Spatial Patterns of Nonmetropolitan Segregation: A Comparison of Racial and Economic Segregation between Metro and Nonmetro Counties

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Introduction

One of the basic premises underlying most measures of residential segregation is the inherent spatial patterning of different groups in an urban environment (Cortese et al. 1976; Duncan and Duncan 1955; Massey and Denton 1988; Massey et al. 1996). The majority of research exploring residential segregation and its potential impact on a variety of health, education, employment, inequality, crime, and other outcomes has focused on metropolitan areas as the unit of analysis, often defined as metropolitan statistical areas (MSAs) or labor market areas (Brown and Chung 2006; Fischer et al. 2004; Frey and Farley 1996; Logan et al. 2002; Logan et al. 2004; Massey 1996; Wilkes and Iceland 2004). However, recent work highlights the importance of considering segregation patterns in nonmetropolitan areas as well. In one of the only national level studies available on the topic, Lichter and colleagues (Lichter et al. 2007) explore racial segregation patterns for rural areas and small-town in the US over the 1990 and 2000 time periods. One of the most important findings from this research was that similar racial residential segregation patterns and trends were observed over this period between metropolitan and nonmetropolitan areas. From a population perspective, the changing population composition of many rural areas elevates the importance of studying segregation in nonmetro and metro areas. What is less clear is how we are to interpret dimensions of segregation between metro and nonmetro areas if we do not notice major differences in the patterns of trends in residential segregation between these two locations. This research starts to fill this gap by using exploratory spatial data analysis techniques to document racial and economic segregation clusters in metro and nonmetro counties by measuring multiple dimensions of segregation.

The purpose of this research is to examine multiple dimensions of racial and economic segregation in the United States in 2000 for metropolitan and nonmetropolitan counties. Additionally we explore potential variation in these measures of segregation based on the level of rurality in nonmetro counties, with specific attention given to population size of the rural areas in the county and adjacency of the county to metro counties. This research adds to the literature by using spatial methods to explore patterns of metro and nonmetro racial and economic segregation across counties in the contiguous United States in an effort to note differences in how segregation works across rural and urban places.

Data and Methods

Data for this analysis comes from two sources: 2000 U.S. Census of Population and Housing, Summary File 3 (block and county data) and Economic Research Service (ERS) rural-urban continuum codes and urban influence codes for counties in 1993. For all segregation measures, each index was based on block group data within each county, which has been argued to be a better unit of analysis for detecting variation in segregation patterns across areal units (Lichter et al. 2007; Reardon and O'Sullivan 2004). We

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measure racial and poverty segregation using three indices including: the dissimilarity index (D) to measure evenness; the delta index (DEL) to measure concentration; and the isolation index (${}_xP^*_y$) to measure exposure (Massey and Denton 1988; Reardon 2006). We calculate each racial segregation index for blacks, whites, and other races, while the economic segregation measure captures poverty segregation, defined as percentage of persons living below the federally designated poverty threshold in each block group.

The dissimilarity index (D) is calculated from the census block group distribution of population by race (black, white, other) and measures evenness. This index measures the degree to which one racial group would have to move to another block-group in the county in order to equalize the racial distribution within the county. The calculation is:

$$D = \sum_{i \in R} \frac{t_i \left| \pi_{ji} - \pi_i \right|}{2T\pi_i(1-\pi_i)}$$

, where T is the total population in the county, t_i is the total population of block-group i, π_i is the proportion of the population of T (county) that is of a certain racial group, and π_{ji} is the proportion of the population in block i that is of a certain racial group. This index measures the degree to which once racial or economic group at the block-group level would have to move to another block-group to equalize the racial or economic distribution within the county, and ranges from 0 (perfect integration) to 1 (perfect segregation).

Concentration, measured by the delta index (*DEL)*, indicates the relative amount of space occupied by a racial or economic group in a county. It is interpreted as the proportion of a certain racial or economic group that would have to move blocks in order to have a uniform density based on race or poverty status across all blocks in the county. Delta is calculated as:

$$DEL = \frac{1}{2} \sum_{i=1}^{n} \left[\frac{x_i}{X} - \frac{a_i}{A} \right]$$

, where x_i is the proportion of the block group that is of a particular racial group (or in poverty), X is the total population of the county that is of that particular racial group (or in poverty), a_i is the land area of block i, and A is total land area in the county. We measure land area in square kilometers.

The isolation index measures potential exposure of one racial or economic group to someone of another racial or economic group with a geographic area. More specifically, it captures the probability that a member of a given race will share a block-group with another member of that race; alternatively the poverty isolation index measures the probability that a person living below the federally designated poverty threshold shares a block-group with other people living in poverty. This value ranges between 0 (complete integration) to 1 (complete segregation). The index is calculated as:

$${}_yP_x* = \sum_{i=1}^{n} \left[\left(\frac{x_i}{X} \right) \left(\frac{x_i}{t_i} \right) \right]$$

, where x_i is the proportion of the block group that is of a particular racial group (or in poverty), X is the total population of the county that is of that particular racial group (or in poverty), and t_i is the total population of the block group.

Based on non-normality of the segregation measures, we employ nonparametric Kruskal-Wallis tests to compare the levels of segregation across the Rural-Urban Continuum codes. This method uses the ranks of the observations, rather than the segregation indices themselves to compare the distributions across the groups, and is robust to both skewness and outliers in the data. We will use exploratory spatial analytical methods to describe the spatial distributions of the various segregation indices. Specifically we will use the local Moran's I statistic as a local measure of spatial clustering. We expect there to be significant clusters of nonmetro areas showing high levels of both racial and economic segregation.

Preliminary Analyses

Initial results indicate there are differences in racial and economic residential segregation patterns across metro and nonmetro counties depending on the dimension of segregation being measured. Tables 1 through 4 provide output from Kruskal-Wallis tests, which test for equality of the distributions of segregation values among county groups defined by the ERS rural-urban continuum codes. Across the three dimensions of segregation presented in these tables, only the isolation index, which measures expose, indicates there are significant differences in exposure of blacks, whites, other races, or persons living in poverty within blocks across metro and nonmetro counties in the US. Like previous research, our statistical tests do not show significantly different patterns of racial and economic segregation measured by the dissimilarity index for metro and nonmetro counties. No significant differences were noted for the concentration dimension of segregation, measured by the delta index, for each racial group and for persons in poverty across the rural-urban continuum code categories. Similar patterns are found for each of these segregation measures across the county urban influence code categories (tables not shown here).

In the included Figures 1 to 3, we display the spatial distribution of the three dimensions of segregation (evenness, concentration, and exposure) discussed above for the black population. In addition to showing the value of the segregation indices, we indicate the locations of metro counties. As we see in these figures, significant areas of the country which are nonmetro areas show relatively high levels of segregation. In preliminary spatial analyses of several of these measures, we note significant spatial clustering in nonmetro areas of both racial and economic segregation, as measured by each of the separate indices.

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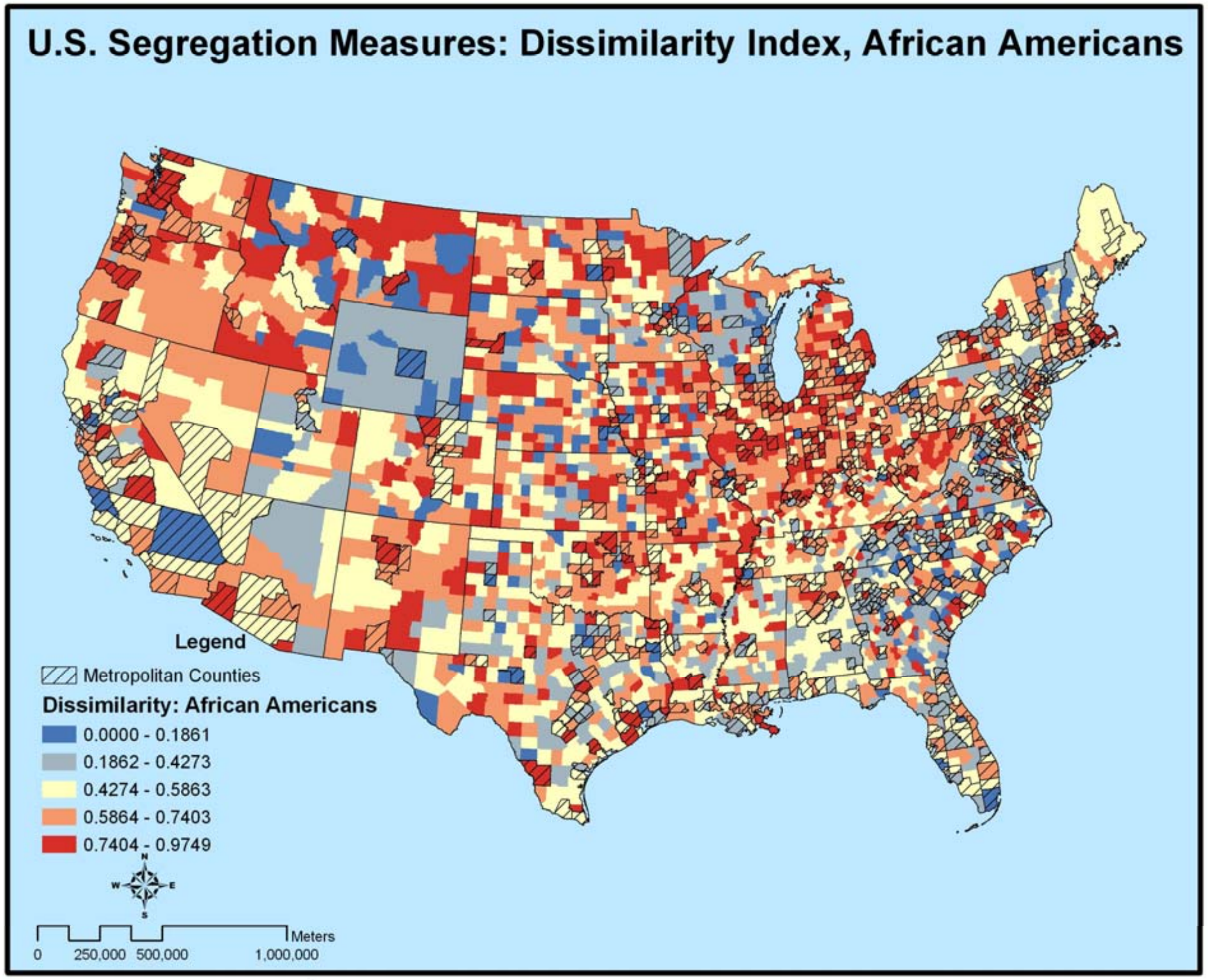
Table 1. Kruskal-Wallis Test of Segregation Measures for African-Americans by Rural-Urban Continuum Codes						
	Evenness *Dissimilarity Index (D)*		Concentration *Delta (DEL)*		Exposure *Isolation Index* $({}_xP^*{}_x)$	
Rural-Urban Continuum Codes	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
(0) Central metro, 1million or more	0.5830	0.1783	0.7340	0.1980	0.1593	0.1873
(1) Metro fringe, 1million or more	0.5834	0.1807	0.7142	0.2145	0.1894	0.2134
(2) Metro, 250,000 – 1 million	0.5605	0.1719	0.7109	0.1813	0.2133	0.2129
(3) Metro, less than 250,000	0.5880	0.1766	0.7374	0.1889	0.1891	0.2126
(4) Urban 20,000 plus, adjacent to metro	0.5603	0.1662	0.7201	0.1966	0.1889	0.1998
(5) Urban 20,000 plus, not adjacent to metro	0.5975	0.1690	0.7625	0.1697	0.1657	0.1929
(6) Urban 2,500-19,999, adjacent to metro	0.5811	0.1711	0.7311	0.1888	0.1888	0.2082
(7) Urban 2,500-19,999, not adjacent to metro	0.5909	0.1798	0.7430	0.1878	0.1672	0.2123
(8) Rural or less than 2,500, adjacent to metro	0.5768	0.1891	0.7130	0.2077	0.1982	0.2281
(9) Rural or less than 2,500, not adjacent to metro	0.5851	0.1780	0.7359	0.1903	0.1433	0.1826
Kruskal-Wallis Test	$Pr\ (\chi^2_9 \geq K)=0.2176$		$Pr\ (\chi^2_9 \geq K)=0.1166$		$Pr\ (\chi^2_9 \geq K)<0.0001$	

Table 2. Kruskal-Wallis Test of Segregation Measures for Whites by Rural-Urban Continuum Codes						
	Evenness *Dissimilarity Index (D)*		Concentration *Delta (DEL)*		Exposure *Isolation Index* $({}_xP^*{}_x)$	
Rural-Urban Continuum Codes	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
(0) Central metro, 1million or more	0.3566	0.1365	0.4811	0.1798	0.8728	0.1218
(1) Metro fringe, 1million or more	0.3686	0.1340	0.4352	0.1719	0.8671	0.1327
(2) Metro, 250,000 – 1 million	0.3690	0.1286	0.4582	0.1620	0.8608	0.1206
(3) Metro, less than 250,000	0.3728	0.1396	0.4716	0.1771	0.8708	0.1232
(4) Urban 20,000 plus, adjacent to metro	0.3781	0.1337	0.4647	0.1693	0.8700	0.1168
(5) Urban 20,000 plus, not adjacent to metro	0.3737	0.1257	0.4728	0.1674	0.8750	0.1241
(6) Urban 2,500-19,999, adjacent to metro	0.3668	0.1320	0.3668	0.1320	0.8719	0.1220
(7) Urban 2,500-19,999, not adjacent to metro	0.3692	0.1387	0.4671	0.1630	0.8787	0.1279
(8) Rural or less than 2,500, adjacent to metro	0.3637	0.1408	0.4507	0.1734	0.8675	0.1318
(9) Rural or less than 2,500, not adjacent to metro	0.3568	0.1400	0.4510	0.1731	0.8980	0.1140
Kruskal-Wallis Test	$Pr\ (\chi^2_9 \geq K)=0.5914$		$Pr\ (\chi^2_9 \geq K)=0.3137$		$Pr\ (\chi^2_9 \geq K)<0.0001$	

Table3. Kruskal-Wallis Test of Segregation Measures for Other Races by Rural-Urban Continuum Codes						
	Evenness *Dissimilarity Index (D)*		Concentration *Delta (DEL)*		Exposure *Isolation Index* $({}_xP^*{}_x)$	
Rural-Urban Continuum Codes	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
(0) Central metro, 1million or more	0.5667	0.2044	0.7548	0.1621	0.0718	0.0826
(1) Metro fringe, 1million or more	0.5816	0.1970	0.7434	0.1516	0.0620	0.0758
(2) Metro, 250,000 – 1 million	0.5748	0.1768	0.7407	0.1527	0.0605	0.0743
(3) Metro, less than 250,000	0.5847	0.2004	0.7564	0.1700	0.0713	0.0803
(4) Urban 20,000 plus, adjacent to metro	0.6054	0.1950	0.7644	0.1550	0.0592	0.0703
(5) Urban 20,000 plus, not adjacent to metro	0.6013	0.1663	0.7498	0.1485	0.0671	0.0893
(6) Urban 2,500-19,999, adjacent to metro	0.5843	0.1848	0.7474	0.1618	0.0630	0.0756
(7) Urban 2,500-19,999, not adjacent to metro	0.5915	0.1920	0.7531	0.1571	0.0580	0.0745
(8) Rural or less than 2,500, adjacent to metro	0.5831	0.1821	0.7386	0.1803	0.0564	0.0680
(9) Rural or less than 2,500, not adjacent to metro	0.5766	0.1856	0.7337	0.1793	0.0520	0.0660
Kruskal-Wallis Test	$Pr\ (\chi^2_9 \geq K)=0.6196$		$Pr\ (\chi^2_9 \geq K)=0.5835$		$Pr\ (\chi^2_9 \geq K)=0.0012$	

Table 4. Kruskal-Wallis Test of Segregation Measures for Persons in Poverty by Rural-Urban Continuum Codes						
	Evenness *Dissimilarity Index (D)*		Concentration *Delta (DEL)*		Exposure *Isolation Index* $({}_xP^*{}_x)$	
Rural-Urban Continuum Codes	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
(0) Central metro, 1million or more	0.2516	0.1052	0.5391	0.1887	0.1802	0.0816
(1) Metro fringe, 1million or more	0.2281	0.0896	0.4978	0.1865	0.1871	0.0978
(2) Metro, 250,000 – 1 million	0.2517	0.1056	0.5302	0.1812	0.1872	0.0841
(3) Metro, less than 250,000	0.2492	0.0999	0.5306	0.1914	0.1946	0.1029
(4) Urban 20,000 plus, adjacent to metro	0.2569	0.0987	0.5295	0.1884	0.1977	0.1013
(5) Urban 20,000 plus, not adjacent to metro	0.2474	0.1067	0.5389	0.1845	0.1861	0.0995
(6) Urban 2,500-19,999, adjacent to metro	0.2455	0.0955	0.5320	0.1769	0.1881	0.0859
(7) Urban 2,500-19,999, not adjacent to metro	0.2423	0.1010	0.5252	0.1807	0.1957	0.1013
(8) Rural or less than 2,500, adjacent to metro	0.2410	0.1044	0.5120	0.1864	0.1802	0.0846
(9) Rural or less than 2,500, not adjacent to metro	0.2342	0.1043	0.5047	0.1917	0.1780	0.0930
Kruskal-Wallis Test	$Pr\ (\chi^2_9 \geq K)=0.0865$		$Pr\ (\chi^2_9 \geq K)=0.2169$		$Pr\ (\chi^2_9 \geq K)=0.0125$	

Figure 1.


U.S. Segregation Measures: Dissimilarity Index, African Americans
Legend
Metropolitan Counties
Dissimilarity: African Americans
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0.1862 - 0.4273
0.4274 - 0.5863
0.5864 - 0.7403
0.7404 - 0.9749
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250,000
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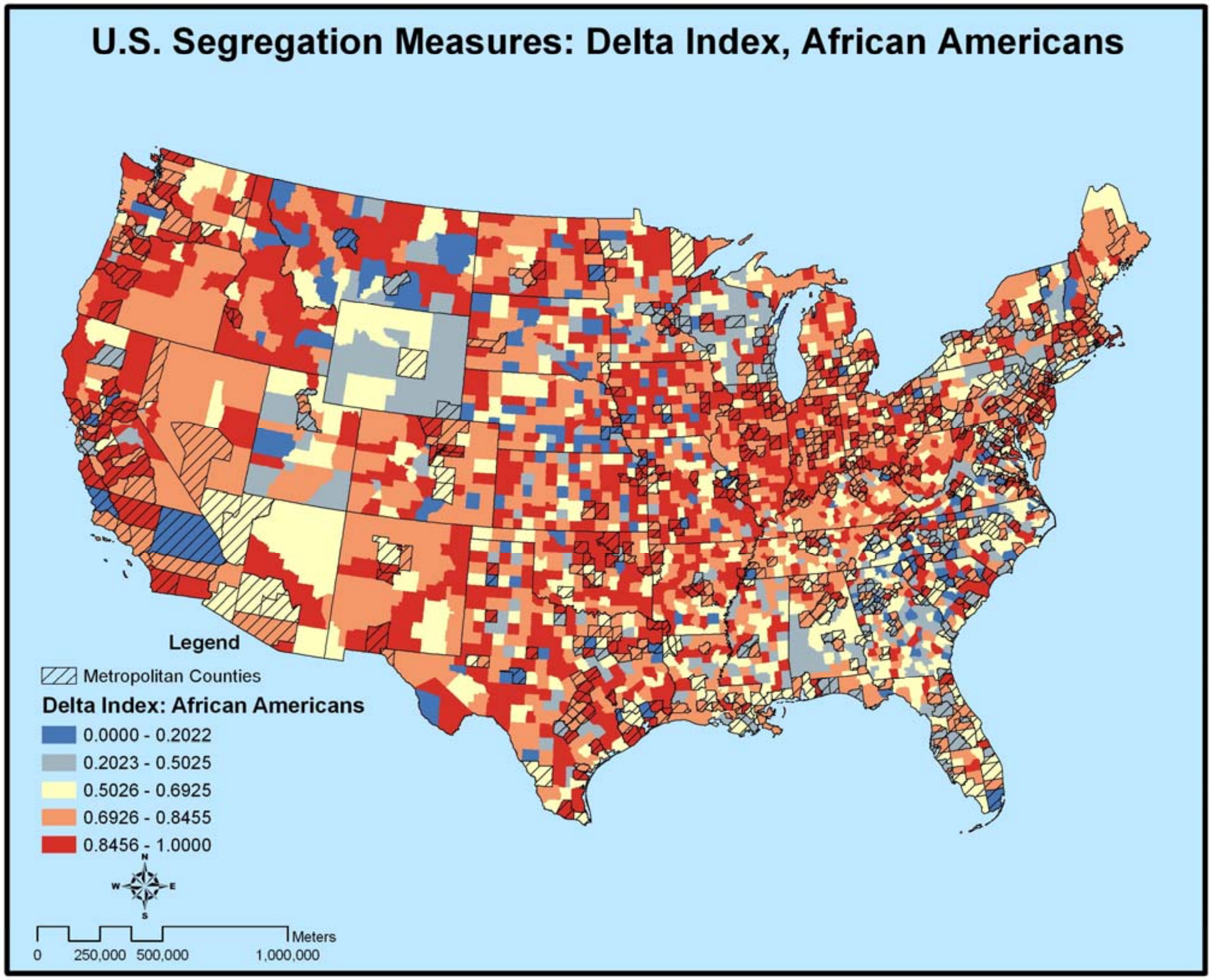
Figure 2.


U.S. Segregation Measures: Delta Index, African Americans
Legend
Metropolitan Counties
Delta Index: African Americans
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0.5026 - 0.6925
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N
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250,000
500,000
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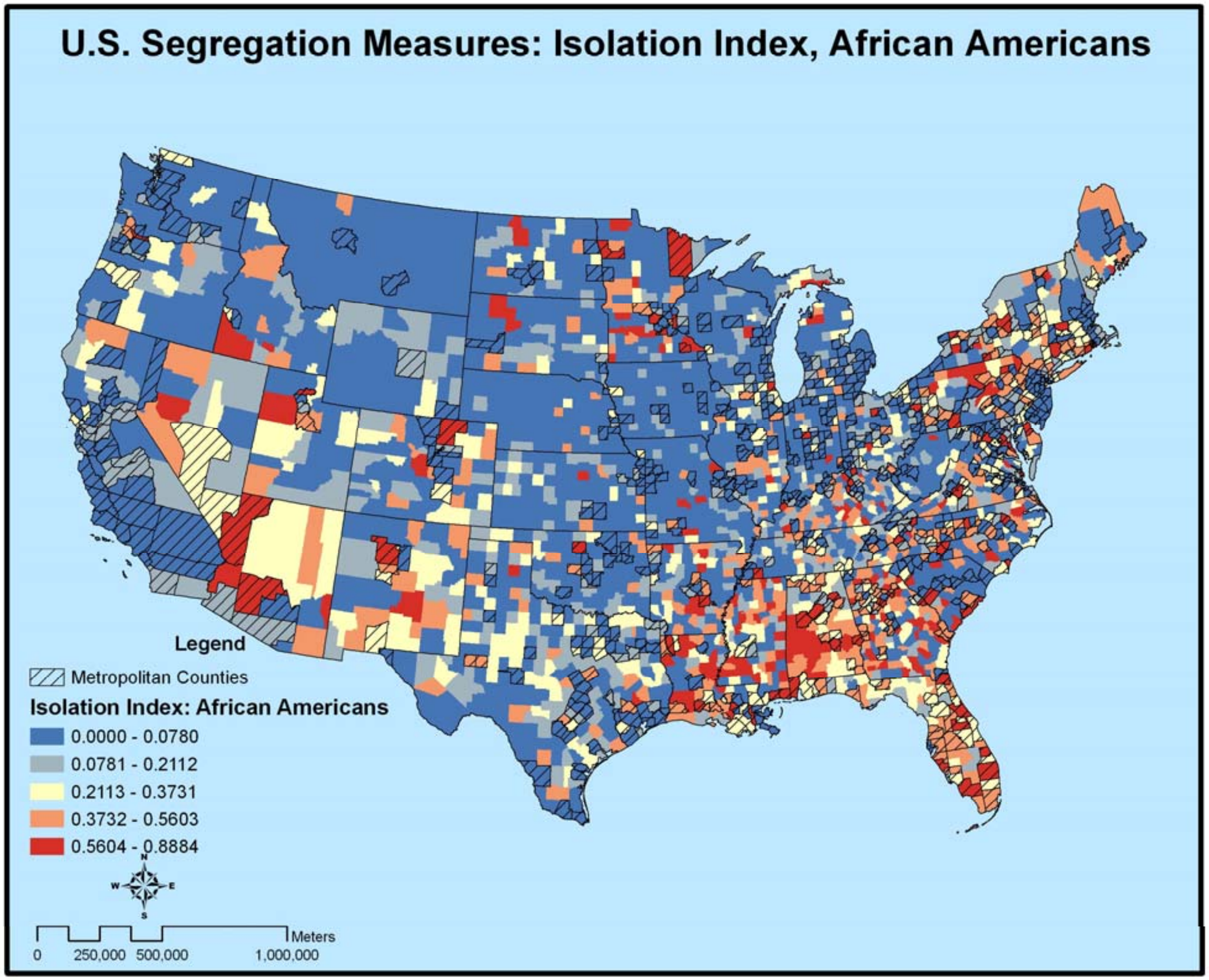
Figure 3.


U.S. Segregation Measures: Isolation Index, African Americans
Legend
Metropolitan Counties
Isolation Index: African Americans
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0.2113 - 0.3731
0.3732 - 0.5603
0.5604 - 0.8884
N
W
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0
250,000
500,000
1,000,000