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Innovative measurement of spatial segregation: Comparative evidence from Hong Kong and San Francisco

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ABSTRACT

The spatial distribution of households of different socioeconomic groups in urban areas has drawn longstanding attention from scholars because residential location patterns have important impacts on social outcomes and the economic efficiency of cities. Recent comparative work on this topic has yielded some insight into the causes and consequences of segregation patterns, but much of this comparison is indirect. An explicitly spatial version of the entropy index has recently been developed that facilitates comparison, as it allows for the disaggregation of segregation levels by scale and income (Reardon and O'Sullivan, 2004; Reardon, 2009; Reardon and Bischoff, 2011). This paper applies these new measurement techniques to two metropolises; Hong Kong and San Francisco. Although overall segregation levels are similar, the shape of the segregation profile across geographic scales and the income distribution is quite different. The paper also includes a script for calculating spatial ordinal segregation indices in ArcGIS.

1. Introduction

As access to geographic data increases, so has international research on segregation, including comparative work (Nightengale, 2012; Maloutas and Fujita, 2012). Yet, too little of this new comparative work in segregation provides direct comparison between cities in different countries. One notable exception is Harsman and Quigley (1995), which compares segregation patterns in San Francisco and Stockholm and assesses the extent to which racial and ethnic segregation is conditional upon housing stock and incomes. Differences between data reporting across countries often complicate comparison, but so do standard measures of the phenomenon, as they often report only one number as the segregation level. Fortunately, new measures have been created that disaggregate segregation across spatial scales and across the income distribution (Reardon and O'Sullivan, 2004; Reardon, 2009; Reardon and Bischoff, 2011). These spatial, ordinal indices have thus far only been applied to cities in the United States.

This paper compares segregation levels and patterns in the San Francisco Metropolitan Statistical Area (MSA) and Hong Kong. Hong Kong has a larger population size, but both metropolitan areas share a similar, land constrained geography, with ample mountains and water throughout. Although San Francisco is one of the densest cities in the United States, Hong Kong is one of the densest cities in the world. With slightly more than 1000 km^2 of land, its urban landscape is characterized by high-rise residential buildings, many of which reach 50 floors, even in areas far from the city center. The prevalence of large residential buildings are likely to affect segregation patterns, concentrating housing units of a similar price and thus households with similar purchasing power on one parcel of land. Hong Kong also has a highly unequal income distribution; data from the most recent census (2006) yielded a Gini coefficient of 0.53 in 2006 (Census and Statistics Department, 2007b), higher than that of most US cities, which have an average of 0.42 (Reardon and Bischoff, 2011).

The spatial dimension of economic inequality in the two cities is compared using recently developed measurement techniques to analyze segregation at different spatial scales and across the income distribution (Reardon and O'Sullivan, 2004; Reardon, 2009; Reardon and Bischoff, 2011). We analyze small area census data with income reported over more than 10 categories over a 15 year period in Hong Kong and compare with the same calculations for the San Francisco MSA in 2000. Hong Kong has a similar overall level of segregation as the metropolitan area of San Francisco and the average city in the United States. However, differences in the way households are segregated across space and the income distribution are substantial. Segregation levels in Hong Kong drop rapidly as the scale increases; a pattern that likely results from its high density but also reflects the fragmentation of urban space in Hong Kong.

The difference in segregation levels across the income distribution is less easily explained. When calculated using a rank-order index, segregation levels are found to increase consistently with income in Hong Kong. Households in the 90th percentile of the income distribution are roughly 2.5 times more segregated than households in

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the 10th percentile. This pattern is in sharp contrast to those found in the United States, where segregation levels tend to form a U-shape when mapped across the income distribution and low-income households experience similarly high levels of segregation as high-income households (Reardon and Bischoff, 2011).

After a brief review of the literature on socioeconomic segregation and recent advances in its measurement, we introduce the urban context of Hong Kong. Then, we present the geographic and census data from Hong Kong and compare them with equivalent data from San Francisco. Finally, segregation levels and patterns in the two cities are analyzed.

2. Spatial socioeconomic segregation

2.1. General approaches the phenomenon

Scholars from the fields of sociology (Duncan and Duncan, 1955; Park, 1957; Wilson, 1987; Massey and Denton, 1993) and urban economics (Tiebout, 1956; Schelling, 1978) have studied the uneven distribution of different groups within cities for decades. Sociologists have tended to focus on the structural forces that separate people of different races or income groups, including racial discrimination (Galster and Godfrey, 2005), public housing policy (Massey and Kanaiaupuni, 1993), patterns of urban immigration and assimilation (Park, 1957), and localized land-use controls (Jargowsky, 2002).

Urban economists, on the other hand, generally emphasize the way individual decisions influence where people live (Tiebout, 1956). One important contribution from the field is the theoretical insight that residential location is determined through a competitive bidding process for land for housing, and thus land markets play an important role in the distribution of different socioeconomic groups (Mills and Hamilton, 1994). As cities grow, land values become increasingly differentiated due to increases in commuting costs and increasing differences in the mix of public services and natural amenities in different locations. This leads to a greater differentiation of residential neighborhoods, although the process is partially endogenous. The connection between this line of reasoning and structural study of racial segregation was emphasized in the work by Harsman and Quigley (1995), who found that a large share of racial segregation could be explained by differences in income between racial groups.

Another avenue of research has attempted to ascertain the determinants of segregation more generally by using statistical analysis across a large number of cities within a country (Telles, 1995; Pendall and Carruthers, 2003; Monkkonen, 2012). These studies assess the relationship of a number of factors with levels of segregation at the city level, using statistical controls to estimate the relative impact of each. In Mexico, for example, cities with more housing finance are more segregated (Monkkonen, 2012). Population density, for example was found to have a quadratic relationship with segregation in the United States; cities with very low and very high population densities had higher levels of segregation (Pendall and Carruthers, 2003). Bigger cities are consistently found to be more segregated, presumably because more competitive land markets lead to greater neighborhood differentiation.

2.2. Advances in measurement

Any analysis of segregation is only as good as the measurement of the phenomenon, which has been an active research area among sociologists, geographers, and other social scientists since the 1950s (Duncan and Duncan, 1955; Taeuber and Taeuber, 1965). This paper takes advantage of recent advances in the measurement of two different aspects of socioeconomic separation within cities that build on a work dating back to the 1970s and 1980s (Morgan, 1975; Jakubs, 1981). The first aspect is the measurement of segregation of multiple, ordinal groups, specifically households of different incomes (Meng et al., 2006; Reardon and Bischoff, 2011) and the second is an explicit consideration of the spatial relationship of households of different groups across a city (Reardon and O'Sullivan, 2004; Wong, 2005).

This literature review focuses on the measurement approaches used in the present analysis. A more complete review of the literature on the measurement spatial and ordinal segregation can be found in Feitosa et al. (2007). The chief segregation index employed in the analysis of Hong Kong and San Francisco is the spatial rank-order information theory index (Reardon and Bischoff, 2011), which allows for explicit consideration of geographic scale in measuring segregation, as well as analysis of socioeconomic segregation across the income distribution. Although this index is not unique in these two features, it has been widely applied in the United States and thus a number of cities' values are available for reference.

The rank-order index is based on Theil's information theory index, or the entropy index (Theil, 1972), which essentially measures the difference between the heterogeneity of the city for a given variable and a weighted average of the heterogeneity calculated for each sub-unit of a city. Detailed formulas for the indices used in this paper, the multi-group index – the ordinal index, and the rank-order index – can be found in Appendix A and their spatial counterparts in Appendix B.

The first step in creating the spatial rank-order index was the development of a multi-group index of segregation, as traditional measures such as the dissimilarity index allowed for measurement of the separation between two groups only (Reardon and Firebaugh, 2002; Meng et al., 2006). The deficiency of the multi-group index for measuring socioeconomic segregation or the separation of different income groups, however, is that it fails to capture the ordinal nature of the data. Conceptually, the difference between a low-income household and a high-income household is greater than the difference between a low-income household and a middle-income household. One way[1] to adapt the entropy measure to ordinal data by using cumulative categories of income groups when calculating the index (Reardon, 2009). The main limitation of this approach is that its value will be influenced to some extent by the way in which income data are categorized. There can be abrupt jumps in the distribution of income when reported as categories, when in reality the distribution is generally smooth.

When income data is divided into a larger number of categories the measure is more precise. The rank-order entropy index bases its calculation on an estimated income distribution using the values of 2-group entropy indices calculated for each cumulative category of income (Reardon et al., 2006; Reardon and Bischoff, 2011). Rather than taking a weighted average of these measures, as in a standard ordinal index, a polynomial function is estimated based on the curve of segregation values across the income distribution. The index value is then calculated based on this curve. In addition to the greater precision, the method allows researchers to easily visualize segregation levels across the income distribution. A graphical illustration is presented in Fig. 5A and B below.

The challenges of accurately capturing the spatial dimension of segregation originally led Massey and Denton (1988), in a classification of the large number of indices that had emerged by the 1980s, to describe three spatial dimensions of segregation – evenness, exposure, and clustering. These three dimensions actually described one so-called super dimension, separation, and the reason for three separate measures was the inadequacy of the techniques themselves (Reardon and O'Sullivan, 2004). In part, a reliance on census tract data led to two basic approaches to measuring the spatial separation of groups: a non-spatial measurement of their distribution across tracts (the evenness or exposure component) and a spatial measure of adjacent tracts similarity (the clustering component).

[1] There are a variety of other ways to measure income segregation, such as those based on income variance (Kremer and Maskin, 1996; Davidoff, 2005). Although these indexes will be highly correlated, the rank-order index is preferable for comparative work as it measures segregation independently of the income distribution and thus inequality.

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