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LOCAL POPULATION CHANGE AND VARIATIONS IN RACIAL INTEGRATION
IN THE UNITED STATES, 2000–2010

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Abstract

While population growth has been consistently tied to decreasing racial segregation at the metropolitan level in the United States, little work has been done to relate small-scale changes in population size to integration. We address this question through a novel technique that tracks population changes by race and ethnicity for comparable geographies in both 2000 and 2010. Using the Theil Index, we analyze the fifty most populous Metropolitan Statistical Areas in 2010 for changes in multigroup segregation. We classify local areas by their net population change between 2000 and 2010 using a novel unit of analysis based on aggregating census blocks. We find strong evidence that growing parts of rapidly growing metropolitan areas of the United States are crucial to understanding regional differences in segregation that have emerged in past decades. Multigroup segregation declined the most in growing parts of growing metropolitan areas. Comparatively, growing parts of shrinking or stagnant metropolitan areas were less diverse and had smaller declines in segregation. We also find that local areas with shrinking populations had disproportionately high minority representation in 2000 before population loss took place. We conclude that the regional context of population growth or decline has important consequences for the residential mixing of racial groups.

Keywords

Residential segregation, race and ethnicity, population change, United States, entropy index

Introduction

Thirty-five years ago, in his Presidential Address to the Regional Science Association, William Alonso reminded researchers that “the later stages [of urban development] have been loosely specified or taken for granted” (Alonso 1980, 5). Alonso spoke of the “bell curves” of development, noting that periods of growth, across a variety of domains of regional science, are often followed by periods of decline, but that patterns of decline and their causes are understudied in the literature. At that time, central cities and metropolitan areas in much of the United States were losing population, prompting new questions about what comes after the initial growth and apex of development of urban areas. In the decades since, the trend of population decline in many older, industrial urban areas has not abated.

However, the situation for most urban areas in the United States has changed in many ways since 1980. Urban growth has exploded in Sunbelt destination cities, attracting new residents from both inside and outside the country. Simultaneously, America has become far more diverse than it was at the time of Alonso’s address. Immigration from Latin America and Asia has had an enormous impact on patterns of residential segregation by race, as has the “great inversion,” a term coined by Ehrenhalt (2012) to describe the trend of reinvestment in central cities (after decades of decline). Residential segregation by race—an almost defining feature of American society—has been steadily declining since 1970, and there has been enormous debate across the social sciences surrounding the causes of these declines. Hypotheses abound, and there is a

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general consensus that no single factor can entirely explain the observed patterns and dynamics of segregation. In this paper, we further explore one such theory of integration: population growth. The regional disparity between the growing, diversifying South and the lagging, more segregated North is widely recognized, and we are interested if this pattern holds within and across metropolitan areas. Our questions include: What roles do areas that undergo concentrated increases or decreases of population play in patterns of segregation? Are these effects different across different metropolitan and regional contexts of change (i.e. large-scale growth and decline)? Where is small scale integration by race most likely to happen? Though it is not explicit in our analysis, our attention to small scales is motivated by the built environment and housing construction. There is evidence in previous research that changes in the urban built environment are related to changes in segregation (Spielman and Harrison 2014), and that active housing markets in growing cities are better positioned to catalyze integration than stagnant ones (Watson 2006).

We apply Alonso's "bell curve" analogy, examining the association between residential population growth and decline and the racial composition of neighborhoods. We find that patterns of urban growth and decline are directly connected to the changing mix of individuals living in these areas. To illustrate these connections, we employ a simple but novel analytical technique that yields exact count changes by racial group for stable spatial units between 2000 and 2010, using high-resolution public domain data at the census block level. Our study examines the fifty most populous Metropolitan

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Statistical Areas (MSAs) in the United States; we make the nation-wide dataset available from the Brown Digital Repository at <https://doi.org/10.7301/Z0QV3JG7>.

We show an important interaction between growth and decline, and population composition. This relationship varies geographically, but we find an important pattern. Between 2000 and 2010, segregation declined the most in growing parts of growing metropolitan areas, while declines were smaller in growing parts of low-growth metropolitan areas. Racial segregation declined the most in the fastest growing metropolitan areas, and these MSAs are overwhelmingly in the southern United States. We assert that connections between segregation and population change must be understood at all scales, and that changes in both the social and physical structure of cities are necessary for sustained integration. In the next section, we provide background for the present study, and present a conceptual framework for our expected results. Following, we describe our data and methods, and then turn to results and interpretation. Finally, we offer conclusions and discuss future avenues of research based on our findings and methods.

Background

The motivation for our research question lies between two related processes: changes in the spatial distribution of population and changes in the built environment, particularly housing construction. A recent simulation study of agent-based models has shown that differences in the built environment will yield differing segregation patterns (Spielman and Harrison 2014), urging that the built environment needs to be better

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addressed in the segregation literature. Farley and Frey (1994) found these processes to be related with declines in metropolitan segregation two decades ago. Between 1980 and 1990, the metro areas with the largest declines in black-white segregation had the largest increases in black population, and tended to have larger rates of housing construction (Farley and Frey 1994). In a separate study comparing the segregation of blacks, Hispanics, and Asians, the authors found that segregation for each group declined the most in metro areas where more members of other minority groups (Frey and Farley 1996). Recent research has deepened the connection between changes in the built environment and segregation. Used as metropolitan-level controls in a regression framework, housing construction has a negative association with immigrant segregation, and vacancy rate, a sign of outmigration and population loss, is positively related with immigrant segregation (Farrell 2014).

Urban decay and population loss are problems for cities around the world, and are recognized to have negative social consequences for affected places (Audirac 2009; Großmann et al 2013). These processes have an important legacy in the segregation and social exclusion of blacks in the U.S. (Wilson 1987; Cutler, Glaeser and Vigdor 1999), and have been connected with the concentration and perpetuation of social disadvantage in other parts of the world (e.g. Skifter Andersen 2002). These forces have complicated spatial patterns; urban decline/population loss can occur in close proximity with urban renewal/population growth, and concentrated local growth often occurs in generally declining regions (e.g. Ehrenhalt 2012). Using Alonso's "bell curves" of regional

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population levels and inequality as conceptual guides, we try to understand local patterns of population growth and decline in context with their regional growth patterns.

We adapt our conceptual model from a study of metropolitan income segregation. Because of the abundant need for new housing in growing regions, the market is more flexible to the needs of different income groups, spurring integration; in declining areas, the cost of new construction is unattainable for all but the wealthiest, perpetuating income segregation (Watson 2006). The author states that this framework is also relevant to racial segregation; her descriptive analysis shows that economically vibrant cities experienced greater declines in racial segregation compared to stagnant cities (Watson 2006). We extend this hypothesis to local areas, and base our framework on the spatial footprint of migration patterns. This shift from economic to racial segregation is relevant, as entrenched differences in socioeconomic status across racial groups remain a crucial barrier to reducing segregation (Logan and Stults 2011; De la Roca, Ellen, and O'Regan 2014).

In our framework, the organization of migration across scales is inherently interrelated. Large-scale patterns population growth and decline are often rooted in differences in fertility, but such patterns also have a strong basis in regional competition for migration (Franklin 2014). High rates of regional and metropolitan population growth result from both domestic and international migration flows, and incoming groups are concentrated through the attraction to new housing construction and other updates to and investments in the built environment. However, this is only likely to happen in rapidly growing metropolitan areas with large amounts of housing construction. In stagnant and

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declining metro areas, there is a larger cost associated with developing the built environment, and new construction projects cater to and concentrate the wealthy (Watson 2006). This process then increases social distance across economic class and associated ethnic patterns. Hence, local areas of construction and population growth in growing metropolitan areas should be sites of increased diversity and decreased segregation, while the same parts of declining cities and metro areas should integrate more slowly, reproducing older patterns of segregation and privileged access to housing.

Data and Methods

Creating the Data

This analysis uses data from the 2000 and 2010 Decennial Census, one table from the 2010 Summary File 1a (Hispanic or Latino Origin by Race) and two tables from the 2000 Summary File 1b (Not Hispanic or Latino Population of One Race by Race, Total Hispanic or Latino Population) at the census block level. This data was obtained for the entire United States from the National Historical Geographic Information System at the Minnesota Population Center (2011) and contains population counts by census block by race and Hispanic origin. We limit our analysis to the fifty most populous Metropolitan Statistical Areas (MSAs) in the United States¹, though we make the full data file available at (url suppressed for peer review). The Census Bureau allowed six responses for racial identification in 2000 and seven in 2010, not including Hispanic and Latino ethnicity. Following other studies, we collapse this information into five racial groups: white, black, Asian, Hispanic, and all other races. The Hispanic category contains people

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of any race who reported Hispanic or Latino ethnicity. The other groups thus only contain non-Hispanic respondents for that racial category. The “other races” category is defined as non-Hispanics who reported being American Indian or Native Alaskan, Hawaiian or Pacific Islander, or some other race, and also includes the “two or more races” category from the 2010 Census.

A crucial step in our analysis was reconciling geographic boundaries between blocks in 2000 and 2010 in order to make their populations comparable, and their changes calculable. To do this, we make novel use of the 2000 to 2010 Census Block Relationship Files, which provide information about which blocks from 2000 overlap with blocks in 2010. Each line in the file represents one overlap between a block in 2000 and one in 2010. Using the “NetworkX” package in Python (Hagberg, Schult, and Swart 2008), we construct a single, massive undirected graph for the entire United States, where nodes represent blocks in 2000 or 2010, and each edge represents a spatial overlap between blocks in different years. The resulting connected components (subgraphs with exactly zero edges connecting to other subgraphs) represent groups of blocks in 2000 and 2010 that only overlap with each other, creating a stable boundary around them in both years. For example, two blocks in 2000 might have changed into four in 2010. This would be represented as a self-contained graph linking the 2010 blocks with any 2000 blocks they overlap. By this method, information from 2000 and 2010 can be combined into identical spatial units. Figure 1 presents a visual representation of this hypothetical case in 2000 and 2010, showing how we overlap and combine the blocks into a comparable unit between the two years.

Figure 1 about here

These subgraphs, or “block components” are our unit of analysis. There are 1,514,398 populated block components in the fifty most populous MSAs; in the entire US, there are 6,501,602 total components. As a point of comparison, there are 73,057 census tracts in all fifty states, which gives our data an enormous boost in resolution compared to studies using tracts. Block components provide a common geographic unit of analysis and allow us to track change in population without interpolation, imputation, or other forms of data manipulation. We aggregate the block data in 2000 and 2010 to match these boundaries. This allows us to calculate changes in total population at a fine geographic scale, as well as changes in each racial group. It the smallest geographic unit of analysis one can identify without some sort statistical interpolation (e.g. Logan, Xu and Stults 2014).

Further, census block boundaries are defined by physical barriers like streets, railroad tracks, highways, and rivers. Block components are groups of such physically defined geographic areas. Changes in block boundaries are generally rooted in changes in the physical landscape. Blocks are unique among the census tabulation geographies in that they are delimited by physical, “real world” geographic phenomena without respect to population thresholds, giving our data an advantage for research questions that are interested in the built environment of cities.

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Classifying Block Components

Classifying these small areas is critical for our large-scale segregation analysis. Some of these are simple geographic information, such as the block component's MSA or Census-defined Region. Other results use the majority racial group to classify the block component. If no single group makes up more than 50% of a block component's population, it is classified as having no majority group.

The most critical classification to our analysis is defined by its overall change in population. A block component is considered “growing” if it gained fifty or more people between 2000 and 2010, “shrinking” if it lost fifty or more people between 2000 and 2010, and “stable” if its net change falls between those thresholds. We use these definitions as sub-regions within larger areas of analysis (i.e. Census Regions and MSAs) that can be explored using segregation indices. When interpreting these thresholds, it is important to consider just how small block components are. Using 2010 counts, they have on average 109.6 people (SD 267.95), the median population size of a block component is 54. A cutoff of fifty people is ultimately arbitrary, but we use it for two reasons. First, it seems to be effective in capturing geographically isolated population growth and decline, while allowing smaller fluctuations in population in local units to balance each other out (see Table 1 in following section). Second, we believe that this threshold excludes most population fluctuations due to local spikes in fertility or mortality, keeping our findings conceptually consistent with our migration-based framework despite our inability to capture the demographic source of population changes. This number is very close to the median population size, meaning that a change of fifty

would represent an enormous proportional shift in ten years for the majority of block components. Unfortunately, we are not able to tell if any such migration originates from a foreign country or within the United States; this topic will be key to address in the future.

Segregation Measures

We use the information theory index (H) to measure changes in population composition. Reardon and Firebaugh (2002) conclude that the information theory index (also known as the entropy index or Theil index) is the ideal segregation measure when considering multiple groups at once. First introduced by Theil as a means of studying segregation in Chicago school districts (Theil and Finizza 1971; Theil 1972), the index measures variation in the multigroup diversity of geographic or administrative units relative to their aggregate diversity. Diversity is measured using an index of racial entropy, which is calculated as (Reardon and O’Sullivan 2004),

$$E = \sum_{m=1}^M \pi_m \log_M (\pi_m)$$

where M refers to the number of groups in the population, and π_m is the proportion of group m within the whole population. E has a minimum value of zero when an area only contains one racial group, and a maximum value of one when each group has equal representation, indicating perfect diversity. The information theory index is defined as (Reardon and O’Sullivan 2004),

$$H = \sum_{r=1}^R \frac{t_r(E - E_r)}{ET}$$

where r is a subarea of region R , E and T are the entropy and total population of region R , and E_r and t_r are the entropy and total population for the subarea r . H has a minimum value of zero, which indicates that a region is perfectly integrated; for this value to occur, each r in R would have precisely the same proportion of each racial group as the overall region. The maximum value of H is one, which would be interpreted as perfect segregation (each r would only contain people from a single racial group). Hence, a larger value for H indicates greater segregation, while a larger value for E indicates greater diversity.

In our discussion, we use “segregation” when referring to H , and “diversity” when referring to E to avoid confusing indices. We primarily calculate these indices for the study region as a whole and for MSAs grouped by four regions defined by the Census Bureau: Northeast, Midwest, South, and West. This means our results should be interpreted as segregation measures for groups of metropolitan areas and their aggregate racial compositions, not averages of metro-level calculations. We also employ E to analyze changes in diversity at the block component level. This is especially important for determining how local changes in composition vary across regions and metropolitan areas.

Results

Population Change by Region

Table 1 displays the total population in 2010, percent population change from 2000, racial composition, and net changes for racial groups in the fifty MSA study area, as well as breakdowns by census region and population change. Across the study area, growing areas more than doubled in population, while shrinking areas lost 30% of residents between 2000 and 2010 (Table 1). Each census region follows this general pattern. Table 1 also shows that the bulk of population growth was focused in the South and West census regions. Southern MSAs in our study area collectively grew by nearly 20%, and those in the West grew by nearly 14%, compared to only 3.4% and 5.5% for the Northeast and Midwest respectively.

Table 1 about here

There are clear differences in growth rates by racial group. Across the study area, the Hispanic population gained around 9.7 million people, the Asian population grew by 3.5 million, the black population grew by 2.8 million, and the white population grew by 380,000. There are also differential patterns in each group's rate of change across regions. The Midwest saw little growth in Asian and Hispanic populations compared to the other three regions, the South saw large growth in both black and white populations relative to other regions, and the Northeast saw a sizable net loss in white population.

Across all regions, we find similarities in the growing, shrinking, and stable areas of MSAs. Growing areas are the only places with net increases of white population. The

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white proportion of total growth in growing areas varies by region; the South and West have lower percentages of white growth (41.2% and 43.3% respectively) than the Northeast and Midwest (49.8% and 68.6% respectively). The fact that the two fastest growing regions have the greatest minority representation in their actual growth is the first promising sign that racial integration is happening there.

Shrinking areas had the lowest white representation as a whole; whites made up 42.6% of the population in 2010, compared to 54.6% in growing areas and 58.4% in stable areas. In the West, Hispanics were actually the dominant group in shrinking areas (40.1% Hispanic vs. 36.6% white). All racial groups experienced a net population loss in shrinking areas. Across our study area, these places lost around 3 million whites, 1.3 million blacks, 200,000 Asians, and 800,000 Hispanics.

Despite little net change in total population, many “stable” areas are actually undergoing significant demographic shifts. Across the study area, stable areas lost around 7.4 million whites, but gained close to 200,000 blacks, 1 million Asians, and 4.8 million Hispanics (Table 1). This process is thus bringing new minority representation into already established parts of metro areas. Our “stable” definition for these places implies that they are changing residents without drastic shifts in family size or building types, and suggests the possibility of linkages between growth in one part of a metro area and integration in another.

However, we cannot be sure that these shifts are actually integration. There were much larger aggregate declines of the white population in stable areas than shrinking areas in all regions; across the entire study area, white net loss in stable areas was 241%

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of white net loss in shrinking areas. That is, the reason many “stable” block components were stable was simply due to population replacement from other racial groups. It is likely that this finding is closer to neighborhood transition than inter-group mixing, where a minority group becomes dominant in a formerly white neighborhood. Of particular note is the Midwest, where population replacement of “stable” areas is largely incomplete. Those areas lost around 1.8 million whites, but only saw a combined net increase of about 1 million from the black, Asian, and Hispanic populations, resulting in the 3.3% net loss of population since 2000. Because those blocks were defined as stable, this decrease must have been widespread geographically, with many block components losing less than fifty people after “replacement.” This process could underlie the finding that whites continue to be highly isolated from all minority groups despite increasing diversity (Rugh and Massey 2014). In order to preserve their economic advantage, whites might be self-segregating, abandoning neighborhoods to other racial groups that might not have the socioeconomic status to maintain their prosperity. Such a process has been connected with depreciating housing values, further entrenching patterns of inter-group inequality and residential segregation (Moye 2014). Additionally, these demographic transitions have been linked with the racial patterning of the recent foreclosure crisis, which had negative consequences for the ability of minority groups to integrate with the white population (Hall, Crowder, and Spring 2015).

Connecting Segregation and Population Change

Table 2 presents the overall entropy, H index, and the geographic decomposition of H for 2000 and 2010 by the same breakdowns as Table 1. The H index is calculated for each region (and growth-defined subregion) as a single unit, comparing each block component's racial composition to that of the entire census region.

Table 2 about here

Amidst regional variation, we find general patterns related to changes in total population. There was clear increase in diversity for the study area as whole, as entropy increased from 0.69 in 2000 to 0.75 in 2010. Shrinking areas were the most diverse across all groups (E in 2010 was 0.83), followed by growing areas (0.77), with the stable areas having the lowest overall entropy (0.73). This means that, as a whole, shrinking areas were about 7% more diverse than growing areas and 14% more diverse than stable areas. However, increases in diversity were dramatic in growing and stable areas (0.09 and 0.06 respectively) relative to shrinking areas (0.02) over the decade. This general pattern is consistent across each region; shrinking places were the most diverse in 2000, but had smaller increases in diversity relative to the other areas.

As a whole, the South had the largest absolute increase in diversity of the four regions, with a 0.07 increase in E , corresponding to changes of 2.2%, 10.3%, 26%, and 23.4% in the white, black, Asian, and Hispanic populations, respectively. The growing parts of the South had the largest increase in diversity of any sub-region (E increased by 0.12), corresponding to changes of 25.8%, 43.7%, 56.6%, and 52.2% in the white, black,

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Asian, and Hispanic populations, respectively. The Midwest had a similar change in E (0.12) but in spite of this change remained the least diverse sub-region in our study (0.45 in 2000, 0.57 in 2010), and the Midwest as a whole was the least diverse region, having the largest white representation (70.3% white, see Table 1).

As the U.S. has become more diverse, its fifty largest metropolitan areas have become less segregated as a whole. The H index for our study area declined from 0.45 to 0.39 across all growth-defined areas, a loss of 0.05. The West was the least segregated region in both 2000 and 2010, but had the slowest absolute change at -0.03 across all areas. The Midwest was the most segregated region in 2000 and 2010, and saw the largest absolute decrease in segregation at -0.07 across all areas. The South, by far the fastest growing region, also had a strong absolute decline in segregation across all areas at -0.06.

In interpreting these results, it is important to consider the baseline composition of block components (i.e. their composition in 2000). To some (unknown) extent, these patterns might reflect the prior characteristics of these regions. A diversifying block component in the already diverse West will not have as large an effect on that region's H index compared to a similarly diversifying place in the mostly-white Midwest. In this sense, the Midwest has more room for change, so its larger declines in segregation are not entirely surprising. Despite this slight discrepancy in the overall pattern of population growth and segregation decline, the pattern holds within each region: segregation declined more in growing areas between 2000 and 2010 than in stable or shrinking areas, particularly in the fast-growing South and West (Table 2, column 6). While the quickly

diversifying Midwest wasn't the fastest growing census region, the relationship between population growth and desegregation is consistent within regions.

Metropolitan-Level Change

The prior section examined relatively large census regions. Here, we address metropolitan level patterns. While we identify clear trends at the scale of census region, these divisions are quite coarse and mask inter- and intra-metropolitan patterns. There is a great deal of heterogeneity in patterns of growth, diversity, and segregation for metros within regional divides, and it would take far more detailed analyses of these places to properly understand how their local contexts affect the wider connections between growth and segregation. However, despite these complexities, we still find a strong, simple relationship between population growth and segregation decline at the metropolitan level.

Figure 2 presents a simple scatterplot of the fifty largest MSAs, comparing percent population change with percent change in H index, with points colored according to their census region. These metro areas have a Pearson correlation of $r=-0.456$, showing a clear association between metro-level population change and metro-level segregation. Figure 2 also shows how much more pronounced growth has been in the South compared to the other regions. Of the sixteen metro areas that saw more than 20% growth between 2000 and 2010, twelve were in the South, and four were in the West. While every MSA in our study area saw at least a small decline in H , it is clear that the index generally declined more in those with more population growth.

Figure 2 around here

However, using these relative changes in H as a benchmark can be misleading, and only tells part of the story. For instance, using Tables 1 and 2, the South had the most population growth and the largest relative decrease in segregation between 2000 and 2010, yet its growing areas saw the lowest relative decrease in segregation compared to growing places in the other regions. This is due to how the Theil Index is constructed. H is a global statistic that compares smaller compositions within a region to the overall composition of that region. As we can see in Table 1, racial composition varies greatly across areas of different growth status; this changes the point of comparison for each block component's composition based on the area global H represents. Additionally, because these racial compositions change from 2000 to 2010, we cannot be sure if changes in H within each area are due to a changing baseline composition, racial sorting within the region, or both (White 1986; Reardon and Firebaugh 2002). In spite of the ontological uncertainty associated with changes in the Theil Index, these changes unambiguously reflect real changes in the local social situation (White 1986). In this light, we can only say that segregation within growing areas decreased more than in stable or shrinking areas relative to 2000. With only these numbers, we cannot determine why, nor can we compare local changes in composition across regions.

Local-Level Change

Thus, in order to determine if local places are becoming more integrated, and to examine large-scale variations in any such changes, we must look at changes in diversity within the block components themselves. Table 3 presents mean and median entropy scores for block components in 2000 and 2010, and the change between the two for block components in the study area, broken down by region and growth. We also present results for the Charlotte, NC and Providence, RI MSAs as case examples. Table 3 notably excludes any growing block components that were unpopulated in 2000 for columns 3-6. This is because it is nonsensical to systematically examine “changes” from a population that were not present in the first time point.

Table 3 about here

Table 3 shows that there was a consistent pattern across regions for the local diversity of places in 2000 by their growth status in 2010. Block components defined as “shrinking” had the highest diversity in 2000; that is, the most diverse block components in 2000 generally lost population in following decade. This loss of population from diverse places is particularly interesting and begs further exploration. We can also see regional differences in shapes of the distribution of local E in 2000. The South and West have only small differences in the means and medians of diversity for each growth area, with the largest difference being a slight upward skew for stable parts of the South (median of 0.24, mean of 0.27, difference of 0.03). This means that many local areas in these regions had relatively high diversity. By contrast, stable areas in 2000 in the

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Northeast had a larger skew (median of 0.16, mean of 0.22, difference of 0.06), indicating that cases of high diversity are outliers. This upward skew existed for all growth-defined areas in the Midwest, and each of those areas had the lowest diversity of all four regions, painting a bleak picture for integration in the Midwest in 2000.

While the Midwest still had the lowest local diversity scores of the four census regions in 2010, there was dramatic increase in the diversity of growing areas. Table 3 shows that the Midwest had the second largest increase in local E for growing areas that had population in 2000, just behind the South. This pattern is very similar to the regional changes in H ; the South and Midwest lead the Northeast and West in decreases in H and local increases in E for growing areas. This suggests that growth-centered integration at a small scale is an important process for desegregation at the metropolitan scale.

There are other important similarities between these small and large-scale changes. Notably, growing areas of each census region (as well as Charlotte and Providence) had the largest increases in local diversity compared to stable and shrinking areas. This lets us be confident that decreases in H at a larger scale are occurring due to increased social mixing at a smaller scale, and not only because of changing baseline populations. Additionally, the small differences between the mean and median changes in Table 3 for all census regions show that this trend is a general pattern, and not the result of a few outliers. Finally, we can see that these increases in local E are much larger for growing areas than stable or shrinking areas, which again follows the identified patterns for decreases in H . Most local increases of E in areas with shrinking populations were small according to both measures of central tendency, and while the mean changes in

stable areas were higher, most regions had low median changes, indicating that large increases of diversity in stable areas are generally outliers. The one exception is the Northeast, which had a noticeably higher median of increases of local E in stable areas than the other regions. This is likely an anomaly due to the New York City metropolitan area, which has a consistent stream of international migration, is a likely candidate for diverse population growth through fertility due to its cohort mix (Franklin 2014), and dominates the Northeast in terms of population. Further analysis is necessary to determine this large-scale population replacement.

Charlotte and Providence provide useful examples for how these regional patterns of diversity and growth are playing out in the metropolitan context. They are very distinct cases. The Charlotte MSA had the largest percentage decrease in H of any MSA in our study area (-24.7%) and the fourth-largest percentage increase in population (32.8%). Its growth was also fairly representative across racial groups, gaining between 100,000 and 150,000 members of the white, black and Hispanic groups each. By contrast, the Providence MSA had the least growth, by both percentage and net gain, of all MSAs that did not have a net population loss. Its percentage decline in H was also modest compared to other metros in the analysis (-11.1%). However, the Providence MSA had a 0.08 increase in overall E , greater than most regions as a whole, making it an interesting case for population redistribution in a metro area with a stagnant total population and housing market.

Many of the same growth patterns present at the regional level are also manifest in Charlotte and Providence. It is clear from Table 3 that the growing parts of Charlotte

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had a dramatic effect on its segregation landscape. In 2000, the mean entropy score was 0.30 for growing block components and 0.41 for shrinking block components. By 2010, the mean entropy was 0.48 in growing block components, 0.04 higher than in shrinking block components in 2010. This means that diversity increase six times as much in growing areas compared to shrinking areas, a dramatic difference across localized areas. This dwarfs the changes in diversity of growing areas in Providence, which had mean increase of 0.11 excluding parts without population in 2000. This leaves a difference of 0.07 in mean local changes in entropy in growing parts of metro areas with very different growth contexts, and represents strong evidence for our expected outcomes.

Figure 3 about here

We can clearly see this pattern at the metropolitan in another simple scatterplot. For each MSA, Figure 3 plots the percent population change on the x-axis and the mean of local changes in E for all growing block components on the y-axis. When calculating, we excluded block components that had no population in 2000, same as in Table 3. The plot shows a positive association for these largest metropolitan areas, with a Pearson correlation coefficient of $r=0.440$. Figure 3 also shows how this pattern exists within census regions; the fastest growing MSAs within each region have the largest local increases in diversity for that region. This is direct support for our theory that growth in metropolitan areas encourages integration through new settlement.

Visualizations of local changes in diversity for the Charlotte and Providence MSAs strengthen this evidence, and help contextualize how these processes play out in these urban environments. Figures 4 and 5 present scatterplots for growing block components in these two metro areas, with population density (using a logarithmic scale) on the x-axis, and change in E on the y-axis. Each block component is then colored by its majority race in 2010. This visualization style adds much needed context to the locations being plotted, and helps us see how they fit into the metropolitan area. Unlike Table 3 and Figure 3, areas unpopulated in 2000 are included, and are plotted as if their E changed from a value of zero. While this is technically not true (E does not mathematically exist for populations of zero), it helps develop the visualization by showing all areas of growth for both metro areas, building contrasts between the two.

Figure 4 about here

Figure 5 about here

Figure 4 shows that growing block components with both white and black majorities are frequently increasing in diversity, signaling that these places could be focal points for racial integration in the Charlotte area. There are also numerous areas without a dominant racial group. Block components with white, black, or no majorities occur across the range of population densities. It does appear that growing block components in the lowest population densities are more likely to have a white-majority population, and growing units with Hispanic majorities are most likely to be higher density and are

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actually becoming less diverse. However, the general picture in Charlotte is much more integrative than it is for Providence. Figure 5 shows a stark racial divide along population density, with white-majority areas systematically having the lowest population densities, and minority-dominated areas systematically having the highest. This suggests a large spatial divide in where the growth of racial groups is concentrated; whites are mostly moving to the suburbs and exurbs, while Hispanics and other minorities are concentrated in dense urban areas. Growing block components at high population densities are more likely to have large minority compositions, but many of those places are losing diversity rather than promoting integration. Finally, block components with no majority race are far less common in Providence than in Charlotte, meaning that intense local integration happens less often. This is further support for our framework, that slow-growth housing markets with stagnant populations segment neighborhood attainment and reinforce segregation by race and income.

Conclusions and Discussion

Motivated by evidence from multiple disciplines, including regional science, geography, and sociology, this article examines how population change is related to decreased racial segregation in a set of metropolitan areas in the United States. We use block level census data to build a novel dataset that determines changes in population by racial group for comparable geographies in 2000 and 2010. In a regional analysis of the fifty most populous MSAs in 2010, we find strong evidence that growing areas in rapidly growing metropolitan areas of the United States are crucial to understanding regional

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differences in segregation that have emerged in recent decades. Our results show that segregation saw the greatest decline in these areas in each region of the U.S., especially in the South, which saw the largest population increase between 2000 and 2010.

Following Watson (2006), we also find that growing parts of stagnant, slow-growth metropolitan areas see less integration occurring, and that many of these places could be extending segregation through selective entry to growing areas. These findings suggest that residents of declining metropolitan areas, regardless of local and neighborhood changes, face the greatest obstacles to integration. Our results for local areas of population decline are harder to interpret, but are interesting. We find that shrinking parts of metropolitan areas were the most diverse across U.S. regions in both 2000 and 2010. Their diversity increased moderately, and their segregation generally declined the slowest compared to areas with stable and growing population counts. More work is necessary to understand what kinds of places these are by studying the social and built characteristics at the beginning and end of the process of decline. Could these be parcels of concentrated poverty left behind by people seeking better neighborhoods? Or do small-scale declines reflect other systematic processes, such as neighborhood-scale cohorts and resulting trends in fertility, mortality, or outmigration?

These findings warrant further analysis and discussion, and there is an enormous body of work on residential integration and diversity that must be reconciled with. For example, a recent review has shown that concepts and measures of diversity in the social science literature have changed over the decades (Sin and Krysan 2015). Our study is successful in its broad conceptualization of diversity across racial groups and multiple

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scales. However, our use of the Theil Index means our measure of diversity is usually blind to which groups are actually integrating. For example, one key debate in the field surrounds the lagging of black-white integration relative to blacks and other groups (Sin and Krysan 2015). A key study that disentangles these patterns of group co-residence finds that black integration with whites generally happens in areas where other minority groups are already present (Logan and Zhang 2010).

Such a focus is an important next step for this research. It will be important to uncover patterns in where certain immigrant groups are able to enter growing parts of metro areas, and which groups these processes actually bring different groups together. Our methodological focus on tracking small-scale changes in racial groups has many applications for other targeted analyses as well. We see three avenues this approach could particularly help. The first is to further explore any connections between racial segregation and housing construction at a small geographic scale. Our methodological approach could easily extend to block level housing data, and provide cross-sectional data on raw housing counts for 2000 and 2010 for the same geographic units as the data in this study. This data would help us understand how the metropolitan level patterns of integration and new construction first identified by Farley and Frey (1994) manifest at small scales. Another avenue of research could be to examine the spatial dependence of changes in groups relative to the presence or changes of other racial groups. For instance, Table 1 shows that whites are leaving areas with stable overall populations in greater numbers than areas with declining populations, indicating that members of minority groups take their place. Our dataset is based on the same scale as data used in recent

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developments for measuring spatial segregation (O'Sullivan and Wong 2007; Lee et al 2008; Östh, Clark, and Malmberg 2015), and could be incorporated into the same frameworks to address such questions. These methods are able to address the local environment of areal units and their arrangement in space, which the methods presented in this study are unable to examine. Third, while our data does not include information on income, it could supplement projects interested in the interactions between segregation by race and income. Indeed, these data and methods seem very applicable to many different spatial data sources, particularly sources created through computational and data-mining techniques that do not have other kinds of social contextual information, particularly small-area racial compositions or population change.

This descriptive analysis contributes to the literature by further exploring how segregation patterns respond to population changes at micro and macro scales. We do not claim that variation in population change is the only important source of differences in segregation dynamics, particularly at the metropolitan level. We report positive correlations between large and small-scale changes of these variables for the MSAs presented, but the observed relationships are not large enough to show that this is the only process that influences declines in segregation. Segregation is both a contemporary and historical phenomenon, so recent information alone will never be able to fully explain its patterns. Further work will need to be done to find a more complete description for how metropolitan growth trends are related with changes in segregation.

New housing construction and population growth have been consistently linked with declines in segregation. Our results support this by connecting population growth

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with declining segregation at small scales, most notably in growing regions. We successfully extend Watson's (2006) hypothesis of income segregation to racial segregation, and we hope that new analyses of the interactions between these two kinds of segregation follow. This paper also addresses population decline and segregation at a local scale, a woefully under-researched topic. These questions cut across disciplines in the social sciences, and require an integrated approach across scales and regions. The United States, like many countries, is facing a demographic transition that will define individual and environmental outcomes far into the future, and we believe that decisions pertaining to urban planning and economic processes can improve these outcomes for everyone. We hope this project will encourage new research and debate on the co-evolution of the social and built environments of cities around the world.

Notes

1. The MSAs included in our analysis are: Atlanta, Austin, Baltimore, Birmingham, Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Denver, Detroit, Hartford, Houston, Indianapolis, Jacksonville, Kansas City, Las Vegas, Los Angeles, Louisville, Memphis, Miami, Milwaukee, Minneapolis, Nashville, New Orleans, New York, Oklahoma City, Orlando, Philadelphia, Phoenix, Pittsburgh, Portland, Providence, Raleigh, Richmond, Riverside, Sacramento, Salt Lake City, San Antonio, San Diego, San Francisco, San Jose, Seattle, St. Louis, Tampa, Virginia Beach, and Washington, DC.

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