Segregation and scale: The use and interpretation of spatial segregation profiles for investigating the causes, patterns, and consequences of residential segregation

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The study of residential segregation is driven by three primary analytic aims: investigation of the patterns of segregation; investigation of the causes of segregation; and investigation of the consequences of segregation. There is, of course, a long research tradition in each of these areas (see, for example, Farley and Frey 1994; Grannis 1998; Krysan and Farley 2002; Logan 2001; Massey and Denton 1993; Taeuber and Taeuber 1965; Timberlake 2002; see, for example, Wilson 1987). In this paper, however, we address an aspect of segregation research which has been largely ignored in prior study—the issue of scale in understanding segregation causes, patterns, and consequences.

By 'scale', we mean the granularity of residential patterns. For example, it may be that some regions are segregated at a large scale (not only are there many monoracial white and black tracts, but these tracts are also clustered together, creating large regions that are predominantly monoracial), while others regions are segregated at a local scale but not at a larger scale (e.g., each block might be monoracial, but many white and black blocks are near one another). Segregation measures that use a large scale will describe the first as more segregated than the second, while segregation measures using a small scale will describe both as highly segregated. Neither description alone is sufficient. Moreover, because the causes and consequences of segregation may depend on its scale, study of segregation requires scale-sensitive measures.

Issues of scale are important not merely in describing patterns of segregation, but in understanding both the causes and consequences of segregation. For example, the causes of micro-segregation may be quite different from those of macro-segregation. For example, factors such as the spatial location of public amenities that draw primarily on pedestrian traffic and local residents (e.g., elementary schools, playgrounds, storefront shopping areas, etc.); the patterns of street networks (Grannis 1998), and families residential preferences may play a role in shaping micro-segregation patterns. In contrast, macro segregation patterns, such as those observed in cities like Chicago, Detroit, and Atlanta, might be caused more by structural economic features (labor markets, e.g.) of regions, racial income inequality, and residual historical settlement patterns (Massey and Denton 1993).

Likewise, the consequences of segregation may depend on the scale of segregation patterns. Local segregation is likely to affect pedestrian contact patterns, for example. Macro-scale segregation, however, may be more likely to affect the spatial distribution of economic, institutional, and political resources, for example. In addition, the consequences of segregation may depend differently on scale for different populations. For young children, who might stay relatively close to home in the course of a day (attending local child care,

preschool, or elementary schools), patterns of local segregation are likely to be most influential in children's lives. For adults, in contrast, who are more mobile, macro-level segregation patterns may be more relevant, because they may be linked to employment opportunities and social and institutional resources.

One limitation of prior studies is that they have largely relied on 'aspatial' measures of segregation—measures that were developed prior to the availability of geographical information system (GIS) software and that consequently ignore the spatial distributions of race and poverty (Grannis 2002; Reardon and O'Sullivan 2004; White 1983; Wong 1997, 1999). The reliance on aspatial measures has two primary drawback: first, it ignores the proximity of census tracts to one another (the checkerboard problem); and second, it results in segregation measures that are sensitive only to segregation at the (arbitrary) scale of census tracts (or blocks, etc). The first limitation has been much remarked on, and a number of measures have been proposed to address this problem (Morrill 1991; White 1983; Wong 1993).

The second limitation—the fact that most methods of measuring segregation (and hence, of assessing it's causes and effects) are insensitive to scale—has received less attention, despite its theoretical importance. Because conventional segregation measures treat census tracts or blocks as independent neighborhoods, they are insensitive to patterns of segregation that occur at scales larger or smaller than tracts/blocks. However, with the advent of better tools for spatial analysis, including GIS software, White (1983) and, more recently, Jargowsky and Kim (2004), Wu and Sui (2001), and Reardon and O'Sullivan (2004) have developed methodological approaches that yield scalable measures of residential segregation, although these measures have not yet been widely used. In particular, spatial segregation measures have not been used to address issues of scale in segregation, despite the fact that they are tailor-made for such analyses.

In this paper, we develop a methodology for addressing questions relating to the scale of segregation. We draw on recent work by Reardon and O'Sullivan (2004), who develop a method of measuring segregation at any scale. This method allows us to compute, for a given region, a spatial segregation profile—essentially a curve that describes the level of segregation at each spatial scale. This profile describes both the level of segregation at a given scale (given by the height of the profile) and the extent to which segregation patterns change with scale (given by the slope of the profile). Preliminary results for 40 metropolitan areas indicate that segregation levels at different scales contain different information—the most locally segregation metropolitan area are often not the most segregated at a larger scale. Figure 1 illustrates two such profiles, for Atlanta and Pittsburgh, respectively. While both metropolitan areas are equally segregated at a local (500m radius) level, segregation in Pittsburgh is much more localized, as indicated by its substantially lower level of segregation at a macro-scale (4km radius).

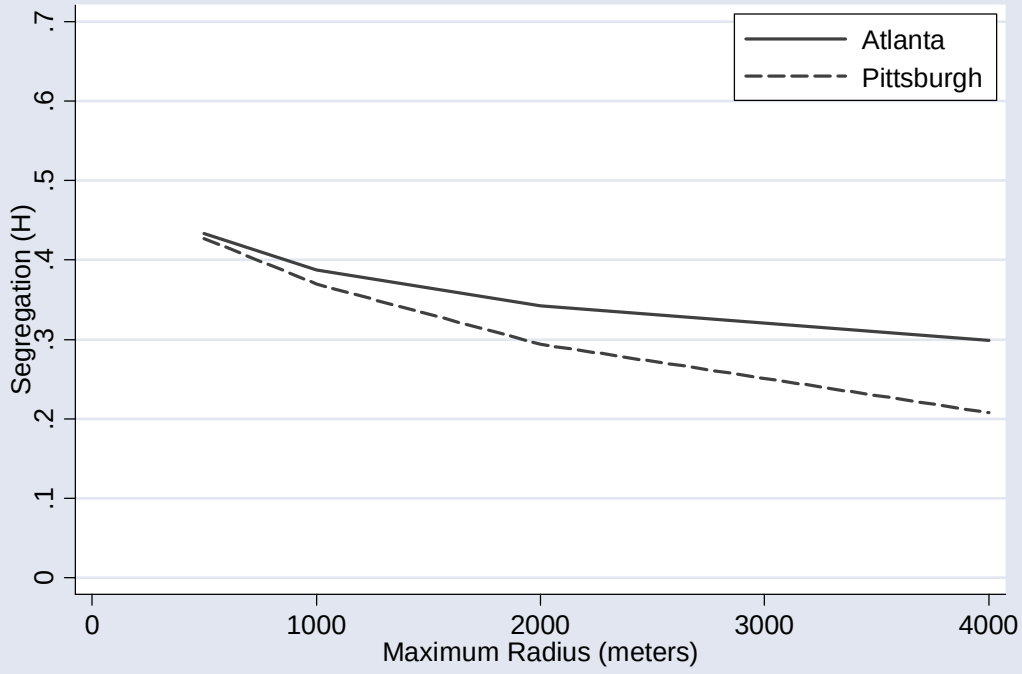
The Reardon and O'Sullivan (2004) approach is based on the understanding that a segregation index is a measure of the extent to which the local environments of individuals differ in their racial or socioeconomic composition (or, more generally, on any population trait). This approach is operationalized by assuming each individual inhabits a 'local environment' whose population is made up of the spatially-weighted average of the populations at each point in the region of interest. Given a particular spatial weighting

function, segregation is measured by computing the spatially-weighted racial (or socioeconomic) composition of the local environment of each location (or person) in the study region and then comparing the average compositions of the local environments of members of each group.

The key to using this approach to investigate issues of scale is that the spatial weighting can accommodate any desired size of local environment, simply by altering the radius used in the spatial weighting. In Figure 1, we describe segregation at scales ranging from 500m radius local neighborhoods (which might approximate the scale of pedestrian movement) to 4km radius local neighborhoods (which might approximate the scale of school catchment areas, local labor markets, and the like).

The paper includes three sections: First, a brief discussion of the theoretical importance of considering scale in investigating segregation; second, a description of the Reardon and O'Sullivan approach to computing segregation profiles; and third, a discussion of how these profiles are to be interpreted. In this third section, we illustrate the discussion with a set of maps and figures to ground the interpretation of the profiles.

Figure 1: Atlanta and Pittsburgh Segregation Profiles, 2000



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