who live in heavily Hispanic neighborhoods changes very little. From the point of

view of Hispanics, growing segregation occurs through substantial growth in the

proportion of persons living in neighborhoods that have modest white representation (10

to 20 percent), and small reductions in proportions of Hispanics living in neighborhoods

where whites are either more or less heavily represented (see top left panel of Figure 4c).

Based on these simulations, the dominant expected trend over the decade is the growing

separation of Hispanics from other groups, the vast majority of whom are non-Hispanic

whites. The lower left panel of Figure 4c illustrates enormous growth in the proportion

of Hispanics who are living in neighborhoods in which Hispanics are a large majority

and a corresponding decline in those who are living in neighborhoods that are 20 to 50

percent Hispanic.

Conclusions

These results illustrate the ways in which individual-level preferences for
different kinds of neighborhoods aggregate into levels of residential mobility that alter
residential patterns. Changing residential patterns, in turn, alter the relative attractiveness
of neighborhoods for future potential movers. The empirical results are numerical
illustrations that are mainly designed to demonstrate the feasibility of this type of model.
They are based on short mobility histories obtained from a small, nonrandom fragment of
a probability sample. Even if the survey data were complete, the simulations would not
constitute a complete or even credible forecast of neighborhood change in Los Angeles.
Most important, the model assumes a population with a static race-ethnic distribution and
closed to growth through immigration and natural increase. The large ongoing increases
in the Hispanic and Asian populations of Los Angeles, mainly through immigration, are
ignored in this exercise.

At the same time, our empirical results are useful for isolating the contribution
that residential preferences and individual level mobility patterns make to residential
patterns. The model estimates the effects of preferences in a world in which no
immigration as possible. Our analysis, moreover, may understate the impact of
residential mobility preferences on changes in segregation. The preliminary L.A.FANS
data underrepresent movers and thus provide an unrealistically static picture of the Los
Angeles population. In a full sample, mobility rates, potential neighborhood change, and
the speed with which a given set of residential preferences may affect residential
segregation may all be greater than those shown here. If the patterns of residential
preferences reported in the present analysis persist in the full L.A.FANS sample, we can

conclude that residential mobility alone is likely to produce substantial change in race-ethnic segregation in the coming decade. Whereas African-Americans will become increasingly integrated with the large white and Hispanic populations, Hispanics and whites will become more segregated from each other. It is not difficult to envision patterns of differential fertility and settlement by new immigrants that may further exacerbate these trends.

The main contributions of this paper, however, are conceptual and methodological. We have developed a closed model that links individual level preferences and mobility behavior to changes in the makeup of neighborhoods. Aggregate neighborhood characteristics affect individual mobility decisions. The accumulated impact of individual moves, however, is to change the characteristics of neighborhoods, thereby altering the relative attractiveness of neighborhoods to future potential movers. This model provides a dynamic mechanism for changes in residential segregation between successive cross section observations and for linking observations on individual preferences to mobility behavior and segregation. We go beyond other recent attempts to use mobility data to understand neighborhood change by allowing both neighborhoods and rates of mobility between them to be endogenous to the model.

In its essential properties, our model is similar to Schelling's models of segregation. We go beyond Schelling, however, in two important ways. First, we derive individual preference functions from mobility behavior in real populations, rather than assuming an arbitrary utility function. Second, we show how to combine preference functions based on sample data with population data on neighborhoods. This enables us to analyze and forecast changes in actual populations. Thus, our approach has the

potential of combining Schelling's models of population dynamics with the descriptive

demography of residential segregation.

In our ongoing work, we are extending the present analysis in several directions

(Mare 2000). These include: (1) Analysis of the impact of residential preferences,

mobility, and segregation along socioeconomic dimensions, such as education,

occupation, and income. This will show the degree to which residential sorting may

account for increases in residential segregation among income groups (Jargowksy 1996;

1997).

(2) Joint analysis of socioeconomic and race-ethnic residential preferences,

mobility, and segregation. This will show the degree to which apparent race-ethnic

preferences are reducible to commonly held preferences for neighborhoods that are safe,

free from extensive poverty, and well served.

(3) Joint analysis of residential and economic mobility. This is an effort to

estimate the relative contributions of neighborhood sorting and increasing socioeconomic

inequalities within neighborhoods to overall residential socioeconomic segregation.

(4) Comparative analysis of mobility and segregation across major metropolitan

areas of the United States. The widely varying race-ethnic composition of American

cities raises the issue of whether residential preferences observed in Los Angeles also

occur elsewhere. Data on residential mobility between zip code areas from the 2000

Census will enable us to address this issue.

(5) The development of more realistic discrete choice models that take account of

the effects of distance and other physical barriers to mobility, the effects of the

characteristics and preferences of other members of an individual's household, and the

effects of the characteristics of geographic areas both larger and smaller than census

tracts.

(6) Combining the empirically estimated residential preference functions obtained

from the L.A.FANS data with computational models of mobility and segregation for

artificial populations. These micro-level computational models permit systematic

investigations of the effects of the number and relative size of ethnic groups and size of

city on the dynamics of mobility and segregation (Bruch and Mare 2001).

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

Census Tracts (1990 Census): 1,639

Respondents in Preliminary L.A. FANS Data: 1,270

	Total	White	Black	Hispanic	Asian
Mobility Decisions					
Year 1	1,153	318	131	641	63
Year 2	1,270	341	142	720	67
Total	2,423	659	273	1,361	130
Race-Ethnic Composition					
Preliminary L.A.FANS (%)	100.0	27.2	11.3	56.2	5.4
1997 Census (estimate)	100.0	34.0	9.4	43.8	12.8
2000 Census	100.0	31.1	10.9	44.6	13.1
Moves Between Tracts					
Year 1	92	27	15	47	3
Year 2	118	24	26	67	1
Total	210	51	41	114	4
Person-Year-Options (Total)					
Year 1	1,889,767	521,202	214,709	1,050,599	103,257
Year 2	2,081,530	558,899	232,738	1,180,080	109,813
Total	3,971,297	1,080,101	447,447	2,230,679	213,070
Person-Year-Options (Choice-Based Sample)					
year1	20,155	5,479	2,295	11,298	1,083
year2	22,376	6,089	2,516	12,578	1,193
Total	42,531	11,568	4,811	23,876	2,276

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

Model	Mover-Stayer Effects	Composition Effects	Nonlinear Terms	Own-Group Preferences	Cross-Group Preferences	Composition* Mover-Stayer	Number of Parameters	Log Likelihood
1.1	Yes	Yes	Yes	Yes	Yes	Yes	17	-2132
1.2	Yes	No	No	No	No	No	1	-2269
1.3	Yes	Yes	Yes	Yes	Yes	No	14	-2159
1.4	Yes	Yes	Yes	Yes	No	No	12	-2163
1.5	Yes	Yes	Yes	No	No	Yes	10	-2180
1.6	Yes	Yes	Yes	No	No	No	7	-2209
1.7	Yes	Yes	No	Yes	Yes	Yes	11	-2161

Table 3. Effects of Respondent and Tract Characteristics on Residential Choice

Variable	Beta	|z(B)|	Beta	|z(B)|	Beta	|z(B)|	Beta	|z(B)|
	Model 1		Model 2		Model 3		Model 4	
D_{ij}	10.844	44.0	9.759	135.0	9.532	122.4	9.559	123.2
%black	6.100	3.3			3.057	1.9	3.845	2.6
D_{ij} * %black	-8.668	4.2						
%black^2	-12.596	3.8			-10.319	3.6	-9.637	-3.5
Dij * %black^2	9.546	2.3						
black * %black	11.617	4.5			11.569	4.0	12.036	4.4
black * %black^2	-12.662	2.9			-12.390	2.6	-15.533	3.4
%Hispanic	-2.536	1.8			-2.956	2.4	-3.183	2.7
D_{ij} * %Hispanic	-1.393	3.7						
%Hispanic^2	2.538	1.7			2.382	1.8	3.062	2.4
Hispanic * %Hispanic	6.200	3.2			5.363	3.1	6.025	3.6
Hispanic * % Hispanic^2	-2.585	1.4			-1.829	1.1	-2.968	1.9
%Asian	3.564	1.9			4.255	2.4	3.775	2.2
Asian * % Asian	3.960	1.8			3.796	2.0	4.151	2.2
%Asian^2	-9.212	2.2			-10.592	2.7	-9.760	2.5
black * %Hispanic	1.899	2.7			1.964	2.8		
Hispanic * %black	1.824	1.6			1.583	1.3		
Log Likelihood	-2132		-2269		-2159		-2163	
N	42529		42529		42529		42529	

Note: Models also include a correction for sampling that is the natural logarithm of the sampling fraction.
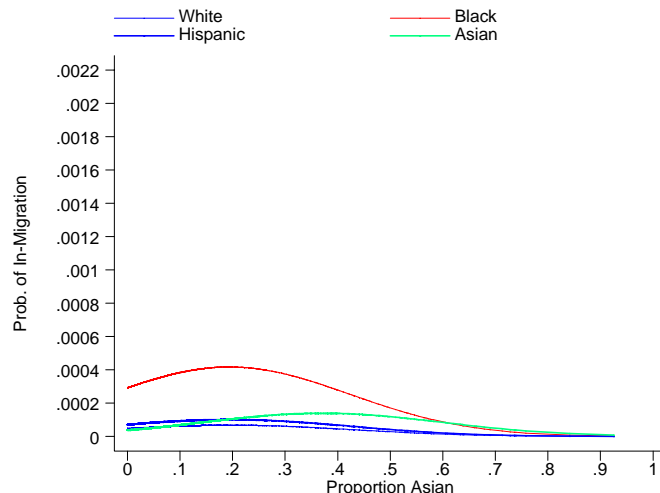
Table 3 (continued). Effects of Respondent and Tract Characteristics on Residential Choice

Variable	Beta	|z(B)|	Beta	|z(B)|	Beta	|z(B)|
	Model 5		Model 6		Model 7	
D_{ij}	11.185	44.7	9.727	126.8	10.708	46.3
%black	9.675	6.1	6.242	5.1	-0.856	1.0
D_{ij} * %black	-8.693	4.4			-4.179	7.4
%black^2	-15.552	5.1	-12.706	6.1		
Dij * %black^2	9.338	2.5				
black * %black					3.503	3.5
black * %black^2						
%Hispanic	-0.819	0.8	-2.126	2.3	-0.252	0.6
D_{ij} * %Hispanic	-1.656	4.3			1.319	3.6
%Hispanic^2	2.886	2.9	3.465	3.7		
Hispanic * %Hispanic					3.546	7.4
Hispanic * % Hispanic^2						
%Asian	2.901	1.6	3.910	2.2	-0.410	0.7
Asian * % Asian					2.644	1.5
%Asian^2	-7.514	1.8	-9.368	2.4		
black * %Hispanic					2.612	4.0
Hispanic * %black					2.142	2.3
Log Likelihood	-2180		-2209		-2161	
N	42529		42529		42529	
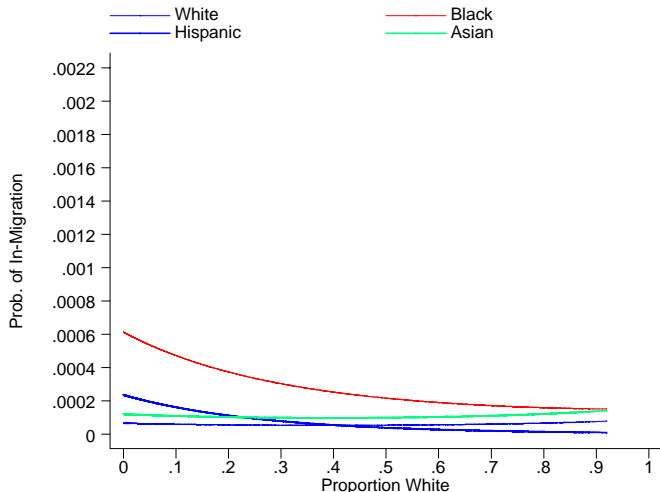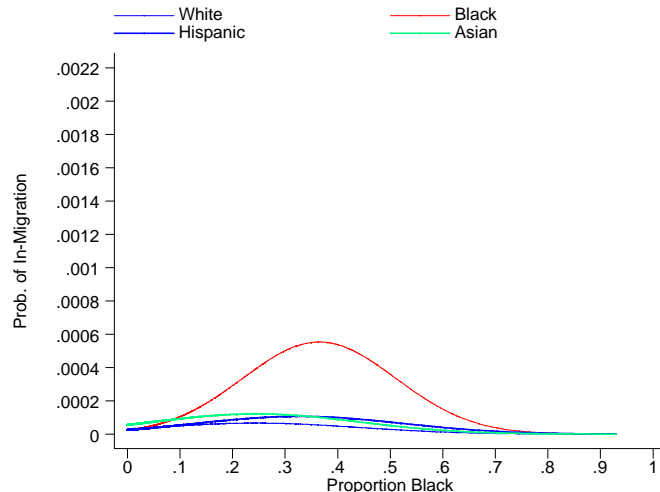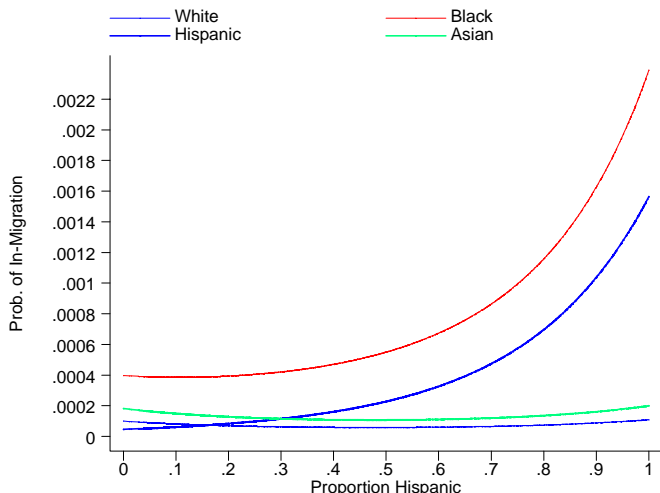
Note: Models also include a correction for sampling that is the natural logarithm of the sampling fraction.

Figure 1. In-Migration Probabilities by Race-Ethnic Composition
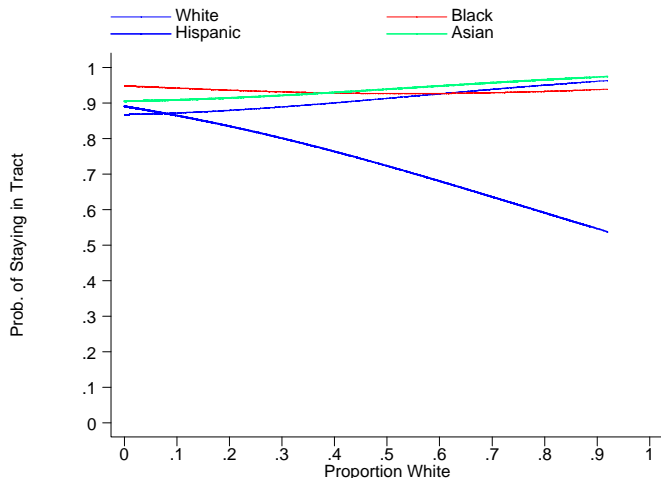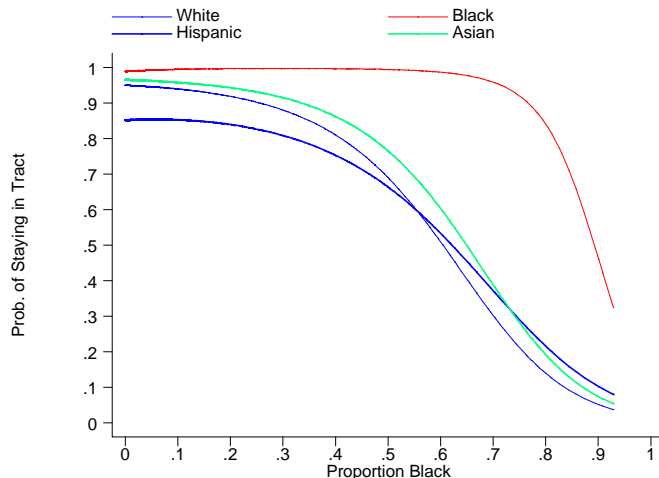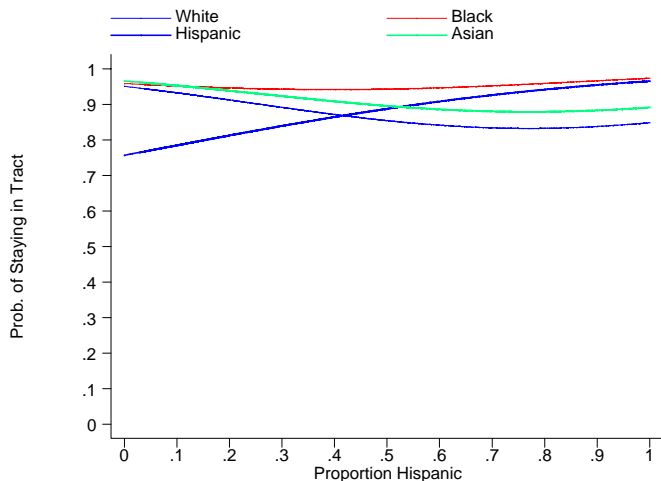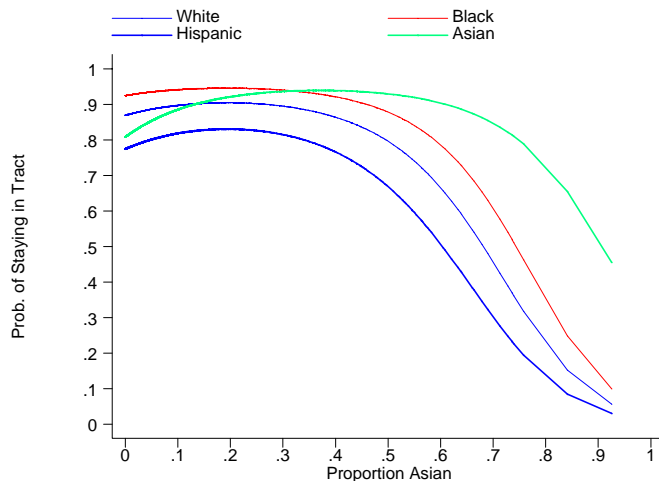
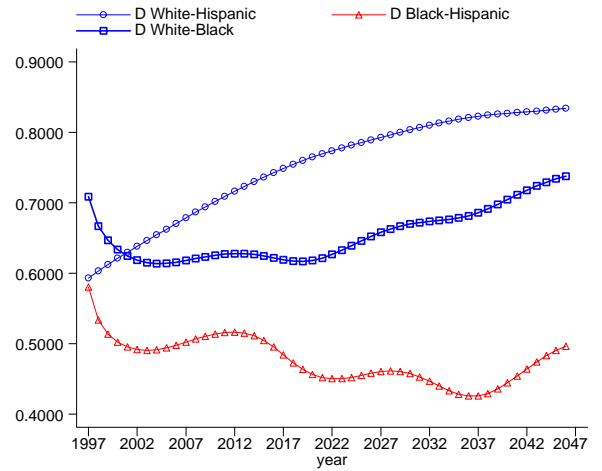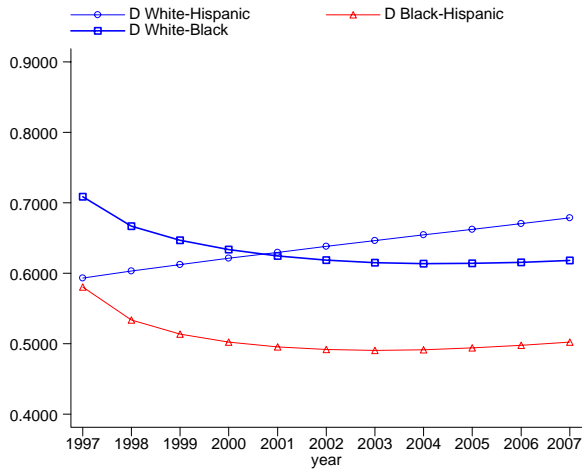Figure 2. Immobility Probabilities by Race-Ethnic Composition

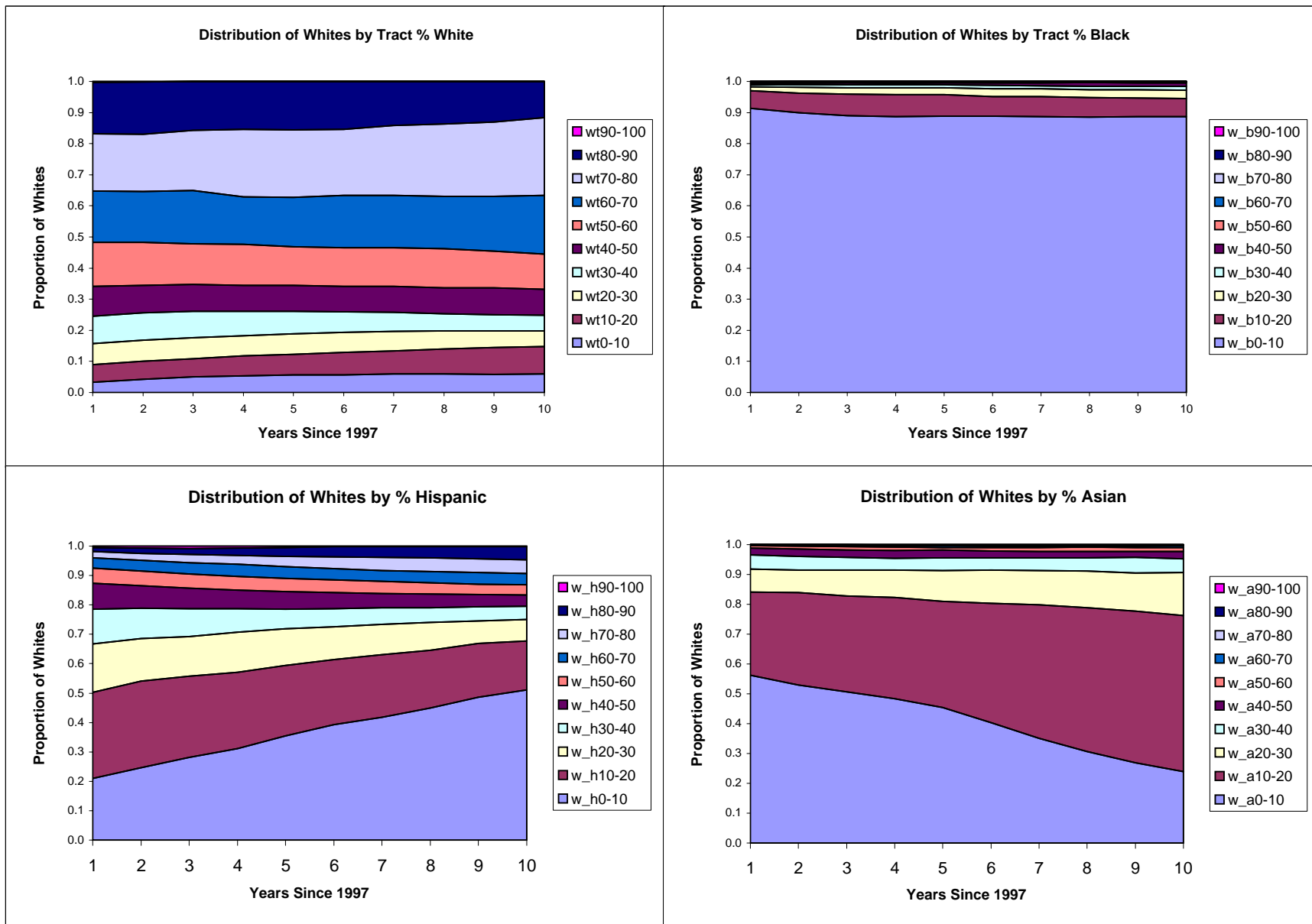Figure 3. Expected Trends in Dissimilarity Index

Figure 4a. Expected Residential Distribution of Whites by Race-Ethnic Composition of Census Tracts
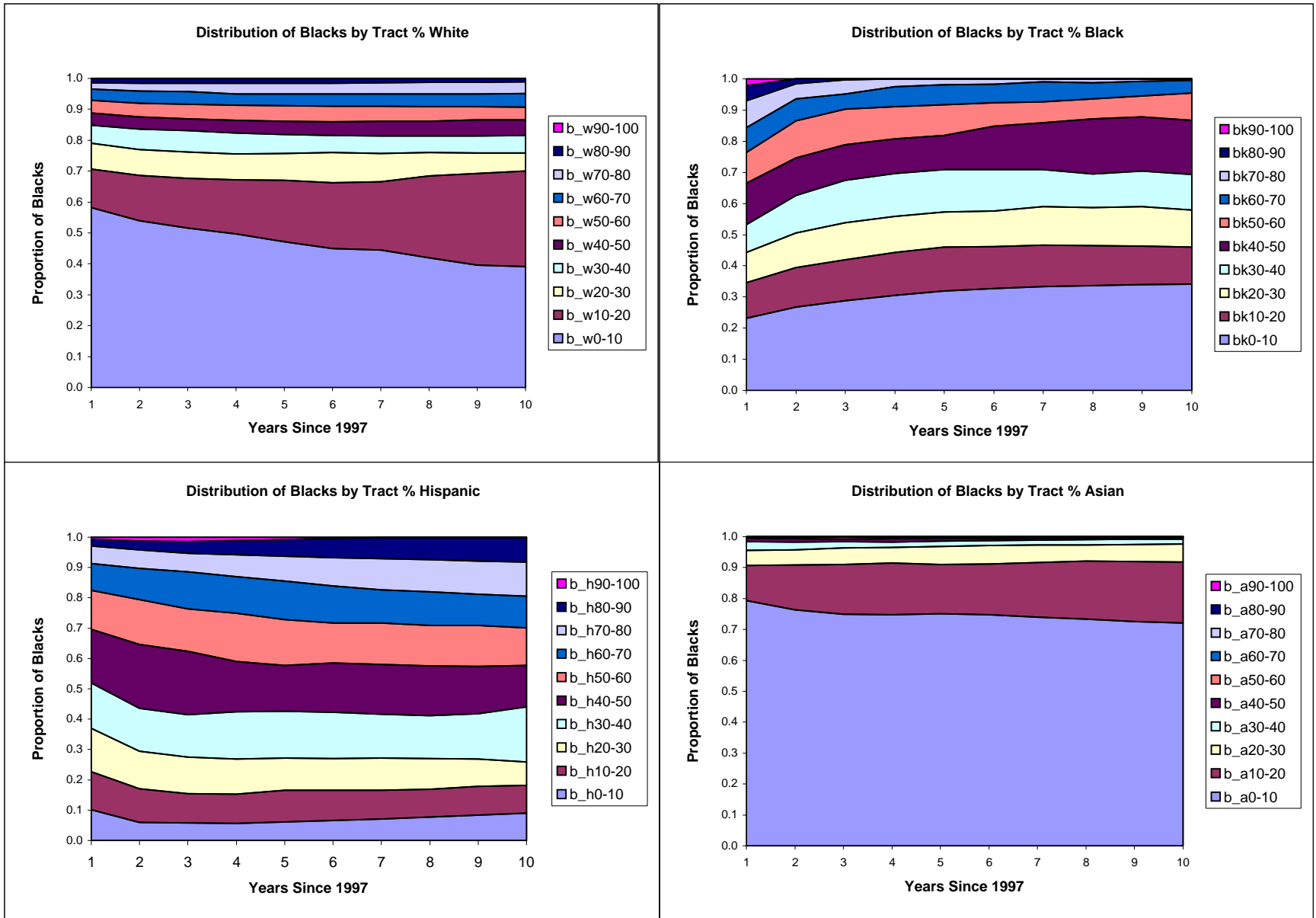
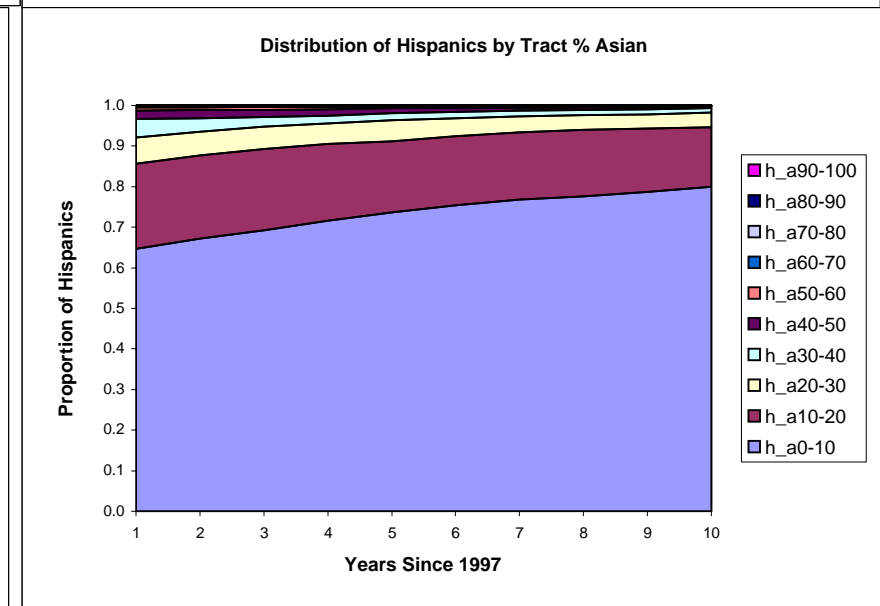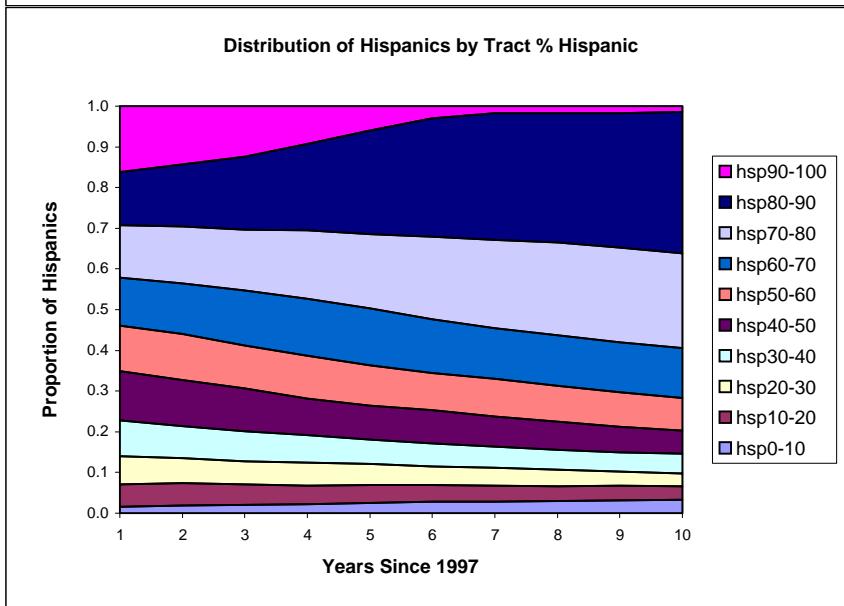**Figure 4b. Expected Residential Distribution of Blacks by Race-Ethnic Composition of Census Tracts**
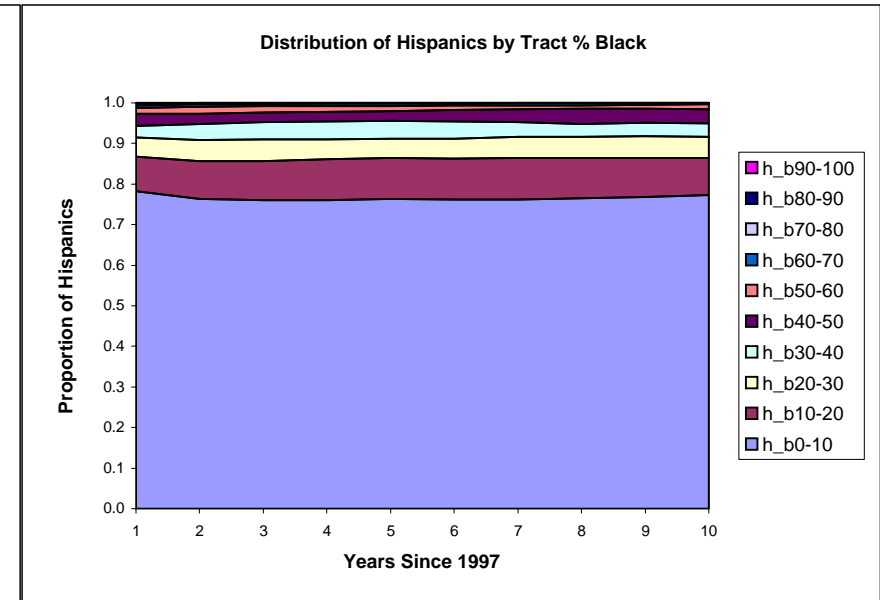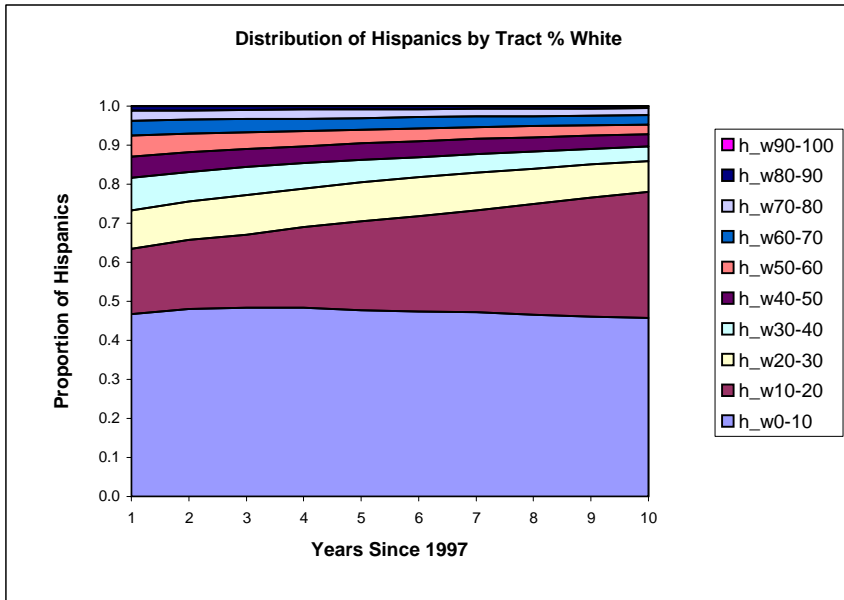
Figure 4c. Expected Residential Distribution of Hispanics by Race-Ethnic Composition of Census Tracts