

Characterizing clusters of gentrification in metro Atlanta, 2000 to 2016

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ABSTRACT

Gentrification can drive residential displacement and exacerbate social inequities; however, no consensus about such impacts exists because gentrification definitions vary, and methods lack spatial statistics. Here, gentrification scores were calculated for census tracts in the Atlanta metropolitan area, 2000–2016. Spatial autocorrelation of gentrification was assessed, and spatial cluster detection identified hotspots and coldspots of gentrification. Sub-analyses evaluated the impact of time period (before/after 2010) and conceptualization of gentrification (purely economic changes or a combination of changes in economic, racial, and age composition) on the size and location of clusters. Extreme gentrification occurred around downtown Atlanta, while southern and eastern reaches experienced economic decline and decreases in older and non-Hispanic White residents. Leveraging spatial statistical analysis and examining gentrification hotspots across metrics, this study establishes critical understanding of historic gentrification in Atlanta and lays the groundwork to further examine gentrification's impact on the wellbeing of residents and communities to inform urban planning decisions to advance equity.

1. Introduction

Gentrification, a term coined in 1964, has long been identified as a force of change in urban landscapes (Glass, 1964), but it has garnered new attention in the 21st century as cities experienced a wave of renewed interest and reinvestment after an extended period of emigration in the 1900s (Baum-Snow & Hartley, 2020; Birch, 2009; D.; Hyra, 2015; Sturtevant & Jung, 2011). Despite continued research and recent attention paid to gentrification, debate persists about policies which shape redevelopment and the economic and social benefits and consequences to new versus longstanding community members.

Generally it is well documented that due to processes of structural racism, predominantly Black and Latinx urban communities have historically suffered from being under-resourced (Anguelovski, 2015; Bonam et al., 2020; Massey, 2012). Many of those communities have become sites of redevelopment projects which invest in restoring infrastructure and boosting economic prosperity. However, when investment is tied to an influx of affluent (and often predominantly White) households and is associated with changes in the housing market that increase housing costs, questions of whether gentrification can exacerbate or alleviate existing social, economic, environmental, and health

inequities are raised.

Does gentrification trigger residential displacement, resulting in instability for those forced to relocate? Do remaining residents suffer from loss of political/social power or benefit from improved access to amenities, education, employment? Research has reported both negative (Elliott-Cooper et al., 2020; Gibbons, 2019; Gibbons & Barton, 2016; Mehdipanah et al., 2018) and positive health impacts (Brummet & Reed, 2019, p. 55; Gibbons et al., 2018), but agrees that impacts often vary by race/ethnicity, age, or income (Bhavsar et al., 2020; Ellen & O'Regan, 2011; McKinnish et al., 2010; Vigdor, 2002). The lack of consensus on how gentrification influences existing social disparities, public health, and resource access may result from variation in how gentrification has been defined. Therefore, it is essential to understand how measures of gentrification have differed when interpreting results across multiple studies, and it is crucial to describe gentrification according to different definitions *prior* to analyzing and interpreting associated outcomes. This research, studying gentrification as a process of changes in the economic, racial and age distribution of an area, accomplishes this task in Atlanta 2000–2016.

A recent systematic review of gentrification literature identifies three categories of conceptualization: 1) Increases in economic and social

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status 2) political conflict and urban restructuring 3) stages of gentrification. The majority of gentrification analyses, and this study, focus on how population characteristics of a neighborhood change over time, specifically as it experiences an influx of people in more economically and socially privileged positions. This framework aligns with examining residential displacement of the original residents, presumed to be of a less privileged economic class and/or social position. At the center of the second conceptualization of gentrification is power – who is granted power in controlling land and the decisions over what happens to the land, with wealthy and White people beholding this power. The last framework for characterizing gentrification involves classifying stages. Given a starting point in time and neighborhood initial conditions, areas are designated as eligible for gentrification (“gentrifiable”) according to preset characteristics. Metrics then define when an area is stable, actively in the process of “gentrifying” or has reached the end of its lifecycle, “gentrified”, which may vary over time according to type and degree of demographic changes (Tulier et al., 2019).

Across these conceptualizations, the role of race/ethnicity and age in gentrification has been questioned, with some scholars arguing that gentrification should be defined purely by changes in economic affluence and not race/ethnicity, age, or other demographic characteristics. Others argue that race/ethnicity is an important marker of gentrification above and beyond the influence of economic processes, given the manner in which the racialized housing system values White property owners and leasers over their counterparts of color (Anderson & Sternberg, 2013; Betancur, 2002; D. S.; Hyra, 2006; Krieger et al., 2020; Lasner, 2020). Investment in infrastructure, a precedent and product of gentrification, is tied to the racial/ethnic make-up of cities, with predominantly Black and Latinx communities often disproportionately burdened by divestment until earmarked for revitalization and/or is characterized by the in-migration of predominantly White middle-to-upper class residents (D. Hyra, 2015; Marcuse, 1985). Furthermore, gentrification in many U.S. cities, which often takes hold in predominantly Black and Latinx communities, has been characterized by high rates of outmigration of Black and Latinx residents who are involuntarily displaced due to inflated housing costs and eviction or voluntarily relocate due to changes in commercial and cultural climates (e.g., closure of amenities and cultural institutions), racial discrimination, and sense of “exclusion from the ever-growing predominantly White spaces” (Holt et al., 2020; Richardson et al., 2019; Versey, 2018). Likewise, age can be critical to narratives around gentrification as young urban professionals (termed ‘yuppies’) are recognized as a privileged group driving the demand and renewed interest in urban spaces (Glow et al., 2014; Lee et al., 2019; Sturtevant & Jung, 2011). Together, race/ethnicity and age are non-economic factors that can be used to distinguish between gentrification which occurs as a solely economic process versus an economic *and* non-economic process. This work conducts analysis with gentrification metrics both excluding and including race/ethnicity and age to understand the implications of this disagreement.

In addition to divergent definitions of gentrification, gaps in the gentrification literature lie in methodological approaches to exploring its spatial dynamics. First, many studies limit their analysis to one city or county and ignore nearby areas that may experience ‘spillover’ gentrification effects within the same broader metropolitan area (e.g., neighbors with similar or opposing trends help explain the focal process). Still, studies with broader spatial extents often characterize gentrification of geographic units as independent and fail to account for the similarity in the gentrification process between neighboring geographies. While they describe spatial variation, classify trends based on location or use proximity to define exposure or outcomes, the methods do not account for neighborhood structure of gentrification in their statistical analysis.

This work advances research on gentrification and addresses gaps in the literature by (1) applying methods of spatial statistics to assess geographic trends and potential hotspots of gentrification across a large

metropolitan area, Atlanta, GA (2) examining gentrification over varied time periods within the metropolitan area and (3) investigating how areas identified as highly gentrified compare when the gentrification metric includes changes in race/ethnicity and age versus exclusively economic changes. Atlanta (ATL) recently ranked 4th among U.S. cities with the highest rates of gentrification (Brummet & Reed, 2019, p. 55), but is relatively understudied compared to other gentrifying cities (NYC, Chicago, LA, SF). This fact, compounded with an understanding that southern cities have a distinctly different history of segregation, urbanization, and economy than cities elsewhere, warrants the need for specific attention and systematic evaluation of gentrification in the ATL metropolitan area (McDonald, 2013, p. 376529; Yonto & Thill, 2020). This paper provides new insights to methods for studying gentrification, lays the groundwork for follow-up analysis of the impacts of gentrification on socioeconomic, health, and environmental conditions, and guides the development of place-based responses to gentrification.

2. Methods

2.1. Overview

Spatial analysis describes geographic trends in gentrification, including spatial autocorrelation and hotspot analysis, for census tracts across the Atlanta metropolitan area. The metropolitan area includes 632 tracts in five core counties: Clayton, Cobb, Dekalb, Fulton, and Gwinnett.

2.2. Gentrification measurement

Informed by prior research (Abel & White, 2011; Hammel & Wyly, 1996; Huynh & Maroko, 2014; D.; Hyra, 2015; Linton et al., 2017; Maciag, 2015), this research conceptualizes gentrification as a change in the economic, racial, and age composition of an area such that the community experiences not only an increase in economic privilege, but may also experience an increase in other markers of privilege, including Whiteness and youth. A variety of neighborhood variables are compiled into a single gentrification score representing the overall degree of gentrification in each geography between two time points. Principal component analysis (PCA) is a common data reduction technique used to create indices that summarize the total area-level variance explained by a large number of indicators. While used to summarize economic disadvantage in several studies (Genberg et al., 2011; Linton et al., 2014, 2017; Messer et al., 2006; Rojas et al., 2021; Walker et al., 2020), few studies have specifically used PCA to develop indices of gentrification.

Census tract economic and other demographic data, including race/ethnicity and age, were acquired from the 2000 Geolytics Neighborhood Change Database, 2010 U.S. Census Bureau Decennial Census, and 2016 U.S. Census Bureau American Community Survey (ACS) 5-year estimates. Seven variables were included as part of the gentrification score: 1) percent of non-Hispanic (NH) White residents 2) percent of residents aged 25–34 years old 3) percent of residents that were *not* in poverty (reversed from percent in poverty value to align with other inputs such that higher value indicates more privilege) 4) percent of residents working in professional occupations 5) median gross rent 6) median house value 7) median household income in the past 12 months. Median gross rent, median house value and median household income were adjusted for inflation to 2016 dollars. Rent and home value were capped at two thousand and one million dollars, respectively, in accordance with 2000 census methodology.

Other variables included in prior literature as indicators of gentrification—percent of college graduates out of adults >25 years old, percent of owner-occupied housing units, and percent of nonfamily households—were not included in this index because of low loadings (<0.3) on the first principal component.

A gentrification score was calculated by summing the standardized percent change between time 1 (t1) and time 2 (t2) for all indicators. A

positive value for any indicator identified a change greater than the metro-wide trend and stronger relative gentrification. After taking the sum of all indicators, the composite gentrification scores were standardized (z-scores) again so that a score of 0 represents average gentrification for the entire study area. To establish interpretable gentrification scores when indicator values at t1 and t2 both equaled zero, 0 was imputed to reflect no change. When indicator values equaled zero at t1 but were non-zero at t2, a small number was imputed (1 added to each value) so that the positive change in given gentrification component would be counted. If an indicator was missing in either t1 or t2, the percent change was NA. Composite gentrification scores were calculated ignoring missing data so long as the majority of the indicators of gentrification (at least four out of seven) were not missing.

Gentrification scores using the 7 indicators were first calculated for 2000–2016. Next, to more closely examine population and economic trends in early versus later stages of gentrification, scores were calculated for two sub-periods, 2000–2010 and 2010–2016. Additionally, to test the degree to which an economic-centric definition of gentrification compared to a definition where economic measures, race/ethnicity and age were included, gentrification scores were re-calculated excluding race/ethnicity and age as indicators—thus, a 5-indicator score. In total, six unique gentrification scores were generated for census tracts in the Atlanta metro area: (1) 7-indicator score 2000–2016 (2) 7-indicator score 2000–2010 (3) 7-indicator score 2010–2016 (4) 5-indicator score (excluding race/ethnicity and age indicators) 2000–2016 (5) 5-indicator score 2000–2010 (6) 5-indicator score 2010–2016. In results and discussion race/ethnicity is often referred to as ‘race’ for concision, but always refers to the indicator for non-Hispanic White population.

2.3. Descriptive spatial analysis

A choropleth map displays the spatial distribution of observed gentrification 2000–2016 (7-indicator score) in the Atlanta metro area. Moran’s I correlograms quantify the degree of spatial autocorrelation, the extent to which neighboring (bordering) tracts have similar degree of gentrification than non-neighboring tracts. Monte Carlo simulations were used to determine the confidence interval for Moran’s I estimates.

2.4. Cluster detection analysis

Six spatial cluster detection analyses were conducted via SaTScan (www.satscan.org) to identify contiguous census tracts which had significantly high and low gentrification scores across varying time periods and conceptualizations of gentrification (six scores as listed in Section 2.2).

SaTScan, a statistical scan software for cluster detection analysis, is a widely accepted and applied method across various disciplines, most notably health but also social science research (Margai & Henry, 2003; Montrone et al., 2009; Trangenstein et al., 2020). SaTScan uses a radial moving window of increasing size to test all locations (census tract centroids) which may geographically represent a potential cluster. For each window (potential cluster) the mean gentrification score inside the window is compared to that outside the window using statistical likelihood ratio methods. Because gentrification scores were continuous values, the Normal model was used in SaTScan with follow-up Monte Carlo methods to determine significance of each potential cluster (those with the highest likelihood ratio) (Kulldorff et al., 2009). Significance level of 0.05 was used to report significant clusters of high values (“hotspots”) and low values (“coldspots”) of gentrification, and the maximum cluster size was preset to 50% of the observations (census tracts) in the study area. For each analysis, characteristics of the hotspots and coldspots of gentrification were described and consistent labeling (i. e. Hotspot, Coldspot 1, Coldspot 2) refers to clusters detected in comparable relative locations across analyses. Identified clusters were further characterized by summarizing information about the indicators of gentrification for all tracts within clusters relative to the rest of the

area.

Hotspots and coldspots were mapped, and the 7-indicator gentrification score from 2000 to 2016 served as the reference to which subsequent variations of the gentrification score were compared. While hotspots of gentrification are understood as places with evident growth and investment, the interpretation of coldspots as the “opposite of gentrification” is less straightforward. Statistically, coldspots are detected where the composite gentrification scores of contiguous tracts were significantly lower than the rest of the Atlanta; this implies they experienced overall economic and other population changes which were below the metro-wide trends. In most instances, this means a decline in income, home values, rent, professional jobs, etc. although it is possible there were modest increases in certain characteristics but only such that the composite score was still relatively substantially lower.

Five tracts were removed from all analyses—one which houses DeKalb County Jail, one the Atlanta Penitentiary, and three which had zero population recorded in 2016. During the imputation process to correct for non-real values in percent change calculations, some high outlying values for gentrification were introduced. Outliers, defined as tracts with gentrification scores over 3 (3 standard deviations above the mean), were removed in the cluster detection analyses, as suggested in SaTScan methodology (Kulldorff, 2018). The primary analysis, identifying gentrification clusters 2000–2016 using seven indicators, included 615 census tracts. For illustration purposes, if an outlier was located entirely within a cluster (all neighboring census tracts are identified as part of a single hotspot or coldspot) it was visualized as being a part of that cluster.

2.5. Sensitivity analyses

Because the gentrification scores varied by analysis (7- versus 5-indicator score, total time period versus two sub-time periods), the total number of observations varied from 613 to 621 census tracts, as reported in Figure captions. Sensitivity analyses tested the influence of the outlier exclusion by re-running all analyses without outliers removed, reported in Appendix.

3. Results

3.1. Atlanta trends and distribution of gentrification

From 2000 to 2016, total population in the Atlanta metro area (for 615 tracts of the primary analysis) increased by 24%. That growth, however, did not occur evenly across neighborhoods as, on the extremes, one census tract experienced a 64.7% decrease while another experienced a 439.7% increase in population (Table 1). As further summarized in Table 1, with the exception of the percent of population in professional occupations and median rent, all indicators of gentrification saw an average decline across census tracts from 2000 to 2016.

Fig. 1 maps gentrification, showing geographic variation across the 5-county Atlanta metropolitan area and indicating that downtown experienced substantial gentrification from 2000 to 2016 relative to the rest of the area. Specifically, most of the highly gentrifying tracts (scores >1, dark red in Fig. 1) are located within the Atlanta city limits (outlined in yellow), with much of the gentrification in or neighboring the Atlanta Beltline Development Area. Meanwhile, areas with lower gentrification were located in the east-northeast and southern-most tracts, partially DeKalb and Gwinnett and Clayton counties. Across ATL census tracts, gentrification was significantly spatially autocorrelated, as measured with Moran’s I correlogram whereby neighboring tracts reported more similar gentrification scores than non-neighboring tracts (Figure A1). This was true over a large area as significance held through 6 spatial lags (neighbors of neighbors 6 times over).

Table 1

Summary statistics for indicators of gentrification, 2000–2016, and percent change over time for census tracts in the Atlanta 5-county metro area (n = 615).

Census Tract Variable	Minimum	Mean (Median)	Maximum
Total Population (count)			
2000	1088	4677.9 (4629)	7997
2016	1159	5781.3 (5294)	25316
Percent Change	−64.7	24.6 (11.4)	439.7
Total Households (count)			
2000	246	1743.3 (1768)	3640
2016	346	2088.5 (1971)	7287
Percent Change	−64.8	21.7 (9.0)	361.9
NH White Population (%)			
2000	0	50.7 (58.2)	96.2
2016	0	38.5 (36.5)	96.6
Percent Change	−100	−2.5 (−25.9)	1175.0
Population Aged 25–34 (%)			
2000	4.5	19 (17.1)	46.6
2016	2.5	16.1 (14.5)	50.6
Percent Change	−82.4	−13.3 (−16.5)	128.2
Population Not in Poverty (%)			
2000	32.7	89.1 (92.6)	100.0
2016	12.5	82.4 (85.6)	99.5
Percent Change	−61.8	−7.4 (−5.6)	66.2
Population in Professional Occupations (%)			
2000	6.1	39.3 (38.8)	74.6
2016	1.3	41.4 (39.4)	82.3
Percent Change	−80.1	9.4 (4.3)	260.9
Median Income (2016 USD)			
2000	16,297	78,794 (71,758)	245,893
2016	6815	64,123 (57,422)	187,750
Percent Change	−60.1	−18.1 (−22.8)	154.5
Median Rent (2016 USD)			
2000	0	1165 (1154)	2000
2016	469	1132 (1082)	2000
Percent Change	−38.3	0 (−6.6)	147.4
Median Home Value (2016 USD)			
2000	0	232,489 (193,382)	1,000,000
2016	10,500	207,134 (163,350)	1,000,000
Percent Change	−91.2	−14.3 (−16.6)	97.5

3.2. Cluster detection analysis

Cluster detection analyses confirmed that, from 2000 to 2016, extreme gentrification, relative to the entirety of the 5-county Atlanta metropolitan area, occurred in the most historically developed and population dense tracts around downtown Atlanta (Fig. 3). The average gentrification score for the hotspot (n = 68) was 0.97, and 6% of the total metropolitan population resided in the hotspot of gentrification (Fig. 2A, Table A1). As expected, mean (and median) percent changes from 2000 to 2016 in indicators of gentrification are significantly higher in gentrification hotspots and significantly lower in gentrifying coldspots as compared to the entire Atlanta metro area (Table 2). The hotspot experienced average *increases* in income (12%), rent (23%), home value (2%), Non-Hispanic White population (144%), young adult population (8%), percent of population not in poverty (2%) and in professional occupations (51%). This deviated from metro-wide changes (−18%, −0%, −14%, −3%, −13%, −7%, 9%, respectively).

Two coldspots of gentrification, illustrated in blue, were identified with Coldspot 1 in the eastern metro area across Gwinnett and DeKalb counties and Coldspot 2 located south of the downtown area, and largely encompassed by Clayton County. These areas experienced a magnitude of mean gentrification of −0.52 and −0.68 across 138 and 46 tracts, respectively, and together include 34.0% of the total Atlanta metro population (Fig. 2A, Table A1). In contrast to hotspot trends, Coldspot 1 showed *decreases* of 32% in income, 8% in rent, 25% in home value, 45% in the NH white population, 15% in young adults, 12% not in poverty, 10% professionally employed. Coldspot 2 similarly experienced *declines* across all indicators of gentrification, in corresponding order: 33%, 7%, 40%, 65%, 15%, 17%, 8%.

3.3. Sub-analysis: variation in time

In sub-analysis of the gentrification process earlier (2000–2010) versus later (2010–2016), hotspots of gentrification partially spatially coincided and had relatively similar mean gentrification scores (0.61 in 2000–2010 and 0.47 in 2010–2016), but the number of census tracts in the hotspot increased from 100 to 143 and the center shifted northward (Fig. 2B and C). In both time periods, the eastern coldspot (Coldspot 1) straddled Gwinnett and DeKalb counties with similar levels of gentrification, −0.42 and −0.49, but shrank in size from 178 to 122 tracts; 118 tracts were included in the coldspot of both timeframes, all of which fall within Coldspot 1 identified over the total period of interest, 2000–2016. A cold spot in Clayton County (corresponding with Coldspot 2) was not detected during the 2000 to 2010 timeframe, but was identified during the 2010 to 2016 timeframe, and was larger in size than Coldspot 2 found in Clayton County during the entire study period of interest. The calculated changes in gentrification indicators in these areas are provided in the Appendix (Table A2).

3.4. Sub-analysis: variation in gentrification conceptualization

In the Atlanta metro area, the inclusion of race/ethnicity and age in the gentrification score did not have a significant impact on classification of hotspots and coldspots of gentrification over the total time period, 2000–2016 (Fig. 3A). Ninety percent of tracts in hotspot and 100% of tracts in coldspots in cluster detection using the 7-indicator gentrification score were identified in the clusters using the 5-indicator gentrification score. The mean gentrification scores in identified clusters were higher (both hot and coldspots) when race and age were included in the analysis, though the magnitude of difference was greater (relative to coldspot comparison) between the hotspot of the 7-indicator gentrification score compared to the hotspot of the 5-indicator gentrification score.

When considering temporal sub-periods, the results for the full gentrification score versus that without race and age varied more substantially (Fig. 2B and C versus Fig. 3B and C). As compared to the 2000–2010 hotspot for the 5-indicator gentrification score, the 2000–2010 hotspot for gentrification including race and age (7-indicator) is larger (100 versus 70 tracts). In contrast, as compared to the 2010–2016 hotspot for 5-indicator gentrification score, the 2010–2016 7-indicator gentrification hotspot is smaller (143 versus 283 tracts). When comparing coldspots, the 2000–2010 5-indicator gentrification coldspot encompassed 166 tracts that accounted for 90% of the 2000–2010 7-indicator gentrification coldspot. However, comparing the 2010–2016 5-indicator gentrification coldspots to the 2010–2016 7-indicator gentrification cold spots, Coldspot 2 was identical, but Coldspot 1 was smaller, encompassing fewer census tracts of Gwinnett County (Table A1).

3.5. Sensitivity analysis

In cluster detection analyses including outliers with high gentrification scores (n = 627), no coldspots were significant for the full 7-indicator gentrification score and just one coldspot (Coldspot 1) was significant in the 5-indicator gentrification score. Details of change in these areas are provided in the Appendix (Table A.3).

4. Discussion

This study applied spatial cluster detection analysis to investigate areas of extreme gentrification in Atlanta and determine how geographic patterns of gentrification vary by time and if race and age are included in measuring gentrification. Findings from this study suggest that measurement of gentrification has particular nuance that must be described prior to investigating how gentrification impacts resource access and resident wellbeing. Results showed that gentrification in

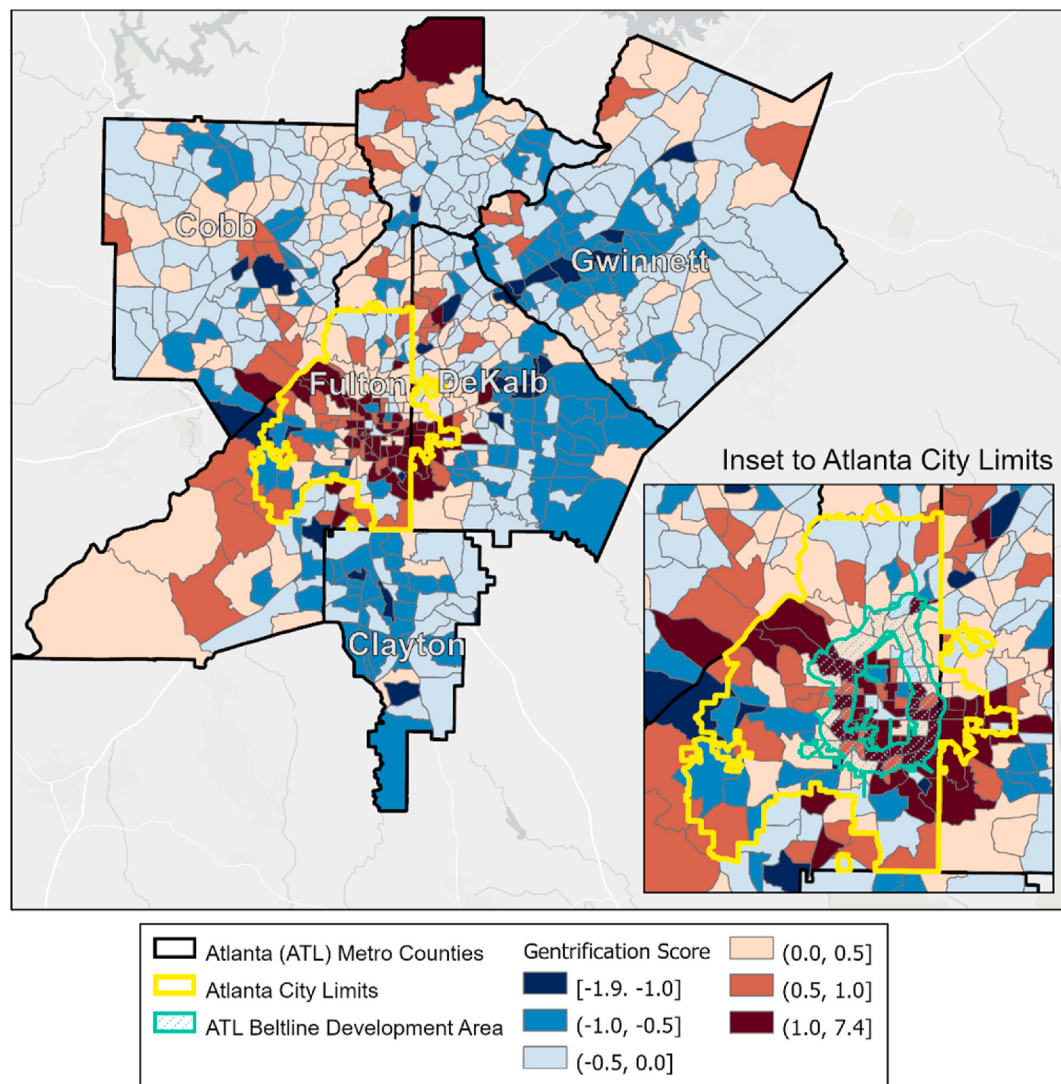


Fig. 1. Spatial variation of gentrification across 627 census tracts in the five-county Atlanta metropolitan area.

Atlanta exhibited strong spatial autocorrelation, such that the magnitude of gentrification in one tract was similar to the magnitude of gentrification up to 6 tracts away. A single hotspot of gentrification was consistently located in the center of the Atlanta metro area, regardless of variation in the gentrification measure. The size of the hotspot, however, varied by time period and race/ethnicity. In contrast, size and location of gentrification coldspots varied by time period and whether race/ethnicity and age were included in the gentrification measure.

The strong spatial autocorrelation of gentrification suggests that gentrification wasn't limited to few and/or scattered neighborhoods, and the urban change occurring in certain swaths of the city substantially differed from elsewhere in the metropolitan area. These findings, measuring neighborhood similarity and employing spatial cluster detection analysis which inherently considers neighborhood structure, support extending current research methods beyond those that examine gentrification without regard to spatial autocorrelation and treat spatial units as independent. By identifying contiguous tracts of statistically extreme gentrification relative to the rest of the study area, cluster detection analysis enables investigation of changes in relative advantage/disadvantage and potential major migration patterns.

From 2000 to 2016, spatial variation of gentrification was evident, with most substantial gentrification taking place in and around downtown Atlanta in Fulton County and in East Atlanta neighborhoods in DeKalb County. The hotspot of gentrification centered across census

tracts that now feature commercial, residential, public places, green space, and tourist attractions, such as the Atlanta BeltLine—a former railway line that has been transformed into a multi-use trail—but prior to the 1990s experienced an out-migration of business and population (Birch, 2009; D. S.; Hyra, 2012; Lee et al., 2019; Sturtevant & Jung, 2011).

There has been contentious debate over business and residential development in many areas in the gentrification hotspot of this study, especially in neighborhoods which were historically, predominantly Black (Lasner, 2020; Martin, 2007; Park & Kwan, 2018). In the BeltLine Development Area, conceived as a strategy for transit growth which prioritized reduction in automobile use and improved access to green-space, housing, and transit, concerns about meeting equity and affordable housing goals have been raised due to construction of higher income residential and commercial properties in the area (Gravel, 1999; Kinney, 2016; Newman, 2017). Disagreement over the quality of impact of this development, and that of other revitalization strategies in Atlanta, plays out across lines of race, wealth, and power; similar narratives around conflicting priorities and inequitable burden between population groups have been evidenced in other gentrifying cities (Betancur, 2002; Gottlieb, 2019; Shinault & Seltzer, 2019).

Environmental gentrification describes gentrification incited by development of greenspace or outdoor amenities and climate gentrification refers to residential displacement prompted by changes in

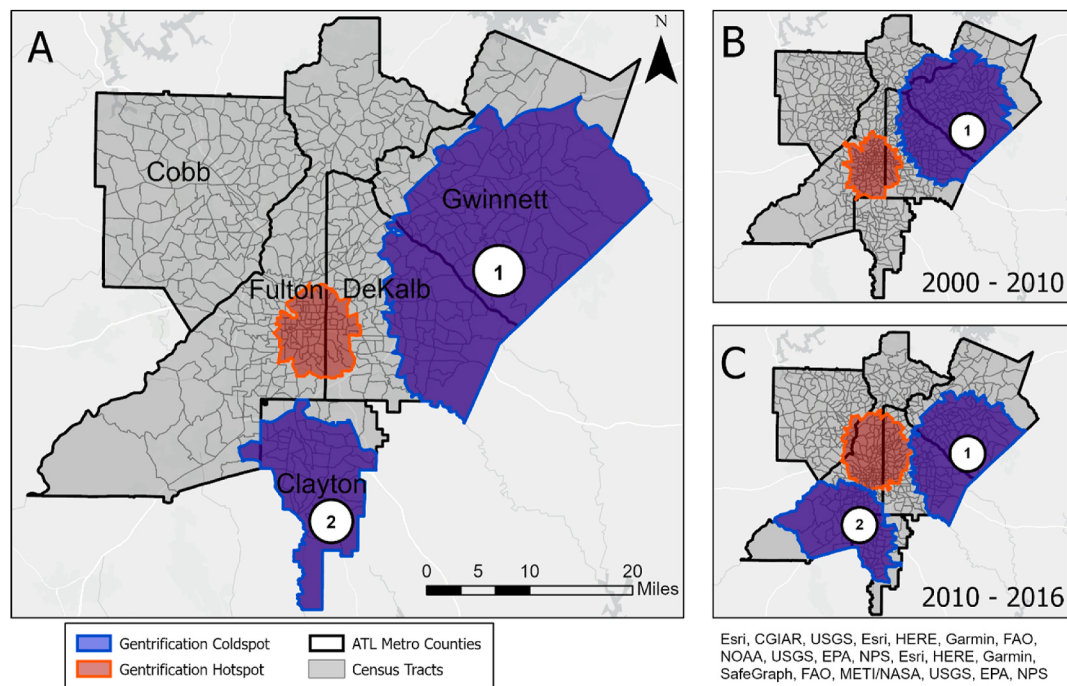


Fig. 2. Clusters of gentrification (7-indicator score) in Atlanta metro area from (A) 2000–2016 (N = 615) (B) 2000–2010 (N = 613) and (C) 2010–2016 (N = 618). Coldspot labels refer to clusters detected in comparable relative locations across analyses.

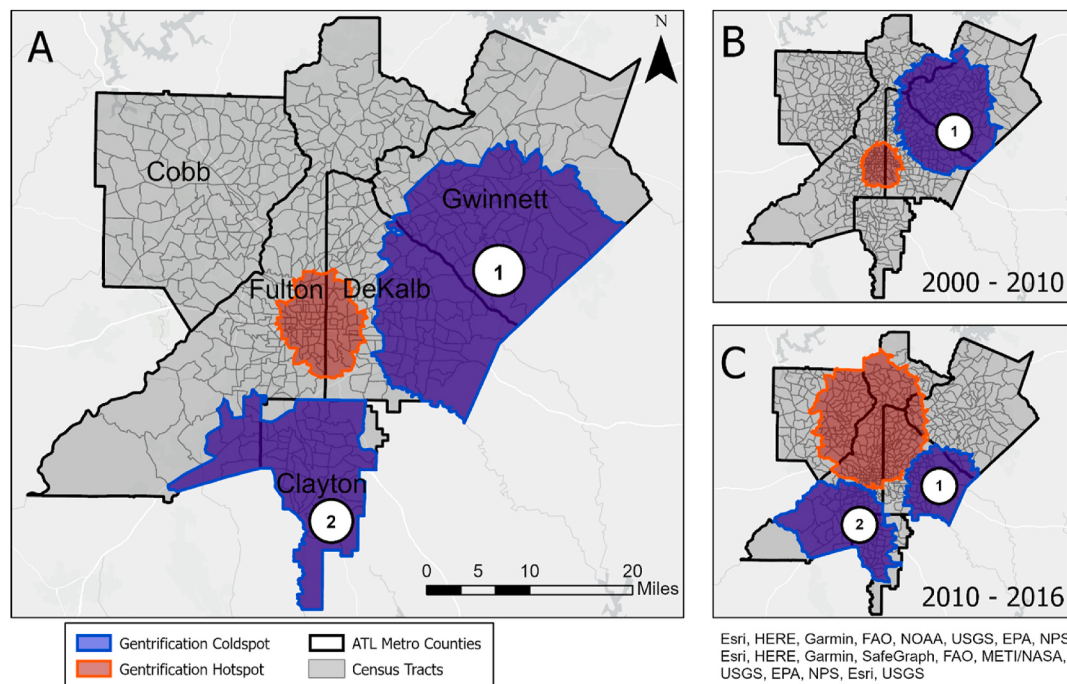


Fig. 3. Clusters of gentrification using scores excluding race and age (5-indicators) in the Atlanta metro area from (A) 2000–2016 (N = 614) (B) 2000–2010 (N = 618) and (C) 2010–2016 (N = 621). Coldspot labels refer to clusters detected in comparable relative locations across analyses.

extreme weather, vulnerable infrastructure, property valuation, etc. due to climate change (Abel & White, 2011; Aune et al., 2020; Crompton & Nicholls, 2019; Rice et al., 2020; Rigolon et al., 2019; G. S.; Smith & Thorpe, 2020; Weber et al., 2017). More broadly, R  rat and Lees (2011) use the term “spatial capital” to describe locational advantages which are an important, though too often overlooked, component causing gentrification. Though this study design was not established to directly evaluate gentrification caused by the BeltLine or other specific

developments, results from this research point to the need to examine improved greenspace as a desired asset and instrument of change. At present, the dynamics of urban change captured in greater Atlanta serve as a resource for stakeholders who seek to summarize large scale trends or to target areas for additional, localized study.

Prior literature has identified reasons *why* gentrification occurs where it does when perhaps there are multiple alternative viable “gentrifiable” areas within the metropolis. Supply-side forces like the rent

Table 2

Mean (and median) percent change in indicators of gentrification in clusters of significant high and low gentrification from 2000 to 2016, describing results in Figs. 2A and 3A.

	ATL Metro (Table 1)	7-Indicator Gentrification Score (Fig. 2A)			5-Indicator Gentrification Score, without age & race (Fig. 3A)		
	Total	Hotspot	Coldspot 1	Coldspot 2	Hotspot	Coldspot 1	Coldspot 2
Tracts	615	68	138	46	74	132	57
Total Population	24.6 (11.4)	15.2 (7.0)	35.4 (17.3)	14.7 (11.5)	14.9 (8.5)	27.9 (12.2)	16 (12.2)
Total Households	21.7 (9.0)	20.8 (5.3)	29.7 (12.3)	8.9 (8.4)	22.9 (6.6)	22.9 (9.4)	10.7 (8.2)
NH White Pop	-2.5 (-25.9)	144.2 (37.5)	-45.4 (-46.4)	-65.1 (-66.8)	127.7 (16.6)	-43.5 (-46.8)	-59.8 (-63.7)
Pop Aged 25–34	-13.3 (16.5)	8.2 (3.5)	-15.4 (-16.7)	-15.0 (-16.4)	6.2 (2.9)	-13 (-14.4)	-12.8 (-15.6)
Pop Not in Poverty	-7.4 (-5.6)	2.0 (0.3)	-11.9 (-10.5)	-17.1 (-17.6)	0.1 (-0.1)	-12.3 (-11.0)	-16.6 (-17.1)
Pop in Professional Occupation	9.4 (4.3)	50.9 (35.3)	-10.4 (-11.4)	-8.2 (-10.8)	51.7 (26.7)	-8.5 (-8.0)	-2.8 (-8.6)
Median Income	-18.1 (-22.8)	11.7 (5.3)	-31.9 (-33.6)	-33.0 (-33.7)	9.6 (4.9)	-32.4 (-34.0)	-32.1 (-32.8)
Median Rent	0.0 (-6.5)	23.3 (15.1)	-8.1 (-13.2)	-7.4 (-12.6)	20.0 (12.2)	-9.7 (-13.5)	-7.6 (-12.5)
Median Home Value	-14.3 (-16.6)	2.0 (-1.2)	-24.8 (-26.6)	-40.3 (-38.1)	0.6 (-1.4)	-25.4 (-27.2)	-38.3 (-37.8)

gap theory (Hammel & Wyly, 1996; Heidkamp & Lucas, 2006; Slater, 2017; N.; Smith, 1987) versus demand-side forces, in the form of business development or lifestyle aspirations (Borén & Young, 2017; Glow et al., 2014; Ley, 1986, 2003), have been posited as explanations. Others argue there is a positive feedback loop between supply and demand forces wherein, developers ensure there is sufficient market for their product before they invest (Hamnett, 2017; Timberlake & Johns-Wolfe, 2017). Research particularly in European cities, has related proximity to city center to changes in income/wealth status of households in the process of classifying why gentrification and migration may vary based on the type/structure of the economy in a given city (Musterd et al., 2020). Results presented here show the Atlanta central business district as highly gentrifying, and renewed interest in and relocation to the historic “inner-city” of Atlanta by largely wealthy, educated, professional, White young people supports a trend common in “renewal” narratives in other cities over a similar time period (Baum-Snow & Hartley, 2020; D.; Hyra, 2015; Su, 2019). Simultaneously, the location of coldspots may support the “suburbanization of poverty,” a trend which can run, and has been studied, in parallel with gentrification as households with lower economic status and/or households that are not predominantly White concentrate in city peripheries (Bailey & Minton, 2018; Hochstenbach & Musterd, 2018, 2021; Kavanagh et al., 2016).

From 2000 to 2016, gentrification coldspots, characterized by declines in economic status and residents who were not NH White were detected among 184 census tracts in the eastern and southern regions of the metropolitan area. Based on prior reporting including our own qualitative work (unpublished), these findings suggest these peripheries may be where people who have been displaced by gentrification have relocated. However, we interpret this hypothesis cautiously, as one must bear in mind that aggregate characteristics of neighborhoods may shift due to resident turnover in the area or via economic upgrading of existing residents – or a combination of the two. Indeed, evidence has shown distinct experiences between in-migrants, out-migrants, and non-migrants (Hochstenbach et al., 2015; Teernstra, 2013). For example, patterns observed, like Coldspot 1, could indicate areas simultaneously experiencing high migration and conditions that limit communities’ upward mobility like a lack of jobs and transit access (Adelman & Jaret, 2010; Rose, 2018; Semuels, 2015). Finally, as we discuss residential displacement, we may also identify the potential for residential exclusion whereby residents who seek economic upgrading via relocation to specific neighborhoods for better opportunity and spatial capital are no longer able make that move as a result of inflated cost of living due to gentrification (Hochstenbach & Musterd, 2018).

Honing in on the 7-indicator gentrification measure, mean scores within clusters were more extreme (higher for hotspots, lower for coldspots) 2000–2016 relative to either sub time-period which indicates the direction of change across population characteristics was consistent over sixteen years rather than opposing signals of gentrification between the earlier and later study periods. Separately, the inclusion of race and age doesn’t substantially impact hotspots or coldspots over the total

time (7-indicator versus 5-indicator score for 2000–2016). These sub-analysis conclusions point to the strength of centering interpretations on the primary measure of gentrification as Fig. 1 maps.

However, when making comparisons between results of sub-analyses simultaneously, there was substantial variation in clusters of gentrification. In the first decade, a smaller hotspot was observed when the gentrification measure excluded factors of race and age. This suggests that both increases in economic status and populations of NH White and young people, drove gentrification 2000–2010 so that a broader area experienced above-average increases in young and/or White population while economic drivers of gentrification dominated a concentrated area of downtown regardless of race and age. Thereafter, 2010–2016 clusters paint a different picture – when race and age were excluded from the gentrification measure the hotspot spanned 283 tracts, suggesting stark inequality in economic growth between north/central and south/east neighborhoods dominated Atlanta trends, irrespective of race and age. In turn, the comparison of coldspots over this same period either muddies or supports this story. Coldspot 2 was identical between conceptualizations of gentrification. Coldspot 1 had a deficit of 66 tracts (almost entirely in Gwinnett County) when race and age were excluded from the gentrification score in 2010–2016, findings which may reflect a stronger role of changes in race and age distribution in Gwinnett County (i.e., out-migration of White and young populations and/or in-migration of non-White and older populations) than in DeKalb County, where low gentrification scores appeared rooted in economic indicators.

In total, this research, compiling a variety of economic and non-economic characteristics into a single value, aligns with prior studies on urban change (Huynh & Maroko, 2014; Linton et al., 2017). This work leverages spatial statistics to quantify “spill-over” effects into neighboring tracts and identify areas of most dramatic change across a large metropolitan area. Though a handful of studies have noted the spatially dependent nature of gentrification (Pánek et al., 2020; Taylor & Covington, 1988), few have employed cluster detection (Morrill, 2008; Van Crielingen, 2008; White, 2012), and even fewer have simultaneously examined multiple measures of gentrification. Yonto and Schuch (2020) has considered two distinct measures of gentrification and compared them across different spatial units but, did not conduct the evaluation of gentrification for an entire metropolitan area to provide insight on residential mobility at large.

Findings must be interpreted in light of some considerations. This work describes gentrification as a process that is not only characterized by economic upgrading but by a combination of changes in economic, racial, and age composition. It digs into the role of race, age, and economic status by detecting gentrification clusters with or without inclusion of race and age in the summary gentrification score and comparing indicators within clusters. Alternative insight might be derived using constructed frameworks which further stratify gentrification by White versus Black gentrification (Anderson & Sternberg, 2013; Gibbons & Barton, 2016; Hwang & Sampson, 2014). While this study summarizes the process of gentrification 2000–2016 and devotes attention to

sub-periods, it does not further capture the pace of the change within the time periods though authors agree the inconsistent pace of gentrification deserves attention in future work (Schnake-Mahl et al., 2020; G. S.; Smith et al., 2020). This time component could, and sometimes has, been related to examining “stages” of gentrification, “state-led” gentrification, or “external shocks” whereby actions of business, government or environment mark inflection points in urban change (Bilal et al., 2020). Additionally, census tracts used to measure gentrification in this study may not adequately consider smaller boundaries within which processes of gentrification occur. While rigorous spatial methods investigate neighborhood clusters of gentrification and variation is examined between metrics and time periods, one cannot make causal conclusions. Finally, work studying the impacts of gentrification should also describe changes to the physical environment in addition to neighborhood population trends.

5. Conclusions

These results inform our understanding of gentrification by examining nuances in gentrification measurement and by leveraging analytical methods designed to address the spatial autocorrelation inherent in population trends. While authors have agreed mixed messages on the effects of gentrification have resulted from inconsistent conceptualization, this work is one of few to have examined different metrics of gentrification within a single study. It is also the only gentrification research to employ this type of cluster detection analysis and compare specific economic and demographic trends between the areas experiencing most extreme change. In future work, the findings will be used to assess social and health effects which resulted from gentrification.

The term gentrification has negative connotations, bringing to mind economic disparities and displacement, while terms like urban

revitalization may be used to examine the same process but in a positive light, wherein communities are turned around, uplifted, brimming with economic growth. This linguistic distinction is often central in fierce battles over neighborhood development initiatives. Research which both demonstrates the impact of metric selection on characterizing urban trajectories and also leverages geographic analysis to describe a process rooted in neighborhood relationships is imperative to unpacking these disagreements. Accomplishing both of those goals, this study establishes critical understanding of gentrification in Atlanta and provides a foundation upon which we will examine how gentrification impacts the wellbeing of residents and communities to inform urban planning decisions to advance equity.

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Author statement

Anne Corrigan: data curation; formal analysis; investigation; methodology; visualization; writing original draft, review, and editing.

Frank Curriero: supervision; methodology; writing review and editing.

Sabriya Linton: study conceptualization; funding acquisition; investigation; writing review and editing; project administration.

Declaration of competing interest

None.

Appendix

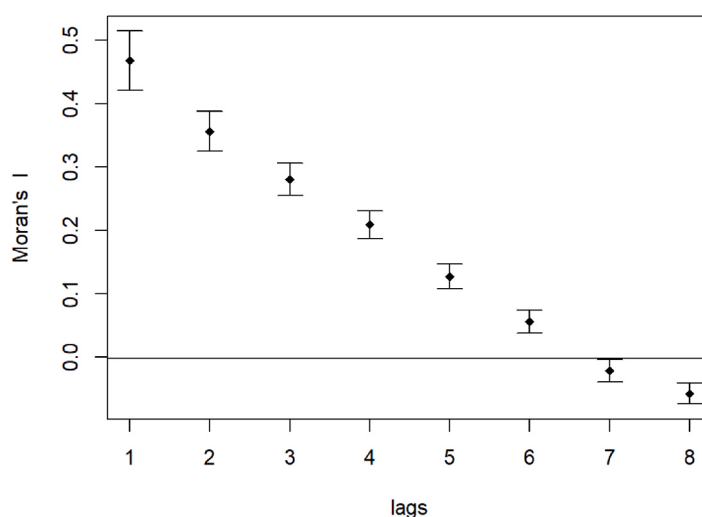


Fig. A.1. Moran's I correlogram for census-tract level gentrification scores in Atlanta metro area (N = 615).

Table A.1

Information for significant clusters of census tracts experiencing high (hotspot) and low (coldspot) gentrification. Coldspot 1 consistently refers to coldspots identified in the east spanning Gwinette and DeKalb counties while Coldspot 2 consistently refers to coldspots identified in south, mainly in Clayton County.

Years	Label	7-Indicator Gentrification Score (Fig. 2)					5-Indicator Gentrification Score, without race/ethnicity and age (Fig. 3)				
		Tracts	Mean In	Mean Out	Variance	p-value	Tracts	Mean In	Mean Out	Variance	p-value
2000–2016	Hotspot	68	0.97	−0.23	0.35	<0.001	74	0.85	−0.23	0.41	<0.001

(continued on next page)

Table A.1 (continued)

Years	Label	7-Indicator Gentrification Score (Fig. 2)					5-Indicator Gentrification Score, without race/ethnicity and age (Fig. 3)				
		Tracts	Mean In	Mean Out	Variance	p-value	Tracts	Mean In	Mean Out	Variance	p-value
2000–2010	Coldspot 1	138	−0.52	0.03	0.44	<0.001	132	−0.59	0.04	0.47	<0.001
	Coldspot 2	46	−0.68	−0.05	0.46	0.03	57	−0.69	−0.03	0.5	<0.001
	Hotspot	100	0.61	−0.24	0.38	<0.001	70	0.87	−0.19	0.46	<0.001
2010–2016	Coldspot 1	178	−0.42	0.03	0.44	<0.001	166	−0.46	0.07	0.52	<0.001
	Hotspot	143	0.47	−0.24	0.48	<0.001	283	0.29	−0.34	0.53	<0.001
	Coldspot 1	122	−0.49	0.03	0.53	<0.001	56	−0.7	0.01	0.59	<0.001
	Coldspot 2	85	−0.64	0.01	0.52	<0.001	85	−0.69	0.05	0.57	<0.001

Table A.2

Mean (and median) percent change in indicators of gentrification in clusters of significant high and low gentrification from 2000 to 2010 versus 2010 to 2016 using full 7-indicator gentrification score, describing clusters in Fig. 2B and C. Tracts for total Atlanta metro area exclude tracts with outlying gentrification scores (3*SD greater than mean) for respective time periods.

	2000 to 2010			2010 to 2016			
	ATL	Hotspot	Coldspot	ATL	Hotspot	Coldspot	Coldspot
Tracts	614	100	178	620	143	85	122
Total Population	13.5 (5.4)	−2.8 (−5.6)	16.7 (5)	10.4 (8.8)	7.0 (5.4)	9.6 (−1.5)	19.3 (5.0)
Total Households	19.9 (5.6)	3.6 (−0.6)	16.7 (5.9)	5.7 (4.6)	13.9 (5.1)	9.8 (−2.0)	19.4 (4.3)
NH White Pop	−15.4 (−20.7)	36.4 (0.1)	−32.0 (−34.5)	14.0 (−6.6)	43.8 (−2.2)	−28.6 (−51.6)	−37.8 (−41.6)
Pop Aged 25–34	−12 (−14.5)	−4.7 (−6.6)	−12.0 (−12.3)	3.7 (−2.9)	−1.5 (−6.7)	−5.8 (−6.0)	−11.2 (−12.3)
Pop Not in Poverty	−5.2 (−4)	−2.9 (−3.1)	−7.1 (−6.1)	−2.4 (−1.6)	0.2 (−1.0)	−6.8 (−6.7)	−8.1 (−7.5)
Pop in Professional Occupation	3.6 (−0.6)	25.6 (18.4)	−7.3 (−5.8)	7.4 (2.3)	20.4 (8.8)	11.6 (1.5)	−9.0 (−8.1)
Median Income	−13.9 (−16.2)	2.3 (−0.8)	−21.4 (−22.4)	−4.6 (−7.1)	0.3 (−5.2)	−16.4 (−19.5)	−23.3 (−24.3)
Median Rent	2.5 (−4.1)	16.5 (12.1)	−5.1 (−9.0)	−1.0 (−2.9)	8.8 (1.6)	9.3 (7.5)	−4.0 (−8.5)
Median Home Value	12.9 (10.7)	31.9 (28.5)	5.9 (4.9)	−23.9 (−22.2)	31.0 (15.0)	19.7 (14.5)	5.2 (4.6)

Table A.3

Mean (and median) percent change in characteristics of gentrification in clusters of significant high and low gentrification from 2000 to 2016 for sensitivity analyses when tracts with high outlying gentrification scores are not omitted (N = 627). Nine out of twelve and ten out of thirteen previously-excluded outliers were located within detected hotspots for the analysis with 7-indicator gentrification score and 5-indicator gentrification score (without age and race), respectively. One coldspot of 211 tracts was detected but not significant using 7-indicator gentrification score and an additional coldspot of 52 tracts was detected but not significant for 5-indicator gentrification score.

	7-Indicator Gentrification Score		5-Indicator Gentrification Score, without Age and Race	
	Hotspot		Hotspot	Coldspot
Tracts	78		68	158
Total Population	14.2 (7.0)		17 (10.7)	32.4 (14.5)
Total Households	23.1 (6.6)		24.5 (8.5)	27.3 (12.2)
NH White Pop	301 (54.2)		294.3 (27.9)	−42.5 (−44.2)
Pop Aged 25–34	15.5 (4.2)		13.8 (3.9)	−15 (−16.7)
Pop Not in Poverty	7.5 (0.6)		8.8 (0.6)	−11.5 (−9.5)
Pop in Professional Occupation	61.4 (37.1)		62.2 (35.3)	−8 (−6.6)
Median Income	18.7 (6.6)		23.1 (9.7)	−30.7 (−32.5)
Median Rent	30.3 (19.3)		31.9 (21.5)	−8.1 (−13.2)
Median Home Value	16.0 (−0.4)		21.8 (5.1)	−23.4 (−25.3)

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