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ABSTRACT

Research using measures of racial exposure has been appearing with increasing frequency in the literature on race relations. A methodological analysis finds the following problems with these measures: (1) they fail to characterize meaningfully the actual composition of sub-areas; (2) a particular exposure value can describe a wide variety of racial distributions. Hence, large changes in residential distributions need not be reflected in changes in exposure values; and (3) the strong correlation between exposure measures and overall racial composition means that changes in racial composition, in the absence of residential redistribution, necessarily produce changes in the exposure measures. Because of these three problems, the sociological concepts of interracial exposure and potential for interaction are poorly served by the current exposure measures. A 20-item list of references is included. Data are presented on seven tables and figures. (Author/BJV)

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ABSTRACT

Research using measures of racial exposure has been appearing with increasing frequency in the literature on race relations. A methodological analysis finds several problems with these measures. (1) They fail to characterize meaningfully the actual racial composition of sub-areas. (2) A particular exposure value can describe a wide variety of racial distributions. Hence, large changes in residential distributions need not be reflected in changes in exposure values. (3) The strong correlation between exposure measures and overall racial composition means that changes in racial composition. in the absence of residential redistribution, necessarily produce changes in the exposure measures. Because of these three problems, the sociological concepts of interracial exposure and potential for interaction are poorly served by the current exposure measures.

MEASURES OF RACIAL EXPOSURE: SOME PROBLEMS

Students of racial and ethnic relations have used various indexes to quantify the degree of segregation in housing and schooling. Methodological discussions of the properties and comparative merits of segregation indexes have been appearing in sociology journals since the 1940's, and the literature is still growing (Duncan and Duncan 1955: James and Taeuber 1985; White 1986; Stearns and Logan 1986). Recently there has been increasing interest in indexes of racial exposure, which are a reworking of a measure discussed by Wendell Bell in the early 1950's (Bell 1954). Exposure indexes are described as capturing sociologically important aspects of segregation that are neglected by the most commonly used segregation indexes.

Consider the cities of Washington, D.C., and Los Angeles. In both cities, blacks are residentially segregated from whites. According to the index of dissimilarity, levels of segregation are similar: 79 for Washington and 81 for Los Angeles. However, Washington is a mainly black city (70 percent black in 1980) while Los Angeles is a mainly white city (17 percent black). These differences in racial composition may well lead to differing perceptions and experiences of residential segregation. A number of recent papers claim that exposure measures are a helpful tool to capture these differences. The exposure measures answer the questions: Where blacks live, what is the proportion white among their neighbors? In the neighborhoods where whites live, what proportion black are they likely to encounter?

Exposure indexes indicate the "relative isolation of groups in terms of probability models of interaction among themselves and with others" (Lieberson and Carter 1982, p. 297). They give, for a randomly selected member of a group, "...the probability that someone else selected from the same residential area will be a member" of a different group (Lieberson and Carter 1982, p. 297). Thus, the exposure measures attempt to describe the potential for interaction between groups, or, conversely, the isolation of one group from another.

Lieberson and Carter (1982, p. 300) note that "if the problem involves consideration of what people experience..., then clearly composition is relevant and the index of dissimilarity does not tell us what they experience in the way of residential isolation." Exposure and actual contact of persons of one race to persons of another race are likely to be important for assimilative behaviors such as reduction of prejudice, language acquisition, friendship formation, and intermarriage. Development and maintenance of a group's cultural, social, political, and commercial institutions are also dependent upon neighborhood context (e.g., Breton 1964; Erbe 1975; Lieberson 1980; Schnare 1980; Farley 1984). These are some of the sociological applications envisioned by proponents of the exposure measures.

Empirical results using exposure measures may differ substantially from results using other measures. Two recent studies of trends in school segregation, based on the same dataset, reached opposite conclusions. One study, using the exposure index, concluded that "there has been little overall change in the segregation of black students in American public schools ...since 1972" (Orfield 1987, p. 1). This study was the basis of a New York Times article which proclaimed that "...the level of segregation of black students remained vitually unchanged between 1972 and 1984" (Fiske 1987). The other study, using the index of dissimilarity, concluded that "...although the rate of desegregation reached its zenith during the early years, 1968 through 1972, and centered on southern districts, it has continued beyond this original era and has included many northern districts in recent years" (Hayward 1987, p. 37).

Duncan and Duncan (1955, p. 217) observed that "the concept of 'segregation' in the literature of human ecology ...involves a number of analytically distinguishable elements, none of which is yet capable of completely operational description....The problem must be faced of considering a variety of possible selections of data and operations on these data in an effort to capture methodologically what is valuable in the work done with the concept prior to the formulation of an index."

This methodological advice from the Duncans provides strong justification for considering multiple measures of segregation. But it also contains a warning that distinguishable concepts and handy measures are not enough. The relation between concept and operational description is always problematic. What is valuable in the concepts of racially-specific exposure, contact, or isolation, may not be captured by the exposure indexes. Our examination of the behavior of exposure indexes in various situations suggests that these measures are not free of peculiarities and the likelihood of misinterpretation.

The Measures

All of the indexes under review are measures of the distribution of sub-areas by racial composition. In basic statistics, the distribution of a variable can be summarized by measures of central tendency or by measures of dispersion. Measures of central tendency, such as the mean, median, or mode, are ways of calculating a "typical" or central value. Measures of dispersion, such as the standard deviation, characterize the distance of observed values from a chosen "typical" value of the distribution. The exposure measures are measures of central tendency, describing the average racial composition faced by members of a particular race. The index of dissimilarity, the Gini index, the variance ratio index, the information theory index, and the Atkinson index are dispersion measures of segregation, describing the deviation of sub-area percentages black from the citywide percentage black (James and Taeuber 1985; White 1986).

The exposure of blacks to whites (EBW) in a city may be calculated as the weighted average percentage white over sub-areas, using the number of blacks in each sub-area as weights. That is,

$$EBW = \frac{\sum b_i(1 - p_i)}{B} \qquad (1)$$

where B is the total number of blacks in the city, p_i and b_i are the black proportion and the number of blacks in the i-th sub-area, and the summation is over all sub-areas. (We prefer the mnemonic symbol EBW to the ${}_bP^*_w$ symbol used by Bell and Lieberson.) Two important features of exposure indexes need emphasis: their asymmetry and their dependence on the aggregate racial composition.

Exposure measures, in contrast to the usual segregation indexes, are not racially symmetric. They are calculated from the perspective of a specific group; the exposure of blacks to whites is not the same as the exposure of whites to blacks. In a two-race situation, there are four exposure measures: EBW, the exposure of blacks to whites; EWB, the exposure of whites to blacks; EBB, the exposure of blacks to blacks; and EWW, the exposure of whites to whites. Knowing any one of the exposure indexes and the overall racial composition allows us to calculate the other three. Interrelationships among the four indexes were noted by Lieberson (1980, p. 257):

$$\text{EBW} = \text{EWB}\ (W/B)$$

$$\text{EWB} = \text{EBW}\ (B/W)$$

$$\text{EBW} + \text{EBB} = 100$$

$$\text{EWB} + \text{EWW} = 100$$

where W/B is the ratio of whites to blacks in the city, and B/W is the ratio of blacks to whites. The own-group exposures, EBB and EWW, are sometimes termed isolation indexes.

Returning to the example of Washington and Los Angeles, the EBW index reveals that the typical black in Washington encounters an average of 9 percent white neighbors (co-residents on the same block). In Los Angeles, an average of 29 percent of the neighbors of the typical black are white. Blacks in Washington are much less likely to have white neighbors than are blacks in Los Angeles.

The situation is reversed for exposure of whites to blacks. Using the EWB index, a randomly selected white in Washington is exposed to an average of 22 percent black among neighbors, compared to 6 percent in Los Angeles. Whites in Washington are much more likely to have black neighbors than are whites in Los Angeles.

The second feature we emphasize is the dependence of exposure measures on aggregate racial composition. This is apparent from the manner in which composition limits the range in exposure values for a particular city or school district. The range in values for each exposure measure is set by the two extreme situations of complete segregation and complete integration. Under complete segregation, each sub-area is uniracial, neither group has any within–sub-area exposure to the other, and both cross-race exposure measures (EBW, EWB) are zero. Under complete integration, each sub-area has the same racial composition as the city as a whole. Blacks in every sub-area are exposed to the same percentage white; EBW is simply the overall percentage white, while EWB is equal to the overall percentage black. Thus, the possible range in EBW for a city is 0 to the citywide percent white, while the possible range in EWB is from 0 to the citywide percent black.

The relationship between the cross-race exposure measures for various levels of racial composition is portrayed in Figure 1A. In a city of 10 percent black, the range for EBW is 0-90 while the corresponding EWB has a much narrower range, 0-10. When the percentage black is low, the range in EBW is very large and the range in EWB is small. When the percentage black is high, the range in EBW is small and the range in EWB is very large (Some researchers have preferred to look at "isolation" indexes, EBB and EWW, which are respectively 100-EBW and 100-EWB. Their relationship for various levels of racial composition is shown in Figure 1B.)[1] These limits result in very high cross-sectional correlations between exposure measures and racial composition. Think of the overall racial percentage as being the population-weighted mean of the racial percentages for sub-areas. Then the various exposure measures may be viewed as partitions of the overall mean. The existence of substantial part-whole correlations is to be expected. These correlations confound interpretation of comparisons among cities or school districts.

(Figure 1 about here)

The index of dissimilarity is a measure of dispersion. It is the sum of the weighted absolute deviations of sub-area black proportions from the citywide black proportion, expressed as a fraction of its maximum value:

$$D = \frac{\sum t_i \mid p_i - P \mid}{2TP(1 - P)} \qquad (2)$$

where t_i and p_i are the total population and the proportion black in the i-th sub-area, T and P are the total population and the proportion black in the city, and the summation is over all sub-areas. By contrast with the exposure measures, the index of dissimilarity is symmetric—the segregation of blacks vs. whites is the same as the segregation of whites vs. blacks—and it is independent of the overall racial composition. These and many other features and limitations have been discussed in the literature (the most recent summary is in James and

Taeuber 1985). To demonstrate some relations among the dissimilarity index, the exposure measures, and the aggregate racial percentage. we prepared a series of illustrative calculations.

Illustrative Examples

Calculation of the various exposure measures and the index of dissimilarity is illustrated in Table 1. Five hypothetical distributions are presented of blacks and whites among 10 sub-areas when the overall racial composition is held constant at 10 percent. These examples illustrate the effect on exposure of changes in the racial distributions. In example A, blacks and whites each live in uniracial areas, segregation is complete, the index of dissimilarity is 100. Neither whites nor blacks are exposed to members of the other race and the exposure measures EBW and EWB equal zero. Racial isolation is complete; EBB and EWW equal 100.0.

(Table 1 about here)

In the intervening examples B through D, we progressively move whites from all-white areas into formerly black areas, making each of them 50 percent black (example B). 25 percent black (example C). or 12.5 percent black (example D). In the final example, E, both blacks and whites are redistributed so that each sub-area is 10 percent black, the same as the city as a whole. and integration is complete.

From example A to E, the index of dissimilarity declines. The sharpest drop is from C to D, which is the transition involving the greatest population redistribution (4,000 people). As the percentage white in the formerly all-black areas increases, EBW increases sharply through its range from 0 to 90, while EWB increases gradually from 0 to its maximum of 10. In these examples, the overall racial composition remains unchanged at 10 percent black; the changes in exposure are solely a result of changing the spatial distributions of whites and blacks among sub-areas and the consequent altering of area-specific percentages black.

These examples illustrate the impact of spatial redistribution on exposure. How are exposure measures affected by changes in the overall racial composition? Some examples are shown in Table 2. Beginning with example B from Table 1, we doubled the black population but kept the same distribution of whites and blacks over sub-areas (example B1). The percentage black increases from 10 to 18.2. Because the spatial distribution of whites and blacks is unchanged, D is unchanged; this is the sense in which D is independent of the overall racial composition. EBW declines from 50.0 to 33.3, a decrease attributable solely to the increase in black population. At the same time, EWB increases by 1.8 points, from 5.6 to 7.4. The general pattern is that if the racial distributions over sub-areas remain unchanged, an increase in the citywide percentage black will produce increases in EWB and EBB, decreases in EBW and EWW, and no change in D.

(Table 2 about here)

We now illustrate the combined effects of changing racial composition and spatial redistribution (cf. Kitagawa 1955). Beginning with example B, we both double the black population and then redistribute whites in the same pattern as example C of Table 1. The results are presented as example B2 in Table 2. The change in EBW from 50 in example B to 60 in example B2 can be decomposed into a decline of 16.7 points attributable to changed racial composition and an increase of 25 points due to the redistribution of whites among schools. (A joint effect accounts for the remaining 1.3 points.) The change in EWB from 5.6 to 13.3 can be decomposed into +1.8 points attributable to changed racial composition, +2.7 due to redistribution, and a joint effect of +3.2 points.

This decomposition technique can be applied to real data. We use trends in exposure for five cities, 1910-1930 (Table 3, based on data in Lieberson 1981, p. 74). In three cities. the black population increased faster than the white population, producing marked increases in the overall percentage black (Buffalo, Newark, and Indianapolis), while in the remaining two (Kansas City and Minneapolis) both races increased at similar rates, resulting in little change in the overall racial composition. Looking first at EWB and keeping in mind that EWB can only vary between 0 and the citywide percentage black, the three cities with rapidly growing black populations increased in EWB and these increases are mainly attributable to population growth rather than redistribution of races among wards. In the two cities with stable racial composition, EWB changed relatively little, although a substantial increase in spatial segregation in Kansas City (as measured by D) produced a slight decline in EWB.

(Table 3 about here)

Results for EBW are similar but again reflect the asymmetry of the exposure measures. Changes in EBW are greater because its range in these cities is greater (from 0 to the overall percentage white). The three cities experiencing large increases in percentage black show large declines in EBW: these declines are due more to changing racial composition than spatial redistribution. Among the two cities with stable racial composition, Kansas City experienced a moderate decline in EBW and this is primarily due to the increased spatial segregation between the races.

As these empirical examples show, exposure measures, which are based on area-specific percentages black, can change because of redistribution of either or both races among sub-areas, and through citywide growth or decline of either or both races. Clearly, if overall racial composition remains stable, then observed changes in exposure are due to spatial redistribution. (However, changes in spatial segregation need not be reflected in changes in exposure, as we shall see in a later section.) On the other hand, if racial residential distributions do not change, an increase in the citywide percentage black must produce increases in EWB and EBB and concomitant decreases in EBW and EWW. If redistribution and change in racial composition both occur, accounting for differences between exposure measures, either in the cross-section or over time, is not simple. While it is true that exposure indexes "permit combining the net consequences of both population composition and dissimilarities in spatial distribution into one indicator," it is debatable whether they have "a clear operational meaning" (Lieberson

1981, p. 72).

Exposure As A Measure of Neighborhood Context

Do exposure measures in fact tell us something useful about the neighborhood context of different groups? At the extremes of complete segregation and zero segregation, all sub-areas are either uniracial or all have the citywide racial composition. The values of the exposure indexes are easily interpreted; concept matches operational definition. Between these extremes, the match may be exceedingly loose.

Illustrations of both good fit and poor fit between concept and measure may be taken from Table 1. In examples A through E, EBW accurately portrays the situation of blacks: all blacks are exposed to, respectively, 0, 50, 75, 87.5, and 90 percent white. For each example, the central tendency measure, exposure, describes the situation of each black and there is no dispersion about this central tendency. The situation of each white, however, is not so clearly portrayed by EWB. In example B, 8,000 whites (88.9 percent of all whites) are exposed to 0 percent black, and the other 1,000 whites (11.1 percent) are exposed to 50 percent black. The white-population-weighted average, EWB, is 5.6. To interpret this value of EWB with the phrase "the typical white is exposed to 5.6 percent black," is misleading. Similarly, in example C, one-third of whites are exposed to 25 percent black while the other two-thirds remain in all-white areas, yielding an EWB of 8.3. These examples make clear that the calculated value of the exposure measure need not depict the actual exposure encountered in any sub-area. The distribution is bimodal and the central tendency measure averages the two extremes. In fact. no whites are exposed to the percentage black indicated by EWB.

We have demonstrated that two statistical properties of the mean pose problems for interpretation of exposure measures: the mean need not be close to the mode, and the mean may fall in an unpopulated region of a distribution. In many applications, the mean is nevertheless an appropriate measure for ranking and comparing distributions. How useful are the exposure measures for this purpose? We believe that the likelihood of misinterpreting the measures is too high. The match between the concept of intergroup exposure and the operationalized index is too loose. To illustrate our concerns, we consider a hypothetical city with an EBW of 50. Knowing this index value, what else can we say about this city?

If EBW for a city is 50, the citywide percentage black must be in the range 0 to 50 (see Figure 1). If EBW is equal to the citywide percentage black, all sub-areas have the same racial composition (in this example 50 percent black, 50 percent white) and segregation is zero. If the citywide percentage black is substantially below the value of EBW, we can't make strong inferences about the racial compositions of sub-areas.

Seven illustrative ways to produce an EBW of 50 in a city of 10 percent black are portrayed in Table 4, Panel A. To simplify the distributions. we restrict the array of sub-areas to three categories of racial composition: uniracial white. uniracial black. or mixed, with all of the mixed sub-areas being assigned the same percentage black.

(Table 4 about here)

In example 1, 100 percent of the city's blacks live in mixed sub-areas; the percent white in those sub-areas is 50. Every black is exposed to 50 percent white, and the EBW of 50 may be interpreted at face value. In example 2, 10 percent of the blacks have been shifted from mixed areas to uniracial areas. In order to meet the constraint that EBW = 50, the percent white in the mixed sub-areas must be 55.6: EBW = (.90)(55.6) + (.10)(0) = 50.0.

In succeeding examples, greater proportions of the black population are moved to uniracial sub-areas, and the percent white in mixed areas is recalculated to satisfy the constraints (EBW = 50; percent black = 10). Among the seven examples, the percentage of the black population that lives in all-black sub-areas ranges from zero to 44.4. The blacks who live in mixed areas are exposed (in the sense of living in the same sub-areas) to anywhere from 50 to 94.4 percent white.

Once EBW and the citywide percentage black are fixed, EWB is also fixed. From the formulas given earlier we calculate that $EWB = (50)(.10/.90) = 5.6$. For each of the seven examples in Table 4, Panel B shows the relative distribution of the white population and the percentage black to which they are exposed in each category of sub-area (mixed, uniracial white, uniracial black).

In a city that is 10 percent black, an EWB of 5.6 can be achieved by a situation in which all whites are exposed to 5.6 percent black (example 6), or in many other ways. The extreme contrast is example 1, where 11.1 percent of whites reside in sub-areas 50 percent black and the remaining whites reside in all-white sub-areas. Note that uniform exposure for whites occurs in example 6 at the opposite extreme from uniform exposure for blacks (example 1). Due to the basic asymmetry of the exposure measures, uniform exposure of blacks to whites cannot occur simultaneously with uniform exposure of whites to blacks (except when each is 50 percent of the population).

The racial social settings presented in Table 4 vary dramatically in the opportunities they offer for own-group and inter-group contact, yet all receive the same score on any of the exposure measures. The analyst's conceptual need to characterize racial geographic patterns according to notions of potential exposure, contact, and interaction is not well-served by the exposure measures.

Exposure Indexes And The Index of Dissimilarity

The index of dissimilarity associated with each of the hypothetical racial distributions is presented in the last column of Table 4. There is wide variation in the indexes of dissimilarity—from 88.9 for the case of uniform exposure for blacks (example 1) to 47.0 for the case of uniform exposure for whites (example 6). The minimum possible value for D is 44.4, obtained from the racial distribution in example 7. In example 1, interracial exposure for blacks is maximized, but proportionately few whites are needed to reside with blacks to produce the stipulated exposure (EBW=50). This leaves a high percentage of whites in all-white areas. resulting in a high index of dissimilarity. As sub-areas deviate from this uniform pattern of exposure of blacks to whites, the spatial distribution as measured by the index of dissimilarity becomes more "integrated."

From the perspective of the majority group (whites in these examples), the situation is reversed. Uniform exposure for the majority group entails a much lower index of dissimilarity than uniform exposure for the minority group. This result illustrates the asymmetry of exposure measures, and also points to the loose relationship between exposure measures and the index of dissimilarity. The examples in Table 4 were contructed for a city with 10 percent black population. What is the relationship between the index of dissimilarity and the exposure measures when racial composition varies?

The relationship between one of the exposure measures (EBW) and the index of dissimilarity is plotted in Figure 2, with the six panels representing cities of varying racial compositions. Consider first the range in D for a given value of EBW. In a city that is ten percent black and with an EBW of 50, the value of D can range from 44 to 89. For each panel, the range in dissimilarity is greater at the intermediate values of exposure and lesser at the extremes of EBW. The possible range in D is wider when the percentage black is very small or very large, and narrower when the city is close to 50 percent black. Table 4 presented one illustration of the variability of D in response to the variety of racial settings that can produce a given value of EBW. The panels of Figure 2 demonstrate that this is a very general feature of the joint behavior of these measures.

(Figure 2 about here)

The relations among the measures may also be examined to ascertain the range in exposure for a given value of dissimilarity. This is accomplished by reading vertically rather than horizontally within any panel of Figure 2. Lieberson (1980) has emphasized that a particular combination of dissimilarity and percentage black yields a determinate range of exposure values. The precise range in exposure values depends on the particular combination of percentage black and dissimilarity: for a racial composition of 30 percent black and D of 40, EBW may range from 42 to 61. In general, the range of possible values for EBW decreases with increasing percentage black. Within a given racial composition, the range in EBW is greatest for middle values of D and decreases as D approaches its extremes of 0 and 100.

What accounts for the range in EBW for a given D and percentage black? The answer to this question requires consideration of the variety of ways a given D can be produced. The index of dissimilarity is geometrically related to the Lorenz curve describing the distribution of racial groups among sub-areas of a city or metropolitan area. To construct a Lorenz curve (or segregation curve), sub-areas are sorted into descending order according to percentage black; the cumulative percentage of whites is then plotted as a function of the cumulative percentage of blacks. Several illustrative curves are presented in Figure 3. A condition of zero segregation is indicated by the diagonal line; this occurs when sub-area racial composition is constant; D = 0, EBW = overall percent white, and EWB = overall percent black. The curve for a completely segregated system lies along the x-axis from 0 to 100 and then rises along the y-axis; D = 100, EBW = 0, and EWB = 0. The index of dissimilarity may be interpreted geometrically as the maximum vertical distance between the segregation curve and the diagonal.[2] A given value of D (other than 100 or 0) can be produced by a variety of different segregation curves. Curves A and B portray two ways of attaining a D of 40. Any other curve tangent to Curve B will also produce a D of 40. Thus, a given value of D may be produced by a few areas that deviate a lot from the citywide composition. by many sub-areas that deviate a little from this standard. or by other patterns. It is this variation that allows for a range in values of EBW for a fixed value of D.

(Figure 3 about here)

The variation in exposure indexes for a given level of D is related to the shape of the corresponding Lorenz curve. For a particular index of dissimilarity and racial composition, the maximum EBW occurs when the standard deviation of sub-area percentages black is minimized; all sub-areas are relatively close to the citywide percentage black. Curve A represents this situation when D = 40 and percent black = 10. In this case, EBW = 84.8. The minimum EBW results when uniracial areas are maximized for both races and remaining areas are at the citywide percentage black thereby maximizing the standard deviation. Curve B represents this situation when D = 40 and percent black = 10. Here EBW = 54.0.

Discussion

Exposure indexes are being used for two analytic tasks: 1) to indicate how "spatially integrated" a city is; and 2) to describe the potential for interracial contact. How well do they perform these tasks?

1) Exposure measures should not be regarded as another segregation index in the sociologist's bag of tools for measuring spatial segregation. "Segregation refers to the differences in the distribution of social groups, such as blacks and whites. among units of social organization" (James and Taeuber 1985). Segregation indexes are measures of dispersion of the racial distribution among sub-areas. Each segregation index is defined in terms of a standard racial composition to which sub-area compositions are compared, a metric for measuring the distance of each sub-area from the standard, and a standardizing formula to set the range. Exposure measures do not summarize the distance of sub-areas from a standard; they incorporate no explicit or implicit notion of distance. If an exposure measure is standardized, as Bell (1954) and others have done, the result is a true segregation index, variously identified as eta-squared, the variance ratio, etc. (James and Taeuber 1985). This standardized index is based on exposure concepts, but it is a dispersion measure and no longer interpretable as a central tendency or weighted average of sub-area compositions. Unstandardized exposure measures are no more measures of segregation than the average income of blacks is a measure of income inequality.

Except for extreme distributions (complete or zero segregation), there is only a loose association between exposure measures and measures of segregation. Within the limits set by their algebraic links, their behavior is quite different. For example, the goal of maximizing exposure of one group to another may be inconsistent with the goal of reducing the segregation between them. Maximizing exposure of one group to another may require increased segregation.

There are many segregation indexes and continued debate about the behavior and relative merits of each. There are other indexes designed to capture aspects of spatial patterning in racial distributions not embraced in the core concept of segregation—centralization, contiguity, relative density, etc. (cf. White 1986). All of these indexes, and exposure measures too, are calculated in whole or in part from a table of the distribution of racial groups among sub-areas, but this commonality should not blur their differing functions. An analyst may wish to use a variety of measures and indexes, but clarity about the conceptual meanings and statistical relations is obviously appropriate.

Comparisons among exposure indexes—among cities at one time, or over time for particular cities—are affected by differences in spatial distributions and in aggregate racial composition. Assuming no change in aggregate racial composition, even large changes in segregation need not produce changes in exposure. By contrast, assuming no change in segregation, changes in composition necessarily produce changes in exposure. Simultaneous changes in residential distribution and population composition produce unpredictable changes in exposure. A change in one factor may be offset, reinforced, or overwhelmed by a change in the other factor. In empirical studies of residential racial distributions in the U.S. (and of school racial distributions), we find aggregate racial composition to exert the dominant influence on values of the exposure measures.

2) Exposure measures need not describe the actual experience of blacks and whites. An EWB of 50 may occur and yet no whites live in neighborhoods that are at or anywhere near 50 percent black. An exposure measure is a weighted

average of the racial composition of sub-areas; it has the same basic properties as any other mean. In a highly segregated society such as the U.S., neighborhoods (or schools) tend to be predominantly black or predominantly white. Exposure measures average this diversity, but the existence of the diversity is easily overlooked. It is common practice to describe an exposure measure, say EBW, as indicating the percentage white in the neighborhood (or school) of a typical black. This is statistically incorrect. In the case of bimodal racial distributions, it is particularly misleading.

Calculation of exposure measures, segregation indexes, and other summary measures entails deliberate loss of information for the sake of facilitating analysis and understanding. Our examples of the behavior of exposure measures in response to various hypothetical distributions leads us to great concern about the information being sacrificed to obtain summary measures of exposure. As we have demonstrated, many combinations of sub-area racial distributions can produce a common value for an exposure measure. For example, a value of 5.6 for EWB may occur when all whites reside in sub-areas that are 5.6 percent black, or when 11 percent of whites live in sub-areas that are 50 percent black and the remaining whites live in all-white areas. An EBW of 50 may occur when all blacks live in 50 percent white neighborhoods, or when 56 percent of blacks live in 90 percent white neighborhoods and the rest live in all-black areas. Exposure measures have been brought into use as indicators of potential contact or exposure, yet surely the sociological circumstances and consequences differ sharply among situations having a common measure.

We have focused thus far on statistical issues. Conceptual issues are also of concern. One way of expressing the .mula for the exposure index, say EBW, is to regard each black as having a characteristic—the percentage white in his sub-area (or census tract, city block, school, etc.). EBW is the average (mean) value of this attribute. Consider a black living in a sub-area that is 30 percent white. In an abstract model of random mixing of sub-area residents, the people to whom this black is exposed or in contact with are 30 percent white and 70 percent black. But given our knowledge of racial stratification, perceptions, and behavior, the model of random mixing is often improbable. In schooling, for example, tracking and other devices may keep black and white children from perceiving or experiencing the racial composition of the school. An extreme example is the "intact busing" that occurred in the Milwaukee public shools for many years: a classroom of black students from a crowded "black school" was bussed to a "white school," kept together in the classroom, and provided a separate time for lunch and recess. Zorbaugh's study of the gold coast and the slum made clear that residential propinquity need not mean social contact.

An interest in the effects of co-occupancy of the same physical space on assimilation, the maintenance of ethnic culture, or other behaviors requires the researcher to specify what aspects of the spatial distributions are important. This may lead to selection of a small set of summary indexes, such as the share of a group that resides in contiguous nearly homogeneous areas, or the share that resides in substantially interracial areas. Or there may be recognition that a small set of summary measures doesn't suffice, and that a more elaborate multiple-indicator approach is required

We believe that the exposure measures are being used without sufficient attention to their statistical or conceptual properties. The casual linking of their name to concepts of exposure, potential exposure, and contact should be taken as a caution flag. Repeated interpretation of exposure measures as representing the experience of the typical black or white is another warning sign. The racial asymmetry that helped attract attention to the measures produces contrasts between black-white and white-black measures that are difficult to interpret because of the underlying statistical relations. The strong influence of aggregate racial composition on the empirical behavior of the measures is a particular danger. Percentage black is related to so many other circumstances and behaviors that spurious or misleading results are difficult to guard against. Failure to recognize the fundamental differences between exposure measures and segregation measures has reduced the contribution of many of the empirical studies using exposure measures.

Many concepts are multi-dimensional in character, and the analytic demands placed on summary measures and indexes are diverse. No single measure can capture all of the analytically distinguishable elements of the concepts of exposure, contact, and segregation. The statistical and conceptual properties of an index that make it especially suitable for one purpose may make it less suitable for another. Summary measures are important tools for empirical social science. A primary requirement for productive research is to achieve a thoughtful match between measurement and concept. We are concerned that what is valuable in the concepts of exposure and isolation in race and ethnic studies is often poorly captured by the exposure measures.

FOOTNOTES

[1]Figure 1B illustrates the inherent stability of majority-group "isolation" indexes at the extremes of racial composition. For example, the lack of variation in EWW in majority-white cities despite increases in black population and dissimilarity has been given substantive significance, e.g., "whites are simply trying to maintain a certain constant high level of isolation from blacks" (Lieberson 1981, p. 75). In fact, this stability is a statistical necessity. Since the percentage black in the cities studied remained relatively low (around 10 percent), EWW could only vary between 90 and 100, giving an appearance of stability.

[2]The Gini segregation index measures the area between the diagonal and the segregation curve as a fraction of the total area below the diagonal. The range in Gini values for any given D is given by the formula

$D \leq Gini \leq 2D - D^2$ (Duncan 1955).

REFERENCES

Bell, Wendell. 1954. "A Probability Model of the Measurement of Ecological Segregation." Social Forces 32:357-364.

Breton, Raymond. 1964. "Insitutional Completeness cf Ethnic Communities and the Personal Relations of Immigrants." American Journal of Sociology 70:193-205.

Duncan, O.D. and Duncan, Beverly. 1955. "A Methodological Analysis of Segregation Indexes." American Sociological Review 20:210-217.

Erbe, Brigitte Mach. 1975. "Race and Socioeconomic Segregation." American Sociological Review 40:801-812.

Farley, John E. 1984. "P* Segregation Indexes: What Can They Tell Us About Housing Segregation in 1980?" Urban Studies 21:331-36.

Farley, Reynolds. 1984. Blacks and Whites: Narrowing the Gap? Cambridge: Harvard University Press.

Farley, Reynolds and Taeuber, Karl E. 1968. "Population Trends and Residential Segregation Since 1960." Science 159:953-6.

Fiske, Edward. 1987. "Integration Lags at Public Schools." New York: New York Times, July 23.

Hayward, William. 1986. Segregation in U.S. Public Schools: Desegregation, Resegregation, and White Flight. Master's thesis, Department of Sociology, University of Wisconsin.

James, David R. and Taeuber, Karl E. 1985. "Measures of Segregation." Pp. 1-31 in Sociological Methodology 1985, edited by Nancy Brandon Tuma. San Francisco: Jossey-Bass.

Kitagawa, Evelyn M. 1955. "Components of a Difference Between Two Rates." Journal of the American Statistical Association L: 1168-94.

Lieberson, Stanley. 1980. A Piece of the Pie: Black and White Immigrants Since 1880. Berkeley: University of California Press.

——. 1981. "An Asymmetrical Approach to Segregation." Pp. 61-82 in Ethnic Segregation in Cities, edited by Ceri Peach, Vaughn Robinson, and Susan Smith. London: Croom Helm. 1981.

Lieberson, Stanley and Carter, Donna K. 1982. "Temporal Changes and Urban Differences in Residential Segregation: A Reconsideration." American Journal of Sociology 88:296-310.

McKinney, Scott and Schnare, Ann B. 1986. Trends in Residential Segregation by Race: 1960-1980. Washington, D.C.: Urban Institute.

Orfield, Gary. 1987. School Segregation in the 1980s: Trends in the States and Metropolitan Areas. Chicago: Joint Center for Political Studies.

Schnare, Ann B. 1977. Residential Segregation by Race in U.S. Metropolitan Areas: An Analysis Across Cities and Over Time. Washington, D.C.: Urban Institute.

——. 1980. "Trends in Residential Segregation by Race: 1960-1970." Journal of Land Economics 7:293-301.

Stearns, Linda Brewster and Logan, John R. 1986. "Measuring Trends in Segregation: Three Dimensions, Three Measures." Urban Affairs Quarterly 22:124-50.

White, Michael J. 1986. "Segregation and Diversity Measures in Population Distribution." Population Index 52: 198-221.

Table 1.–Indexes of Dissimilarity and Exposure Measures: Hypothetical City of 10 Percent Black

	Example A		Example B		Example C		Example D		Example E	
Sub-area	Black	White	Black	White	Black	White	Black	White	Black	White
1	200	—	200	200	200	600	200	1400	100	900
2	200	—	200	200	200	600	200	1400	100	900
3	200	—	200	200	200	600	200	1400	100	900
4	200	—	200	200	200	600	200	1400	100	900
5	200	—	200	200	200	600	200	1400	100	900
6	—	1800	—	1600	—	1200	—	400	100	900
7	—	1800	—	1600	—	1200	—	400	100	900
8	—	1800	—	1600	—	1200	—	400	100	900
9	—	1800	—	1600	—	1200	—	400	100	900
10	—	1800	—	1600	—	1200	—	400	100	900
Total	1000	9000	1000	9000	1000	9000	1000	9000	1000	9000

Measure	Example A	Example B	Example C	Example D	Example E
D	100.0	88.9	66.7	22.2	0.0
EBW	0.0	50.0	75.0	87.5	90.0
EBB	100.0	50.0	25.0	12.5	10.0
EWB	0.0	5.6	8.3	9.7	10.0
EWW	100.0	94.4	91.7	90.3	90.0

Table 2.–Effects of Population Growth and Redistribution on Exposure Measures

	Example B		Example B1		Example C		Example B2	
Sub-area	Black	White	Black	White	Black	White	Black	White
1	200	200	400	200	200	600	400	600
2	200	200	400	200	200	600	400	600
3	200	200	400	200	200	600	400	600
4	200	200	400	200	200	600	400	600
5	200	200	400	200	200	600	400	600
6	—	1600	—	1600	—	1200	—	1200
7	—	1600	—	1600	—	1200	—	1200
8	—	1600	—	1600	—	1200	—	1200
9	—	1600	—	1600	—	1200	—	1200
10	—	1600	—	1600	—	1200	—	1200
Total	1000	9000	2000	9000	1000	9000	2000	9000

Measure	Example B	Example B1	Example C	Example B2
%B	10.0	18.2	10.0	18.2
D	88.9	88.9	66.7	66.7
EBW	50.0	33.3	75.0	60.0
EBB	50.0	66.7	25.0	40.0
EWB	5.6	7.4	8.3	13.3
EWW	94.4	92.6	91.7	86.7

Table 3.–Decomposition of EWB and EBW: Selected Cities, 1910-30

Measure	City				
	Buffalo	Newark	Indianapolis	Kansas City	Minneapolis
Percent Black:					
1910	0.4	2.7	9.3	9.5	0.9
1930	2.4	8.8	12.1	9.6	0.9
%-change, 1910-30:					
Black	665.0	310.3	101.5	63.7	61.1
White	32.6	19.2	51.1	59.2	53.8
Dissimilarity:					
1910	63.2	38.6	44.4	38.4	34.3
1930	79.9	46.6	40.1	59.8	33.7
EWB:					
1910	0.4	2.7	8.4	8.2	0.9
1930	1.8	7.4	10.2	7.3	0.9
Difference	+1.4	+4.8	+1.8	-0.9	+0.0
Dissimilarity Effect	+0.0	-0.1	-0.4	-1.0	+0.0
Growth Effect	+1.5	+5.5	+2.2	+0.1	+0.0
EBW:					
1910	94.3	94.6	81.5	78.3	98.3
1930	75.8	77.1	74.0	68.4	98.4
Difference	-18.5	-17.5	-7.6	-9.9	+0.0
Dissimilarity Effect	-0.1	-3.6	-3.4	-9.6	+0.1
Growth Effect	-17.7	-10.4	-4.3	-0.3	-0.1

Table 4.–Relationship Between Index of Dissimilarity and Exposure
(Percent Black = 10; EBW = 50; EWB = 5.6)

		Panel A: EBW		Panel B: EWB		Index
Example	Sub-area Composition	Percent of Blacks in Sub-areas	Percent White in Sub-areas	Percent of Whites in Sub-areas	Percent Black in Sub-areas	of Dissim-ilarity
1	Mixed	100.0	50.0	11.1	50.0	88.9
	White	—	—	88.9	0.0	
2	Mixed	90.0	55.6	12.5	44.4	
	White	—	—	87.2	0.0	87.5
	Black	10.0	0.0	—	—	
3	Mixed	80.0	62.5	14.8	37.5	
	White	—	—	85.2	0.0	85.2
	Black	20.0	0.0	—	—	
4	Mixed	70.0	71.4	19.4	28.6	
	White	—	—	81.0	0.0	80.6
	Black	30.0	0.0	—	—	
5	Mixed	60.0	83.3	33.3	16.7	
	White	—	—	66.7	0.0	66.7
	Black	40.0	0.0	—	—	
6	Mixed	53.0	94.4	100.0	5.6	47.0
	Black	47.0	0.0	—	—	
7	Mixed	55.6	90.0	55.6	10.0	
	White	—	—	44.4	0.0	44.4
	Black	44.4	0.0	—	—	

Figure 1A.--Relationship Between EBW and EWB, by Percentage Black

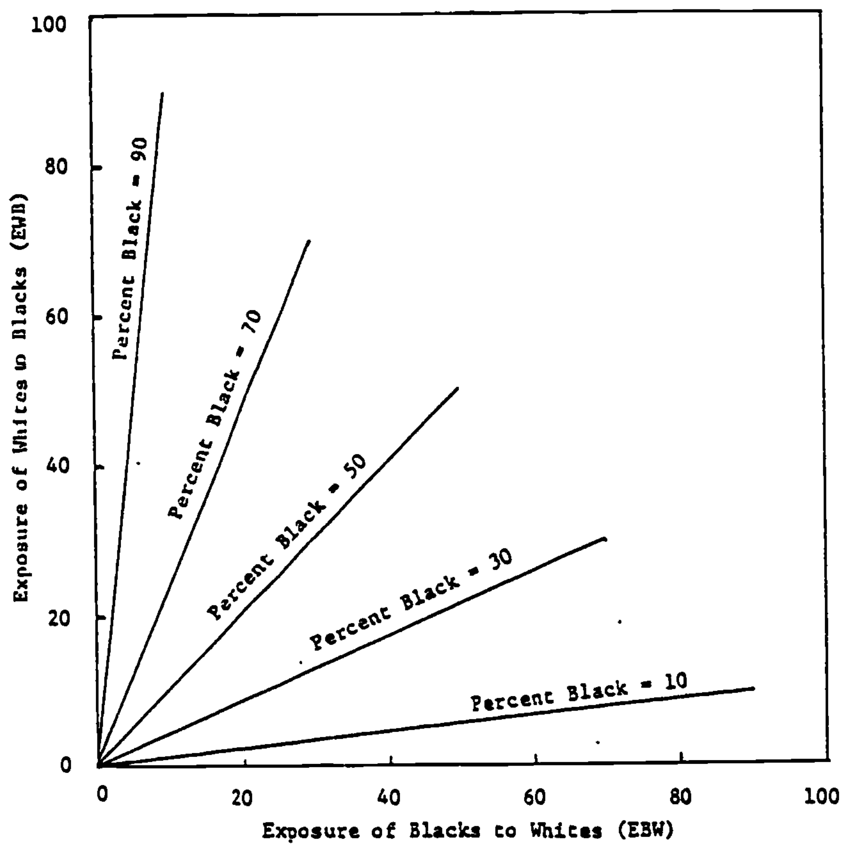


Figure 1B.--Relationship Between EBB and EWW, by Percentage Black

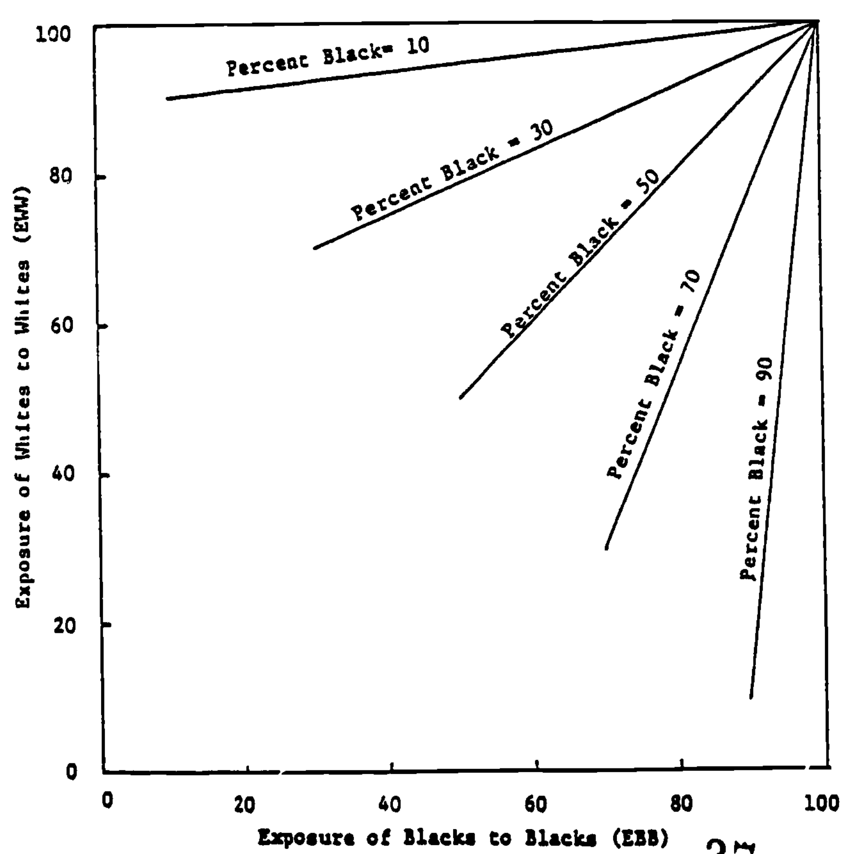


Figure 2.--Relationship Between EBW and D for Selected Racial Compositions

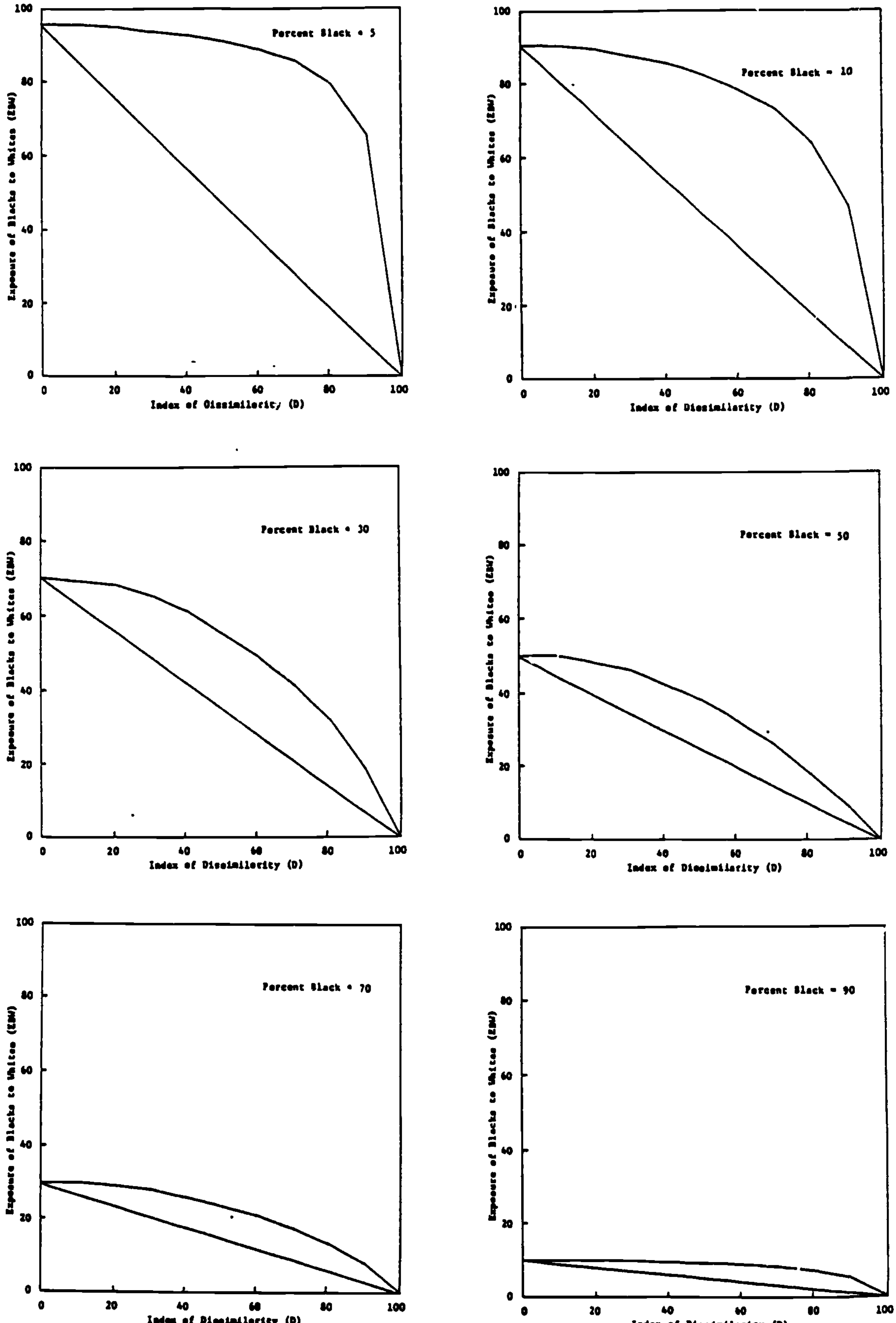
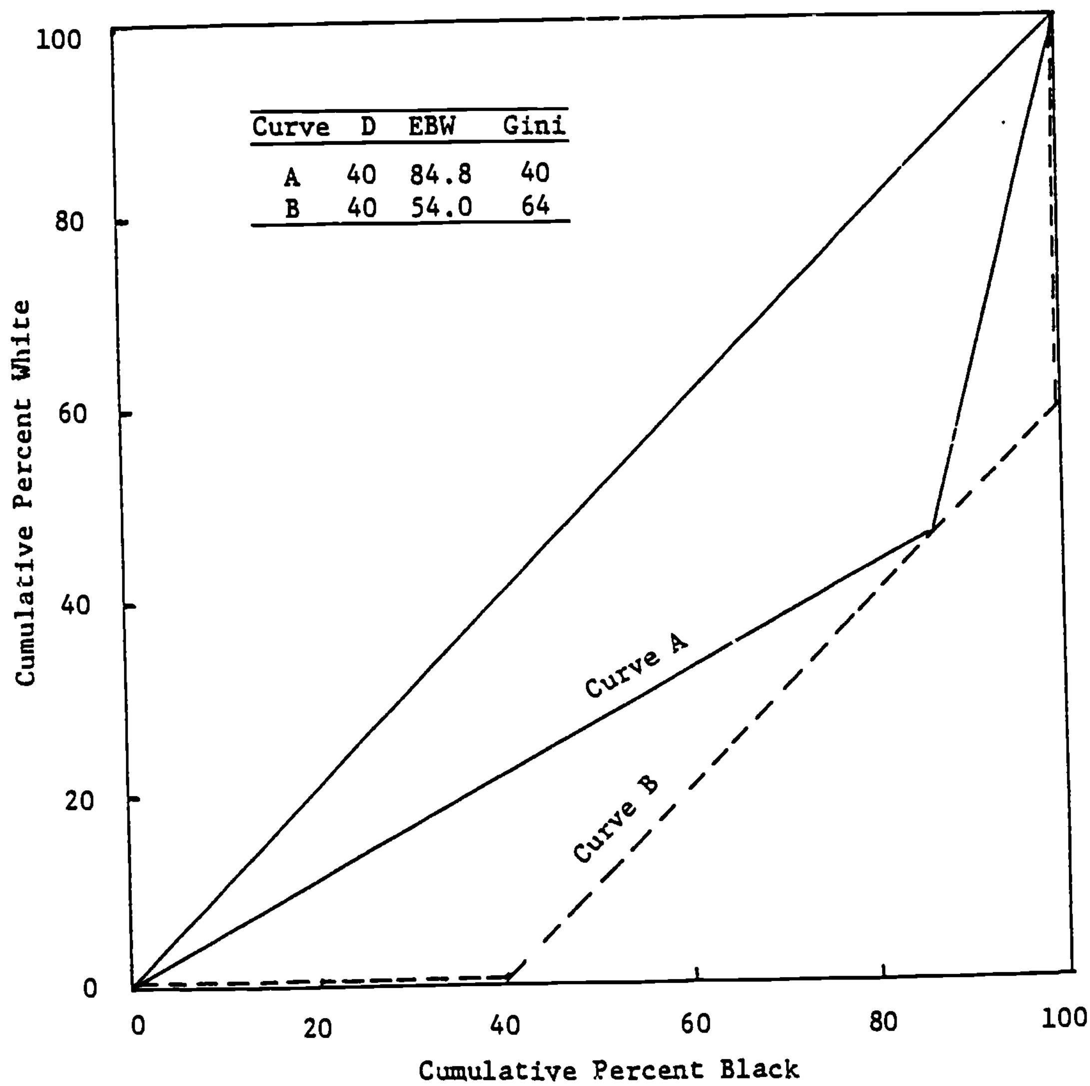


Figure 3.--Illustrative Lorenz Segregation Curves

(D = 40; Percent Black = 10)



Curve	D	EBW	Gini
A	40	84.8	40
B	40	54.0	64

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