Urban Affairs Review
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Urban Affairs Review 2007 42: 479
DOI: 10.1177/1078087406292701

The online version of this article can be found at:
http://uar.sagepub.com/content/42/4/479

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On behalf of:
apsa
The Urban Politics Section, American Political Science Association

Urban Affairs Review
Volume 42 Number 4
March 2007 479-504

10.1177/1078087406292701
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Ethnic and Racial Segregation in U.S. Metropolitan Areas, 1980–2000

The Dimensions of Segregation Revisited

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United States metropolitan area data for three ethnic groups—African-Americans, Asians, and Hispanics—are used to explore the dimensions of residential segregation at the 1980, 1990, and 2000 censuses at the census tract scale. Although set within Massey and Denton's five-dimensional conceptual schema, the study was unable to replicate their identification of five empirical dimensions that correspond with the conceptual set. Instead, separate analyses for each ethnic group at each of the three censuses suggested two superdimensions: separation and location. These apply across all three groups and three censuses, although the degree of separation varies considerably among the three groups.

Keywords: *ethnic segregation; residential segregation; hypersegregation; multiethnic urban populations*

The United States has long been a multiethnic and multicultural society. In recent decades, however, the nature of its internal ethnic variety has been substantially altered with rapid immigration and growth of populations claiming Hispanic or Asian ethnicity alongside those claiming African-American ethnicity, which also continue to grow in number. This

Authors' Note: We are grateful to the United States Bureau of the Census for making the data deployed in this article publicly available on its Web site and to John Iceland for making us aware of this. The program of work of which this article forms part was funded by grants from the Australian Research Council and the British Academy, which are gratefully acknowledged.

is generating a complex multiethnic character to many of the country's urban places. In 1980, for example, the metropolitan populations of those three main ethnic minority groups as defined by the Census Bureau were 22.1 million, 3.2 million, and 13.1 million, respectively, for African-Americans, Asians, and Hispanics.[1] The figures 10 years later were 25.7 million, 6.9 million, and 20.5 million, and in 2000 they were 31.5 million, 11.8 million, and 32.2 million. During two decades, the African-American population of metropolitan America had increased by 43%, the Hispanic component by 146%, and the Asian component by 259%.

One aspect of America's multiethnic urban populations that attracted very considerable academic attention for much of the twentieth century was residential segregation—the degree to which members of the various ethnic minority groups lived apart both from each other and from the rest of the population. There is a very large literature on the changing nature of this segregation, the processes that have generated it, and its consequences—a literature within which is embedded a great deal of methodological debate about how segregation should be measured, which in turn has stimulated discussions about how segregation should be conceptualized.

In a much-cited article that paved the way for their classic study of hypersegregation in the United States, Massey and Denton (1988) both synthesized the large and diverse literature on ethnic residential segregation and reported a study of the various dimensions of segregation in America's large cities in 1980; a decade later, Massey revisited the issues using 1990 census data and very largely reiterated the original conclusions (Massey, White, and Phua 1996).[2] Five separate conceptual dimensions of segregation were identified within the large literature (evenness, exposure, concentration, centralization, and clustering), and Massey and his coworkers' empirical studies were interpreted as showing that all five can be identified as separate dimensions of the residential mosaic of the country's metropolitan areas (MAs). Ethnic residential segregation, they argued, is a five-dimensional phenomenon and should be studied as such.

The contemporary relevance of that conclusion is the focus of the current article. Massey and Denton (1988) presented their original work as a general finding bringing "order to the field" of studies of ethnic residential segregation in United States cities (p. 282). The five separate conceptual dimensions Massey and Denton claimed to have identified empirically were central to that "order," and the claim was repeated in Massey, White, and Phua's (1996) updating of the original article using 1990 data; later authors (such as Wilkes and Iceland 2004) have accepted that claimed order as the framework for

analyses using more recent data. Furthermore, and even more importantly, Massey and Denton (1989) used their findings to propose a new concept of hypersegregation, which they defined as high values on each of the indices selected to represent the five dimensions. In 1980, 10 standard metropolitan statistical areas (SMSAs) met their hypersegregation criteria for Blacks; none did so for Hispanics. Massey, White, and Phua (1996), 10 years later, identified 29 SMSAs meeting the hypersegregation criterion for Blacks according to the 1990 census data—which they extended to 36 if they relaxed the criterion to extreme levels of segregation on only four of the five selected indices.[3] They recommended that to "produce results that are robust with regard to the number of dimensions required to achieve hypersegregation . . . the [five] indices originally proposed" be deployed (p. 202).

Our goal is not to address the very many issues regarding the nature and measurement of residential segregation that have been raised during recent decades and that continue to attract the interest of researchers, nor is it to explore further at this stage the applicability of Massey and Denton's hypersegregation concept (as, for example, in Wilkes and Iceland [2004], who accepted the Massey-Denton five-dimensional schema without testing its validity with 2000 census data). Rather, we limit ourselves solely to the issue of the empirical validity of the five-dimensional schema, inquiring whether it provides a viable framework for continuing study of ethnic residential segregation in United States MAs given the massive growth in the American ethnic minority populations during the past two decades.

The analyses reported here are not a replication of Massey and Denton's classic study with more recent data. This proved not feasible for three reasons, each of which is set out in more detail below: (1) one of Massey and Denton's indices was not in the available data set; (2) Massey and Denton's original method (relaxed in the 1990 extension) of looking at all ethnic groups in one analysis made interpretations difficult since it assumed similar patterns for each ethnic group; and (3) most importantly, Massey and Denton's methodological procedure (principal axis factor analysis) cannot be deployed using data matrices that include closed number sets.[4] Instead, we use a larger data set to explore the dimensions of segregation at the three most recent censuses for each of the country's main ethnic minority groups. Our goal is to establish empirically the number of separate dimensions of ethnic segregation in United States MAs in 1980, 1990, and 2000 and to explore whether these are consistent during those three censuses. The slight differences between our study and Massey and Denton's are such that they should nevertheless result in very similar outcomes, thus allowing us to address the question of whether Massey and Denton's findings regarding

five separate dimensions to ethnic segregation stand up after two decades of substantial change in the ethnic composition of many United States MAs.

Massey and Denton's Contributions

Massey and Denton's 1988 paper was of both conceptual and empirical importance. In the former context, it joined the challenges to an earlier received wisdom that a single measure—the index of dissimilarity—was sufficient to reveal all that was desired regarding the nature of ethnic (and other forms of) residential segregation. A plethora of alternative measures had been proposed (and has continued to be since), and Massey and Denton (1988, p. 282) found

> little agreement about which measure is best to use and under what circumstances. Studies using inconsistent segregation measures are multiplying and the comparability of research has suffered.

Massey and Denton thus characterized the "field of segregation studies . . . [as] presently in a state of theoretical and methodological disarray" to which they attempted to bring order by evaluating and classifying 20 different indices.

The Conceptual Contribution

Massey and Denton's (1988) classification was conceptually derived from an examination of 20 measures of residential segregation proposed in the research literature and resulted in a fivefold categorization of segregation dimensions comprising:

1. Evenness. This refers to any difference in the distribution of two groups (or one group and the remainder of the population) across the spatial units (such as census tracts) into which an urban area is divided and for which the ethnic population is reported in censuses. Two groups are evenly distributed relative to each other when each spatial unit contains the same proportion of the citywide population of each. The greater the difference between those two sets of proportions, the greater the unevenness in the relative distributions and the greater the degree of segregation of one relative to the other.
2. Exposure. This refers to the probability of contact—or interaction—between either two members of the same group or two members of different groups.

The greater the probability of the former, the greater the group's isolation. If members of a group predominate in some parts of the city, the probability that the first person they meet at random in their residential area comes from the same group as themselves is much greater than if they are evenly dispersed across the city. The larger that probability, the greater the group's isolation—what Massey and Denton (1988, p. 287) term "the likelihood of their sharing the same neighborhood." Measures of that isolation are attempts to measure the experience of segregation in daily lives.

3. Concentration. This refers to the related concept of population density, or the amount of physical space occupied by a given number of individuals from a particular group. If a group's members are to be found in a few relatively small areas within the urban fabric, they are living at high densities and are residentially concentrated compared to those living in areas of lighter density (of dwellings to area, for example).
4. Centralization. The preceding concept of concentration refers to the spatial proximity condition within which groups live but not to where this occurs within the city—it is an absolute rather than a spatial expression. Centralization refers to the location of the areas occupied by a group and is measured as the proximity and/or accessibility of those areas to the city center. The closer on average that a member of a group lives to that center, the more centralized is the group as a whole.
5. Clustering. All measures of segregation on the above four dimensions refer to the population composition, density, and location of the spatial units deployed in the measurement process but pay no attention to the relative location of those units to one another. A group may be totally isolated, for example, in that all of its members live in census tracts that contain only members of that group. Those tracts may be randomly scattered across the urban area, however, or they may be concentrated into one part of it, with each neighboring another. The closer the situation is to the latter ideal, the more clustered the group's residential areas are.

Each of these dimensions is conceptually distinct and identifies a separate component of segregation. It is possible for a group to be highly segregated on one dimension but not the others, since they refer to different aspects of the geography of where the group's members live.[5] A group may be isolated but neither concentrated nor centralized, for example, because the areas where it predominates are suburban. The group may not even be clustered, because those areas are scattered through the suburbs rather than gathered together as neighbors in one part of suburbia. For Massey and Denton (1989), hypersegregation involves high values on all five dimensions.

Although conceptually distinct, however, the various indices are not necessarily computationally distinct, either between or within the groups.

Within groups, since the indices were devised to measure (at least partially) the same thing, and in some cases have common elements in their formulas, it is not surprising that they are interrelated (the three exposure indices clearly fall into this category). Similarly, there can be overlap between groups of indices. Clustering and evenness both may partly reflect the scale at which the indices are measured.

The Original Empirical Analysis

Massey and Denton's second major contribution involved an empirical investigation of the relevance of those five conceptual dimensions to understanding contemporary segregation in America's largest cities. Massey and Denton identified 20 separate indices of segregation, with at least three relating to each of the five dimensions (Table 1; full mathematical details on those indices are given in the original article, Massey and Denton 1988).[6] Massey and Denton's values were calculated for each of the three main ethnic groups (African-American, Asian, and Hispanic) in each of the 60 selected cities.

Analysis of those index values using weighted correlation and factor analysis led Massey and Denton to conclude that the five dimensions were not only conceptually but also empirically separate—though they were not independent, as an oblique rotation of the factors showed considerable intercorrelation among the five factors extracted. Furthermore, Massey and Denton claimed that each of the indices was closely linked to the factor that was readily identified as relating to its conceptual dimension. Indeed, Massey and Denton (1988, p. 305) claimed that the three smaller factors, representing concentration, centralization, and clustering respectively, were "clearly interpretable as independent axes corresponding to the hypothesized dimensional structure of segregation."[7] As a result of this empirical validation of their conceptual scheme, Massey and Denton then selected one index as representative of each dimension, which was then deployed in their later studies of hypersegregation (Massey and Denton 1989, 1993).

In the conclusion to their 1988 article, Massey and Denton (pp. 311–12) argued that

> recently, much controversy has centered on defining what segregation is or should be. Some observers have emphasized evenness, others exposure, and still others clustering, with each person advocating a particular index as the appropriate measure of segregation. We argue that segregation is a multidimensional phenomenon that should be measured by a battery of indices

Table 1
The 20 Segregation Indices Analyzed by Massey and Denton

Dimension	Measure
Evenness	
D	Index of dissimilarity
G	Gini index
H	Entropy or information index
A1	Atkinson index with $b = 0.1$
A5	Atkinson index with $b = 0.5$
A9	Atkinson index with $b = 0.9$
Exposure	
xPy	Interaction index
xPx	Isolation index
V	Correlation ratio (eta squared)
Concentration	
DEL	Duncan's delta index
ACO	Absolute concentration index
RCO	Relative concentration index
Centralization	
(PCC	*proportion in central city)*
ACE	Absolute centralization index
PCE	Relative centralization index
Clustering	
ACL	Absolute clustering index
SP	Spatial proximity index
RCL	Relative clustering index
DPxy	Distance-decay interaction index
DPxx	Distance-decay isolation index

Note: The italicized index within brackets is not used in the current study. PCC = percentage of the population living in the central city.

> rather than one single index. Viewing segregation as a multidimensional construct will, we hope, encourage research into the many ways that segregation can affect people's lives. Its effects are easier to imagine in terms of concrete spatial outcome, such as evenness, exposure, concentration, centralization, and clustering, than in terms of the ambiguous idea of segregation.

That conclusion has not stopped the search for improved measures of one or more of the concrete outcomes, but the conceptual scheme suggested an order to the field. (These include studies that combine two or more of the separate dimensions, such as the work by Wong—e.g., Wong 1993, 1998—that incorporates aspects of evenness and clustering into a single spatial index of dissimilarity; see also Reardon and O'Sullivan 2004.) The current

article explores the degree to which the five conceptual dimensions, as presented by Massey and Denton, are also empirically distinct. Three questions are addressed:

1. Are there five independent dimensions, conforming to the Massey-Denton conceptual schema, to ethnic residential patterns in contemporary United States cities?
2. Are those five similarly distinct at each of the past three censuses? and
3. Are they present in separate analyses of the major ethnic groups, given the large-scale Asian and Hispanic migration to those cities in recent decades?

Replication and Extension

After publication of the 1990 census results, Massey, White, and Phua (1996) both replicated the 1980 analysis and extended it to cover all 318 metropolitan statistical areas. Again, they reported on analyses using weighted data but noted that "patterns do not differ substantially when unweighted figures are used" (p. 178).[8] The methodology was not quite the same. They report using a principal components analysis as the first stage rather than a principal axis factor analysis as in the first article, but this was then followed, as before, by Varimax and Promax rotations.

In the replication of the 1980 analyses, using the same set of cities, they argue from the Varimax loadings that "the pattern of factor loadings is generally similar across years and appears to reconfirm the multidimensional nature of residential segregation" (p. 182), although they follow this up with the statement that "factorial complexity is greater and the five axes are not as well defined as before" (p. 182). The main change, they suggest, is very largely a technical one—that the "centralization and concentration axes have shifted places in the order of factor extraction" (p. 184). The oblique rotation "simplified and sharpened the overall factor structure" (p. 185) and, in effect, reduced the number of interpretable dimensions to four—evenness, exposure, centralization, and concentration—with most of the clustering indices loading highest on the exposure dimension.

The second set of analyses covered all 318 metropolitan statistical areas, with all three ethnic minority groups combined into a single analysis. The result after both sets of rotations, Massey, White, and Phua contend, "reconfirms the multidimensional nature of segregation and corroborates the dimensional structure uncovered by Massey and Denton in their 1980 study" (p. 192). Again, only one of the five clustering indices has its highest loading

on the fifth dimension. One has its highest loading on the evenness factor and the other three on the exposure dimension. There were essentially four dimensions.

Summarizing these analyses, Massey, White, and Phua (1996, p. 190) concluded that the 1990 replication of the 1980 study indicated a "real, substantive change in the dimensional structure of segregation within the nation's largest metropolitan areas and those that contain large numbers of Hispanics" because "although evenness, exposure, concentration, and centralization all emerge as separate and interpretable factors . . . clustering appears to have become empirically confounded with exposure and evenness" (p. 189). Nevertheless, Massey, White, and Phua claim that their extended study for 1990 sustained the five-dimensional scheme, leading to the overall conclusion that the work (p. 200):

> reconfirm[s] Massey and Denton's finding of five, empirically identifiable dimensions of residential segregation: evenness, exposure, concentration, centralization, and clustering. Although we were unable to identify a separate fifth factor corresponding to a clustering dimension when we factor analyzed the original set of 60 metropolitan areas, a clear structure of five interpretable dimensions readily emerged when we expanded the analysis to include all 318 US metropolitan areas.

The Research Question

From their analyses of 1980 and 1990 census data, Massey, White, and Phua (1996) have claimed that empirical validation of the five-dimensional scheme withstood the growing ethnic diversity of urban America between 1980 and 1990, with only small changes that do not dent their overall conclusion. Does it withstand a further decade of change? Were there five empirically distinct dimensions to the residential segregation of African-American, Asian, and Hispanic ethnic minority groups in 2000?

To answer that question, we report analyses of the 1980, 1990, and 2000 census data for all United States MAs, using all but one of the 20 indices analyzed by Massey and Denton, as calculated by the United Staes Bureau of the Census. However, some methodological reformulation of Massey and Denton's studies has been undertaken for several reasons:

1. The data set used here (provided by the United States Bureau of the Census) does not include one of the variables deployed by Massey and Denton—PCC, the percentage of the population living in the central city. This is, in

any case, a very weak and coarse measure of centralization since it depends on the administrative geography of individual MAs—which varies considerably across the country (some MAs are much more balkanized than others) and also changes through time.[9]

2. Massey and Denton report using principal axis factor analysis, which we were unable to do because the correlation matrices were not positive definite.[10] (This was almost certainly because they used two pairs of variables—isolation index [xPx] and interaction index [xPy], distance-decay interaction index [DPxy] and distance-decay isolation index [DPxx]—which are necessarily perfectly correlated as one is the inverse of the other.[11]) Instead, principal components factor analysis is used here for all three years.
3. Massey and Denton combined measures of the segregation of the various ethnic groups into a single data set (so that each MA appeared three times). This assumes that the intercorrelations of the various measures do not vary across those groups—which may not be the case, given that African-American ethnic enclaves and ghettos were established in many MAs several decades before large Hispanic and Asian populations arrived there.[12] Further, although Massey and Denton used a weighting procedure so that patterns in the places with the larger ethnic populations had more impact on the intervariable correlations and the subsequent factor structures, nevertheless their procedure does include indices referring to relatively small populations (which may be little more than random noise). Each major ethnic group's segregation is therefore analyzed separately here.

This article reports on analyses of the dimensions of segregation across the metropolitan United States using 2000 census data for 19 of the 20 indices, calculated for each of the three main ethnic groups in each of 331 MAs (330 for 1980) at the census tract scale, for each of the three censuses. These are available to researchers on the United States Bureau of the Census Web site, http://www.census.gov/hhes/www/housing/resseg/ (see also Iceland, Weinberg, and Steinmetz 2002).

The Dimensions of Segregation, 1980–2000

One of Massey and Denton's analytical concerns—as shown by their use of weighted correlations—was the impact on their segregation measures when a group had only a very small number of residents in the MA. Those measures may be little more than random noise. Weighting reduces the influence of places with small ethnic populations but does not remove it. It also inflates the influence of those places with substantial populations of the minority group.

To circumvent this problem and to look at the pattern of segregation only in those places in which the ethnic group concerned was of a substantial size, we limited our analyses to MAs in which the relevant group comprised at least 25,000 persons—the equivalent of little more than five census tracts. For 1980, this gave us 220 observations for the 19 segregation measures: 136 related to African-Americans, 68 to Hispanics, and 16 only to Asians;[13] for 1990, there were 286 observations, and for 2000 there were 365.

Our first analyses involved combining the 19 segregation indices for all three ethnic groups into single principal components factor analyses, thus approximating the approach taken by Massey and Denton (1988). At each date, these identified just three dimensions with eigenvalues exceeding 1.0.[14] The loadings on those three dimensions after Promax rotation are shown in Table 2. For 1980, the three dimensions can be readily identified with (1) unevenness, (2) isolation and clustering (though Massey and Denton's favored clustering measure—spatial proximity index [SP]—loads substantially on both unevenness and isolation), and (3) centralization plus, to some extent, concentration. This analysis was repeated for the 1990 and 2000 census data, with an increased number of cases reflecting the growing ethnic minority populations. The patterns of loadings (also in Table 2) are very similar; the clustering and isolation measures covary, as do those for concentration and centralization.[15]

Ethnic-Group–Specific Analysis

Grouping observations on the 19 measures for all three ethnic minority groups assumes that the interrelationships among those measures are the same for each. This need not necessarily be so. Given the recency of much Asian and Hispanic migration to the United States relative to the long-established African-American enclaves and ghettos in many MAs, it may be that the patterns differ, especially with regard to the three sets of measures of spatial location—centralization, concentration, and clustering. Because of this, we have run separate analyses for each ethnic group, again restricting them to MAs in which the group comprised 25,000 or more members.[16]

For African-Americans, the same, very distinct pattern of three dimensions appeared in each year (the order of the factors is irrelevant as this reflects slight variations in the size of the eigenvalues associated with the various factors[17]). Two elements to the segregation of this group are common throughout the period (Table 3): (1) unevenness and (2) isolation and clustering. However, whereas in 1980 concentration was linked to the unevenness dimension, in 1990 and 2000, it was closely linked to

Table 2
Promax-Rotated Factor Loadings for Analyses of 19 Segregation Measures in All Metropolitan Areas in Which an Ethnic Group Comprises 25,000 or More Members: 1980, 1990, 2000

	1980 (N = 220)			1990 (N = 286)			2000 (N = 365)		
	I	II	III	I	II	III	I	II	III
D	**0.98**	0.48	0.44	**0.97**	0.54	0.46	**0.98**	0.51	0.46
G	**0.97**	0.47	0.41	**0.96**	0.53	0.45	**0.97**	0.50	0.45
H	**0.97**	0.56	0.42	**0.97**	0.61	0.43	**0.98**	0.60	0.43
A1	**0.94**	0.47	0.43	**0.94**	0.50	0.48	**0.97**	0.51	0.48
A5	**0.98**	0.48	0.44	**0.98**	0.53	0.47	**0.99**	0.52	0.46
A9	**0.95**	0.45	0.41	**0.95**	0.53	0.43	**0.96**	0.51	0.42
xPx	0.61	**0.95**	0.09	0.58	**0.97**	0.08	0.57	**0.98**	0.08
xPy	–0.61	**–0.95**	–0.09	–0.58	**–0.97**	–0.08	–0.57	**–0.98**	–0.08
V	**0.91**	0.68	0.33	**0.90**	**0.72**	0.35	**0.92**	**0.72**	0.35
DEL	0.62	0.03	**0.79**	0.50	0.00	**0.87**	0.38	0.04	**0.84**
ACO	0.49	–0.54	*0.60*	0.53	–0.56	*0.63*	0.26	–0.54	*0.60*
RCO	0.63	–0.05	0.68	0.58	–0.11	**0.74**	0.48	–0.08	**0.79**
ACE	0.28	0.03	**0.87**	0.24	0.00	**0.86**	0.16	–0.02	**0.83**
RCE	0.50	0.11	**0.79**	0.60	0.06	**0.73**	0.51	0.02	**0.72**
ACL	0.54	**0.83**	0.17	0.61	**0.84**	0.10	0.68	**0.73**	0.13
SP	**0.76**	**0.70**	0.32	**0.78**	**0.73**	0.27	**0.84**	**0.72**	0.28
RCL	*0.59*	–0.11	0.48	*0.66*	–0.02	0.31	*0.65*	–0.06	0.22
DPxx	0.34	**0.99**	0.07	0.36	**0.99**	–0.05	0.42	**0.99**	–0.01
DPxy	–0.34	**–0.99**	–0.07	–0.36	**–0.99**	0.05	–0.42	**–0.99**	0.01
Interfactor Correlations									
	1.00	0.38	0.51	1.00	0.42	0.52	1.00	0.46	0.46
		1.00	0.00		1.00	0.00		1.00	0.00
			1.00			1.00			1.00

Note: For a key to the indices, see Table 1. Loadings exceeding 0.7 are shown in bold. Where the largest loading for a variable is less than 0.7, it is shown in italics.

centralization. The implication is clear. Whereas in 1980 in those MAs whose African-American populations were most unevenly distributed (i.e., most segregated on that set of measures), these populations were also most concentrated into higher density areas; this was not the case in either 1990 or 2000. As more African-Americans moved to lower density (i.e., less concentrated) areas, they did not necessarily remain very unevenly distributed.

Table 3
Promax-Rotated Factor Loadings for Analyses of 19 Segregation Measures in All Metropolitan Areas in Which African-Americans Comprise 25,000 or More Members: 1980, 1990, 2000

	1980 (N = 136)			1990 (N = 153)			2000 (N = 166)		
	I	II	III	I	II	III	I	II	III
D	**0.96**	0.58	0.46	0.67	**0.96**	**0.70**	0.62	**0.96**	0.62
G	**0.96**	0.57	0.44	0.65	**0.95**	**0.71**	0.60	**0.96**	0.63
H	**0.92**	**0.74**	0.41	0.79	**0.92**	0.65	**0.74**	**0.94**	0.56
A1	**0.88**	0.61	0.39	0.66	**0.90**	0.68	0.63	**0.95**	0.60
A5	**0.96**	0.62	0.45	0.69	**0.95**	**0.71**	0.65	**0.97**	0.61
A9	**0.91**	0.58	0.43	0.68	**0.88**	0.68	0.64	**0.92**	0.59
xPx	0.49	**0.98**	0.04	**0.99**	0.50	0.24	**0.99**	0.52	0.17
xPy	–0.49	**–0.98**	–0.04	**–0.99**	–0.50	–0.24	**–0.99**	–0.52	–0.17
V	**0.80**	**0.87**	0.29	**0.91**	**0.81**	0.53	**0.86**	**0.85**	0.46
DEL	**0.87**	0.14	0.67	0.15	**0.73**	**0.91**	0.04	0.67	**0.88**
ACO	**0.79**	–0.12	0.58	–0.09	0.67	**0.82**	–0.25	0.62	**0.77**
RCO	**0.81**	0.10	0.54	0.19	0.63	**0.85**	–0.14	0.66	**0.84**
ACE	0.46	0.16	**0.88**	0.15	0.39	**0.81**	0.12	0.34	**0.85**
RCE	0.62	0.22	**0.82**	0.22	0.53	**0.81**	0.19	0.49	**0.81**
ACL	0.52	**0.90**	0.27	**0.86**	0.66	0.30	**0.78**	**0.77**	0.30
SP	0.61	**0.84**	0.37	**0.85**	**0.70**	0.37	**0.84**	**0.77**	0.37
RCL	0.53	–0.01	*0.69*	0.12	**0.74**	0.41	0.07	**0.75**	0.36
DPxx	0.15	**0.94**	0.12	**0.94**	0.22	0.02	**0.98**	0.32	0.03
DPxy	–0.15	**–0.94**	–0.13	**–0.94**	–0.22	–0.02	**–0.98**	–0.32	–0.03
Interfactor Correlations									
	1.00	0.43	0.54	1.00	0.52	0.25	1.00	0.48	0.14
		1.00	0.00		1.00	0.71		1.00	0.63
			1.00			1.00			1.00

Note: For a key to the indices, see Table 1. Loadings exceeding 0.7 are shown in bold. Where the largest loading for a variable is less than 0.7, it is shown in italics.

Instead, concentration at the later censuses was closely linked to centralization. Only when African-Americans were congregated into inner-city areas were they also highly concentrated spatially.

That significant change in the nature of African-American segregation in MAs during the 20-year period was not replicated in the experience of Asians, for whom the number of places with more than 25,000 residents increased almost fourfold from 16 to 63. Indeed, Table 4 shows patterns of loadings that are extremely consistent across the three censuses. Similarly,

Table 4
Promax-Rotated Factor Loadings for Analyses of 19 Segregation Measures in All Metropolitan Areas in Which Asians Comprise 25,000 or More Members: 1980, 1990, 2000

	1980 (N = 16)			1990 (N = 40)			2000 (N = 63)		
	I	II	III	I	II	III	I	II	III
D	0.38	**0.93**	0.66	0.53	**0.97**	0.27	0.49	**0.97**	0.08
G	0.35	**0.95**	0.64	0.53	**0.98**	0.24	0.49	**0.98**	0.10
H	0.63	**0.88**	0.55	0.74	**0.92**	0.26	0.75	**0.89**	0.12
A1	0.26	**0.91**	0.55	0.49	**0.95**	0.31	0.49	**0.96**	0.15
A5	0.31	**0.97**	0.63	0.53	**0.98**	0.30	0.51	**0.98**	0.14
A9	0.24	**0.98**	0.61	0.50	**0.98**	0.28	0.48	**0.96**	0.13
xPx	**0.98**	0.16	–0.18	**0.99**	0.46	–0.05	**0.99**	0.41	–0.08
xPy	**–0.98**	–0.16	0.18	**–0.99**	–0.46	0.05	**–0.99**	–0.41	0.08
V	**0.88**	0.58	0.29	**0.89**	**0.73**	0.19	**0.90**	0.66	0.08
DEL	–0.16	0.33	**0.94**	–0.05	0.10	**0.92**	–0.04	–0.04	**0.91**
ACO	**–0.76**	0.16	0.59	*–0.67*	0.07	0.55	*–0.69*	–0.05	0.56
RCO	–0.20	0.52	**0.93**	–0.05	0.43	**0.89**	–0.04	0.29	**0.91**
ACE	–0.32	0.44	**0.78**	–0.17	0.15	**0.91**	–0.23	0.02	**0.89**
RCE	0.05	*0.55*	0.07	0.04	*0.42*	*0.35*	–0.17	*0.38*	0.29
ACL	**0.98**	0.26	–0.05	**0.90**	0.64	0.07	**0.94**	0.50	–0.14
SP	**0.79**	0.48	0.38	**0.84**	0.68	0.17	**0.85**	0.56	0.09
RCL	–0.16	**0.77**	0.25	–0.08	0.58	–0.14	–0.10	0.57	–0.31
DPxy	**–0.95**	0.01	0.27	**0.98**	0.33	–0.11	**0.99**	0.33	–0.10
DPxx	**0.95**	0.01	–0.29	**–0.98**	–0.33	0.11	**–0.99**	–0.33	0.10
Interfactor Correlations									
	1.00	0.25	0.00	1.00	0.45	0.00	1.00	0.42	0.00
		1.00	0.00		1.00	0.29		1.00	0.13
			1.00			1.00			1.00

Note: For a key to the indices, see Table 1. Loadings exceeding 0.7 are shown in bold. Where the largest loading for a variable is less than 0.7, it is shown in italics.

Table 5 shows a very consistent pattern of loadings for Hispanics at each of the three censuses, with the number of MAs having 25,000 or more Hispanic residents doubling during the two decades. Furthermore, the two groups had the same three-factor structure in each of the analyses, although the ordering of the rotated factors is different. (This is neither statistically nor substantively significant.) One factor—the first in each analysis for Hispanics and the second for Asians—has high loadings for the six unevenness measures plus the V measure of isolation (although this loading is somewhat smaller for the

Table 5
Promax-Rotated Factor Loadings for Analyses of 19 Segregation Measures in All Metropolitan Areas in Which Hispanics Comprise 25,000 or More Members: 1980, 1990, 2000

	1980 (N = 68)			1990 (N = 93)			2000 (N = 136)		
	I	II	III	I	II	III	I	II	III
D	**0.98**	0.27	0.33	**0.98**	0.31	0.28	**0.98**	0.25	0.36
G	**0.98**	0.29	0.32	**0.98**	0.32	0.28	**0.98**	0.27	0.33
H	**0.99**	0.27	0.37	**0.99**	0.32	0.28	**0.99**	0.35	0.34
A1	**0.99**	0.23	0.36	**0.98**	0.26	0.29	**0.98**	0.28	0.35
A5	**0.99**	0.13	0.36	**0.99**	0.24	0.29	**0.99**	0.25	0.35
A9	**0.98**	0.16	0.36	**0.98**	0.23	0.28	**0.98**	0.28	0.32
xPx	0.40	**0.97**	0.14	0.40	**0.97**	0.07	0.35	**0.98**	0.05
xPy	–0.40	**–0.97**	–0.14	–0.40	**–0.97**	–0.07	–0.35	**–0.98**	–0.05
V	**0.90**	0.47	0.33	**0.90**	0.50	0.24	**0.90**	0.54	0.28
DEL	0.21	0.10	**0.76**	0.29	0.01	**0.86**	0.23	0.13	**0.78**
ACO	0.17	**–0.85**	0.28	0.24	**–0.83**	0.30	0.15	–0.61	0.45
RCO	0.40	–0.11	*0.61*	*0.50*	–0.28	0.47	0.41	–0.18	**0.70**
ACE	0.13	0.04	**0.81**	0.14	0.00	**0.85**	0.07	–0.03	**0.80**
RCE	0.46	–0.05	*0.68*	*0.54*	–0.15	0.51	0.45	–0.17	*0.69*
ACL	0.23	**0.77**	0.04	0.38	**0.84**	–0.14	0.43	0.67	–0.04
SP	0.66	0.61	0.20	**0.74**	0.62	0.16	**0.77**	0.61	0.14
RCL	*0.60*	–0.35	0.13	*0.67*	–0.21	0.04	*0.64*	–0.19	0.06
DPxx	0.20	**–0.99**	0.05	0.21	**0.99**	0.01	0.20	**0.99**	–0.02
DPxy	–0.20	**–0.99**	–0.05	–0.21	**–0.99**	–0.01	–0.20	**–0.99**	0.02
Interfactor Correlations									
	1.00	0.22	0.36	1.00	0.23	0.31	1.00	0.26	0.33
		1.00	0.00		1.00	0.00		1.00	0.00
			1.00			1.00			1.00

Note: For a key to the indices, see Table 1. Loadings exceeding 0.7 are shown in bold. Where the largest loading for a variable is less than 0.7, it is shown in italics.

Asian than Hispanic analyses). A further factor—the first in the Asian analyses and the second in those for Hispanics—has high loadings for the two perfectly correlated isolation measures derived from Lieberson and for most of the clustering measures. Finally, the third factor brings together some of the measures of concentration and centralization.

For Asians and Hispanics, therefore, these analyses of data from the 1980, 1990, and 2000 censuses relating to MAs where they form substantial communities clearly identify just three segregation dimensions: (1) unevenness,

(2) isolation and clustering, and (3) concentration and centralization. In MAs in which people of Asian and/or Hispanic ethnicity are relatively isolated from the remainder of the population (and thus also from each other), they also tend to be clustered into a cohesive block of territory. That block need not be in the central city area, however, as would be indicated by high indices of concentration and centralization. Isolation and location are largely independent. Nor does isolation necessarily imply unevenness in distribution across the MA census tracts. Nevertheless, in both sets of analyses—and also in those for African-Americans—the intercorrelations between the first two pairs of factors indicate some commonality in the patterns of unevenness and exposure. They are not entirely independent (a finding that indicates the value of using oblique rather than orthogonal rotations). Furthermore, for African-Americans and, to a lesser extent, Asians the intercorrelations in 1990 and 2000 suggest greater overlap between the isolation and concentration/centralization dimensions than was the case in 1980.

For African-Americans, on the other hand, there have been some changes in their spatial patterning during the two decades. This could be a general shift, or it could be a consequence of the addition of 30 MAs with African-American populations exceeding 25,000 in 1990 (an extra 17) and 2000 (a further 13). To test which was the case, we undertook further analyses. In the first, the factor analyses reported above were replicated for 1980, 1990, and 2000 for the 136 MAs with more than 25,000 African-Americans in 1980 only. The results in Table 6 are consistent with those in Table 3 for all MAs with 25,000 or more African-Americans in each year.[18] Through time, a clear third dimension emerged linking the concentration and centralization indices, whereas in 1980, despite high cross-loadings, the two sets formed separate constructs.

Table 7 summarizes the detailed results shown in Tables 2 through 5, indicating for each conceptual dimension the number of times its associated indices had a loading of 0.7 or greater on each of the three empirical dimensions (with eigenvalues exceeding 1.0) identified in those tables. (These are named unevenness, isolation/clustering, and centralization/concentration, respectively.) The clearest pattern emerging from this summary is the consistent high loadings for the six unevenness indices on the unevenness dimension, with one measure of exposure (V) and one of clustering (SP) also loading on that dimension in a number of cases. Similarly, the three indices of exposure have high loadings on the isolation/clustering dimension in almost all of the analyses; the main exception is with V for Hispanics. That dimension also has high loadings for a majority of the clustering indices in almost every case, though with slightly smaller numbers in

Table 6
Promax-Rotated Factor Loadings for Analyses of 19 Segregation Measures in the 136 Metropolitan Areas in Which African-Americans Comprise 25,000 or More Members in 1980: 1980, 1990, 2000

	1980			1990			2000		
	I	II	III	I	II	III	I	II	III
D	**0.96**	0.58	0.46	0.63	**0.96**	0.60	0.59	**0.97**	0.56
G	**0.96**	0.57	0.44	0.61	**0.95**	0.62	0.56	**0.96**	0.58
H	**0.92**	**0.74**	0.41	**0.76**	**0.92**	0.56	0.70	**0.94**	0.51
A1	**0.88**	0.61	0.39	0.64	**0.90**	0.57	0.60	**0.94**	0.54
A5	**0.96**	0.62	0.45	0.66	**0.96**	0.62	0.61	**0.97**	0.56
A9	**0.91**	0.58	0.43	0.64	**0.89**	0.61	0.60	**0.92**	0.55
xPx	0.49	**0.98**	0.04	**0.99**	0.48	0.16	**0.99**	0.50	0.10
xPy	–0.49	**–0.98**	–0.04	**–0.99**	–0.48	–0.16	**–0.99**	–0.50	–0.10
V	**0.80**	**0.87**	0.29	**0.88**	**0.81**	0.45	**0.83**	**0.85**	0.41
DEL	**0.87**	0.14	0.67	0.11	**0.77**	**0.77**	–0.02	0.68	**0.87**
ACO	**0.79**	–0.12	0.58	–0.14	**0.71**	**0.78**	–0.32	0.63	**0.73**
RCO	**0.81**	0.10	0.54	0.15	**0.70**	**0.86**	0.07	0.69	**0.78**
ACE	0.46	0.16	**0.88**	0.12	0.39	**0.86**	0.09	0.35	**0.87**
RCE	0.62	0.22	**0.82**	0.21	0.60	**0.82**	0.16	0.54	**0.79**
ACL	0.52	**0.90**	0.27	**0.86**	0.64	0.25	**0.76**	**0.76**	0.28
SP	0.61	**0.84**	0.37	**0.84**	**0.69**	0.31	**0.81**	**0.77**	0.33
RCL	*0.53*	–0.01	0.69	0.07	**0.71**	0.37	0.00	**0.73**	0.37
DPxx	0.15	**0.94**	0.12	**0.95**	0.19	–0.03	**0.98**	0.28	–0.02
DPxy	–0.15	**–0.94**	–0.13	**–0.95**	–0.19	0.03	**–0.98**	–0.28	0.02
Interfactor Correlations									
	1.00	0.43	0.54	1.00	0.47	0.15	1.00	0.44	0.00
		1.00	0.00		1.00	0.66		1.00	0.60
			1.00			1.00			1.00

Note: For a key to the indices, see Table 1. Loadings exceeding 0.7 are shown in bold. Where the largest loading for a variable is less than 0.7, it is shown in italics.

the analyses of Hispanic segregation. These two dimensions—unevenness and isolation/clustering—are common to all of the analyses, with generally similar patterns of loadings for each of the separate ethnic groups as well as when all three groups are analyzed together.

Finally, there is less consistency in the pattern of loadings for the indices of concentration and centralization. There are substantial differences across the three ethnic groups and, although with the exception of the situation for African-Americans in 1980, there is little cross-loading onto other

Table 7
Summary of the Pattern of Loadings (All Loadings Greater Than ± 0.7) on the Three Dimensions Identified in Tables 2–5

Conceptual Dimension*			EV	EX	CO	CE	CL
Number of Indices			(6)	(3)	(3)	(2)	(5)
Total Population (Table 2)							
Unevenness	1980	I	6	1	0	0	1
	1990	I	6	1	0	0	1
	2000	I	6	1	0	0	1
Isolation/clustering	1980	II	0	2	0	0	4
	1990	II	0	3	0	0	4
	2000	II	0	3	0	0	4
Centralization/concentration	1980	III	0	0	1	2	0
	1990	III	0	0	2	2	0
	2000	III	0	0	2	2	0
African-Americans (Table 3)							
Unevenness	1980	I	6	1	3	0	0
	1990	II	6	1	1	0	0
	2000	II	6	1	0	0	3
Isolation/clustering	1980	II	1	3	0	0	4
	1990	I	0	3	0	0	4
	2000	I	0	3	0	0	4
Centralization/concentration	1980	III	0	0	0	2	0
	1990	III	3	0	3	2	0
	2000	III	0	0	3	2	0
Asians (Table 4)							
Unevenness	1980	II	6	0	0	0	1
	1990	II	6	1	0	0	0
	2000	II	6	0	0	0	0
Isolation/clustering	1980	I	0	3	1	0	4
	1990	I	0	3	0	0	4
	2000	I	0	3	0	0	4
Centralization/concentration	1980	III	0	0	2	1	0
	1990	III	0	0	2	1	0
	2000	III	0	0	2	1	0
Hispanics (Table 5)							
Unevenness	1980	I	6	1	0	0	0
	1990	I	6	1	0	0	1
	2000	I	6	1	0	0	1
Isolation/clustering	1980	II	0	2	1	0	3
	1990	II	0	2	1	0	3
	2000	II	0	2	0	0	2
Centralization/concentration	1980	III	0	0	1	1	0
	1990	III	0	0	1	1	0
	2000	III	0	0	2	1	0
TOTAL			75	42	28	18	53

Note: Key to dimensions: EV = evenness; EX = exposure; CO = concentration; CE = centralization; CL = clustering.

dimensions, the overall pattern is much less clear cut than it is for the other two. Whereas unevenness and isolation/clustering come through as unambiguous, separate empirical dimensions for all three ethnic groups, centralization/concentration is not as clear as a third general pattern. Indeed, as the results for African-Americans show, the changing patterns of loadings for the centralization and concentration indices indicate alterations to the spatial patterning of segregation through time. With African-Americans, for example, concentration was strongly linked to unevenness in 1980 but not 1990 and 2000. At the first date, high levels of unevenness in the distribution of African-Americans were associated with high levels of concentration into high-density areas. In 1990 and 2000, the two patterns were dissociated; for African-Americans, they were very unevenly distributed in an MA, but this did not necessarily mean they were also highly concentrated, presumably as a result of movement out from some of the very high-density older residential areas of the inner city.

The Basic Dimensions

Having identified five separate dimensions to ethnic residential segregation within their sample of MAs, Massey and Denton selected one index to represent each. Their chosen five also were seen as excellent representatives of each group of measures. Each had a high correlation with most of the other measures in its group. We have deployed those five—index of dissimilarity (D), xPy, relative concentration index (RCO), absolute centralization index (ACE), and SP—here, in a final set of analyses designed to identify the basic set of dimensions for each ethnic group in each year.

In all nine analyses, only two factors with eigenvalues exceeding 1.0 were extracted. The resulting Promax-rotated factor structures and their intercorrelations are in Table 8. Two very clear dimensions to ethnic residential segregation stand out, with just two minor exceptions. The relatively low loading for D on the first factor in the Asian analysis for 1980 (which covered just 16 MAs) and the relatively low loadings for ACE on the second factor in all three analyses for Hispanics. The basic patterns for the two factors are:

1. Unevenness, isolation and clustering, or *separateness*—a composite concept, covering three of Massey and Denton's dimensions, of the degree to which members of the ethnic group live apart from the remainder of the population in a coherent block of urban territory; and

2. Concentration and centralization, or *location*—a composite concept incorporating the degree to which members of the group are congregated (irrespective of their degree of isolation) into high-density, inner-city areas.

The two are largely independent, totally so in the case of Asians. They are weakly related in the case of Hispanics—an average correlation of 0.22 indicates that less than 5% of the variation in one factor can be accounted for by variation in the other. Additionally, there is only a slightly stronger relationship for African-Americans. An average correlation of 0.41 indicates that only 17% of the variation can be accounted for. In general, therefore, whether members of either of the three groups are clustered together in relative isolation is unrelated to the geography of where they live within an MA.

Given the clarity of these two composite concepts, there are two ways in which the concepts can be implemented empirically. The first and the most straightforward is to select one index to represent each concept. Given the size of the loadings in Table 8, separateness is probably best represented by the index of interaction (xPy), while location is best represented by RCO. Alternatively, principal components factor analysis of all five indices could be undertaken and the scores on the respective components used as the composite indices for each. The advantage of the former approach is that the two selected indices have clear interpretative value. The component scores are dimensionless standardized numbers.

This final set of results has identified two basic underlying dimensions—separateness and location—to segregation, therefore, which apply across all three ethnic groups at all three dates. The interrelationships among the various segregation measures are basically the same for each group at each date. This does not, however, imply that the degree of segregation is the same for each group. Indeed, African-Americans are more segregated than Hispanics (as Massey and Denton [1989] recognized in their initial study of hypersegregation, which casts doubt on their decision in the original article on the dimensions of segregation—Massey and Denton 1988—to include all ethnic groups in a single analysis); Hispanics, in turn, are more segregated than Asians in most MAs. African-Americans, on average, have higher dissimilarity and spatial proximity indices and lower interaction indices than either of the other two, especially the Asians. The separateness dimension applies equally to all three groups, but African-Americans are much more separated in terms of their residential patterning than are the other two. On the location dimension, in most of the MAs, all three groups have high centralization and concentration scores, but there are more outliers on both (MAs with relatively low indices) for Asians than African-Americans, and especially, Hispanics.

Table 8
Promax-Rotated Factor Loadings from Analyses of the Reduced Set of Segregation Measures: 1980, 1990, 2000

African–Americans

	1980		1990		2000	
	I	II	I	II	I	II
D	0.81	0.75	0.84	0.65	0.87	0.62
xPy	–0.93	–0.25	–0.93	–0.19	–0.92	–0.18
RCO	0.38	0.87	0.38	0.87	0.43	0.88
ACE	0.25	0.79	0.22	0.85	0.22	0.85
SP	0.93	0.44	0.94	0.37	0.96	0.41
Correlation	0.45		0.39		0.40	

Asians

	1980		1990		2000	
	I	II	I	II	I	II
D	*0.68*	0.56	**0.83**	0.32	**0.78**	0.14
xPy	**–0.83**	0.40	**–0.88**	0.17	**–0.88**	0.17
RCO	0.12	**0.96**	0.20	**0.94**	0.13	**0.94**
ACE	–0.08	**0.92**	–0.06	**0.91**	–0.16	**0.93**
SP	**0.94**	0.15	**0.95**	0.08	**0.94**	–0.02
Correlation	0.00		0.00		0.00	

Hispanics

	1980		1990		2000	
	I	II	I	II	I	II
D	**0.80**	0.45	**0.82**	0.56	**0.80**	0.50
xPy	**–0.83**	–0.03	**–0.84**	0.07	**–0.78**	–0.11
RCO	0.17	**0.82**	0.13	**0.87**	0.19	**0.85**
ACE	0.12	*0.68*	0.11	*0.54*	0.01	*0.68*
SP	**0.91**	0.17	**0.93**	0.24	**0.93**	0.15
Correlation	0.23		0.24		0.19	

Conclusions

This article has addressed just one of many conceptual and empirical issues that are discussed widely in the literature on ethnic residential segregation in United States urban areas. Is segregation a multidimensional concept, and if

so, how many separate dimensions are there? This has involved revisiting and extending the classic work of Massey and his coauthors.

In revisiting Massey and Denton's pioneering study with only slight variations in methodology, instead of identifying five separate, if related, empirical dimensions that mapped into Massey and Denton's five conceptual dimensions, we could identify only three, which suggested that the pattern of segregation was both simpler but also less clear cut than Massey and Denton's analyses indicated.[19] Furthermore, when focusing on the five indicator measures selected for applying Massey and Denton's conceptual dimensions to the study of hypersegregation, we identified only two clearly separate patterns, which were very largely consistent through time and across the three ethnic groups. Extending Massey and Denton's work to data taken from the 2000 census, we have reiterated that conclusion, and therefore suggest that further work on this subject should concentrate on those two basic patterns.

These findings are consistent with Reardon and O'Sullivan's (2004; see also Reardon and Firebaugh 2002) argument that Massey and Denton's five conceptual dimensions should be reduced to two, which Reardon and O'Sullivan term *spatial exposure* and *spatial evenness* (equivalent to our *separateness* and *location*, respectively: we prefer our terminology because of the ambiguity in the use of *spatial unevenness*—for Massey and Denton, indices of unevenness are measures of separateness, not location). Reardon and O'Sullivan's main concern—along with that of others such as Wong (1993, 1998)—is that many of the indices of segregation regularly deployed, such as those of dissimilarity and isolation/exposure, are aspatial and take no account of the relative location of the census tracts used in measuring segregation and its implications for the modifiable areal unit problem (whereby different spatial structures can produce different outcomes for the same basic data). Reardon and O'Sullivan introduce criteria for evaluating spatial segregation measures, on which foundation they develop a general spatial exposure index, extending earlier work that they review and compare with their own formulation. Their approach is admitted as not problem free, however, and they report no empirical applications. Although they are, in effect, combining the two basic dimensions identified here—so that, for example, an exposure index would be lower if the group being considered was distributed across a randomly scattered rather than a concentrated set of tracts, with the same numbers in each tract—so that a single index would summarize both aspects, it may be that in doing so some valuable information is lost and the resultant index may be difficult to interpret. (It may be, for example, that a group with a medium level of exposure but concentrated in one cluster of

tracts would have the same index as a group with a high level of exposure but distributed across several smaller clusters.) Clearly, there is potential for further work on such measures.

This article provides strong evidence that rather than conceive of ethnic residential segregation in United States MAs as a five-dimensional structure, as suggested by the conceptual schema outlined by Massey and Denton, just two dimensions are sufficient to encompass most of the variation across cities for all three major groups. We have termed these dimensions *separation* and *location*. The separation dimension encompasses the conceptually distinct concepts of unevenness, isolation, and clustering. In MAs in which members of an ethnic group are very unevenly distributed, they tend also to be both (1) more isolated from members of other groups—that is, to live in relative spatial exclusion at the census tract scale—and (2) clustered together—that is, the tracts in which they dominate the population tend to be clustered together. The location dimension encompasses the conceptually distinct concepts of centralization and concentration. In MAs in which members of an ethnic group live at relatively high densities, they also tend to live close to the city center—though not necessarily in a single cluster.

Having reached this conclusion, it is interesting to speculate why our findings differ from Massey and Denton's. As already noted, we have been unable to use the same methodological procedure—principal axis factor analysis—because this requires positive definite correlation matrices that do not appear when closed number set variables are deployed. However, the switch to principal components analysis should not produce a very dissimilar outcome, nor should the exclusion of one variable representing centralization.[20] In part, we believe that Massey and Denton (1988) seemed determined to identify five clear dimensions even if the pattern of loadings hardly sustained this (see Tables 4 and 5 in their original article and Tables 3 through 5 in the article reporting the 1990 analyses: Massey, White, and Phua 1996). Nevertheless, our analyses clearly extracted a smaller number of factors with eigenvalues exceeding 1.0 for both the 19-variable and 5-variable data sets. The (albeit slight) differences between our work and theirs should have much less impact in the latter case than in the former. Whatever the reasons for the differences, we have clearly identified a smaller number of dimensions of ethnic residential segregation than Massey and Denton's, which raises important issues regarding the future use and operationalization of Massey and Denton's concept of hypersegregation.[21]

Whatever the merits of Massey and Denton's five-dimensional conceptual schema for ethnic segregation studies in the United States, separate empirical analyses for MAs with substantial populations of African-Americans, Asians,

and Hispanics in 1980, 1990, and 2000 indicate that these can be collapsed into just two. Ethnic residential segregation there has two major dimensions to its spatial patterning—separateness and location. If hypersegregation remains a valuable concept, it should be related to those two dimensions only.

Notes

1. The data refer to the 330 metropolitan statistical areas in 1980 analyzed here and the 331 at each of the subsequent censuses.

2. According to the Web of Knowledge (Web site: last searched March 17, 2006), the original article has been cited 250 times since its appearance in 1988; the 1996 article has been cited 28 times.

3. Wilkes and Iceland (2004) identified 29 MAs as hypersegregated for Blacks in 2000 and two for Hispanics.

4. This casts doubt on the exact nature of Massey and Denton's methodology.

5. It may well be, of course, that though Massey and Denton present them as conceptually distinct to some extent, this reflects the findings of their empirical analyses of 1980 data: what has become a priori was initially a posteriori!

6. They can also be found on the Census Bureau Web site from which the data for this study were obtained: http://www.census.gov/hhes/www/housing/resseg/app_b.html.

7. The relative size of the various factors was in considerable measure a function of the number of indices representing each conceptual dimension and the perfect, inverse correlations within two pairs of indices. They were not independent, as the interfactor correlations showed—and as Massey and Denton recognized later in the page when noting that "the apparent empirical insignificance of the last three factors . . . is largely an artifact of the assumption of factorial independence. . . . Although conceptually the dimensions might be distinct, in the real world they tend to be empirically correlated with the major axes of evenness and exposure" (p. 305).

8. Their argument for using weighted data was that this meant that the results represented "the viewpoint of the typical minority member rather than the typical metropolitan area and produce results that are less sensitive to random fluctuations in the indexes, which frequently occur when the relative number of minority members grows small" (p. 178). Both approaches are valid; our preference is for the latter.

9. Massey and Denton realized that PCC had several drawbacks, however, because "the relative size of the central city is . . . largely a function of the era in which the city developed, and does not indicate the extent of a group's centralization in any real sense. Moreover, it takes no account of the actual distribution of a group in space" (Massey and Denton 1988, p. 292). Its exclusion from the data set is therefore very largely unproblematic. One possible consequence is that exclusion of one of the three centralization measures may result in an eigenvalue of less than 1.0 for that group; however, PCC only loaded weakly on the centralization dimensions identified by Massey and Denton (1988) and Massey, White, and Phua (1996) and this is therefore unlikely to have been the reason for the absence of separate centralization dimensions in the analyses reported here.

10. This problem was encountered with several variants of factor analysis tried with both weighted and unweighted data. All of the analyses were conducted using the SPSS package.

11. Indeed, removal of one of the indices from each of those pairs, reducing the number of variables to 18, does allow a principal axis factor analysis to be conducted.

12. Given that there were large numbers of African-Americans in many MAs several decades before the arrival of substantial numbers of Hispanics and/or Asians and that there has been little invasion and succession of African-American ghettos by members of those two groups, it is likely that the latter would have been both less concentrated and less centralized than the African-Americans. Including all three groups within a single data set will thus confound the interindex correlations.

13. In effect, therefore, the great majority of MAs analyzed by Massey and Denton had little more than a handful of Asian residents then.

14. Massey and Denton also used the conventional practice of an eigenvalue-greater-than-1.0 criterion for determining the number of significant dimensions.

15. As suggested above (Note 9), the covariation of concentration and centralization almost certainly reflected the situation for African-Americans, who dominate the data matrices.

16. Massey, White, and Phua (1996) also did this for their 1990 data.

17. Slight variations in the pattern of loadings can change the relative size of the factors, as indicated by their eigenvalues, without any change in the relative importance of the major loadings.

18. This is largely unsurprising, since the 136 MAs used in the 1980 analyses dominated the 166 used in 2000.

19. We were unable to replicate Massey and Denton's findings for 1980, using the same sample of MAs. We could only identify three separate factors with eigenvalues exceeding 1.0, not five, as they did.

20. Massey and Denton's weighting procedure may account for the differences: Table 2 in their original article (Massey and Denton 1988) shows much smaller weighted than unweighted standard deviations for the 20 variables, and Table 3 indicates slightly smaller intervariable correlations for the weighted data. (Smaller intercorrelations could lead to the identification of more dimensions.) However, as noted above, Massey and Denton suggested that there were no substantive differences when they analyzed the unweighted data, and we similarly found no major differences when experimenting with weighted data.

21. The robustness of our findings is, of course, open to reanalysis. The data are all publicly available.

References

Iceland, J., D. H. Weinberg, and E. Steinmetz. 2002. *Racial and ethnic segregation in the United States: 1980–2000*. Washington, DC: U.S. Bureau of the Census.

Massey, D. S., and N. A. Denton. 1988. The dimensions of residential segregation. *Social Forces* 67**:**281–315.

———. 1989. Hypersegregation in U.S. metropolitan areas: Black and Hispanic segregation along five dimensions. *Demography* 26:373–93.

———. 1993. *American apartheid: Segregation and the making of the underclass*. Cambridge, MA: Harvard Univ. Press.

Massey, D. S., M. J. White, and V.-C. Phua. 1996. The dimensions of segregation revisited. *Sociological Methods and Research* 25:172–206.

Reardon, S. F., and G. Firebaugh. 2002. Measuring segregation: Measures of multi-group segregation. *Sociological Methodology* 32:33–68.

Reardon, S. F., and D. O'Sullivan. 2004. Measures of spatial segregation. *Sociological Methodology* 34:121–62.

Wilkes, R., and J. Iceland. 2004. Hypersegregation in the twenty-first century. *Demography* 41:23–36.
Wong, D. W. S. 1993. Spatial indices of segregation. *Urban Studies* 30:559–72.
———. 1998. Measuring multi-ethnic spatial segregation. *Urban Geography* 19:77–87.

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