Gentrification and neighborhood change over eight decades: Integrating Census and Zillow building data for Denver from 1940-2016

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PWP-CCPR-2018-011

December 7, 2018

California Center for Population Research
On-Line Working Paper Series

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Version: December 2018

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Abstract

Current research provides conflicting images of low-income neighborhoods as both highly persistent through time but also increasingly at-risk to gentrification. Attempts to understand neighborhood persistence and change are severely limited by the absence of long-term longitudinal neighborhood data. Using Denver as a proof-of-concept, we devise a new approach to study how neighborhood development and change over eight decades. We find that the structure of Denver neighborhoods has, indeed, been highly resilient with respect to neighborhood income, and this persistence is closely linked to the racial stratification of places. We do also, however, show that gentrification is significantly higher today than in the past, and today's gentrifying neighborhoods differ in their racial and locational characteristics when compared to the changing neighborhoods of the past. We conclude that taking a long-term perspective on neighborhoods may help reconcile conflicting claims regarding the prevalence and nature of changes in cities today.

1. Introduction

The urban social landscape of the United States has changed dramatically since the 1940s with the population of urban areas growing from 70 to 250 million by 2010 (54% to 81% of the total U.S. population). History tells us that American cities changed dramatically over this period. Following

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the Second World War, urban renewal policies, intensifying racial segregation, suburbanization, and disinvestment sent cities into economic and demographic contraction. These changes drove a four decade decline in the share of Americans living in central city areas (Glaeser & Shapiro, 2003). Cities did not rebound until the 1990s, when renewed urban investment and in-migration have yielded changes often described as the gentrification or 'rebirth' of the city (Florida, 2002; Glaeser, 2011).

Despite this sweeping image of urban transformation, there have been few direct investigations of long-term neighborhood change. These images of change also contrast with a large body of evidence showing neighborhoods to be highly persistent over time (Sharkey and Faber, 2014). Further, as concern continues to mount around growing gentrification, we know little concrete about how changes in neighborhoods today may differ from those in the past. Thus, we ask: Is neighborhood status highly persistent over long time periods? And do neighborhood changes today substantially differ from those in the past? We answer these questions by constructing new longitudinal neighborhood data for the City of Denver that span more than eight decades. We use these data to undertake the first systematic analysis of long-term neighborhood change since the '40s.

Neighborhoods studies continue to generate conflicting images of how cities have been changing. The most divergent discourses are between those which present gentrification and neighborhood change as an almost unstoppable and increasingly endemic force that is transforming low-income neighborhoods (Brown-Saracino, 2017), and a more comparative literature showing greater persistence in the relative status of neighborhoods over time (Delmelle, 2017; Hwang & Sampson, 2014; Wei & Knox, 2014). It is crucial that we understand neighborhood change processes, as there is growing causal evidence that neighborhoods directly impact health, educational and income inequality (Chetty, Hendren, & Katz, 2016; Sharkey & Faber, 2014; Wodtke, Elwert, & Harding, 2016).

A preview of our newly constructed data provides credence for the claim that neighborhood status and income is highly persistent. In Figure 1, we plot the median household income of census

tracts in Denver in 1940 against their corresponding values in 2016.[2] Although Figure 1 reveals considerable variation over time, the median incomes of neighborhoods are strongly positively correlated from the beginning to the end of this 76-year period (+0.64). Thus, despite considerable shifts in the distribution of income across neighborhoods over recent decades (see Reardon & Bischoff, 2011), the relative position of Denver neighborhoods has remained quite stable.

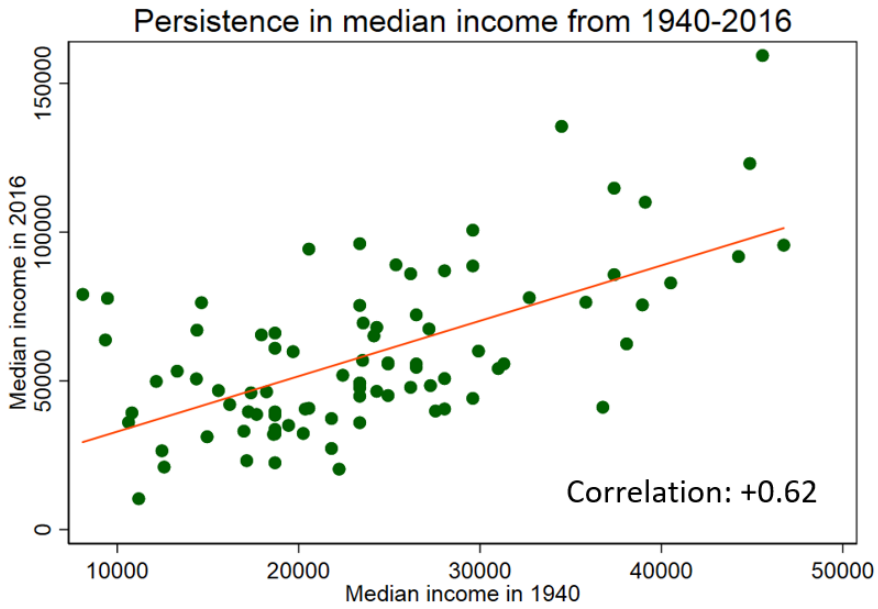


Figure 1. Persistence in median income from 1940-2016

Note: We measure median household income from the 1940 Census and the 5-year American Community Survey. We adjust dollar values to 2010 levels.

How does this broad picture of income persistence over the last eight decades square with our analysis of individual neighborhood change? Our first main finding is that while neighborhoods does exhibit persistence across our 76-year period, these patterns are particularly evident among higher income White neighborhoods and lower income neighborhoods with larger Black and Hispanic populations. In a panel analysis of which neighborhoods move up income quartiles over time, we find highly robust negative relationships between the Black and Hispanic

[2]Although there is no singular definition of a neighborhood, we rely on census tracts as our primary unit of analysis as they are designed to represent neighborhoods and are regarded as sufficient for studying neighborhood-scale processes (Iceland & Steinmetz, 2003; Sharkey & Faber, 2014).

shares of neighborhoods and their probability of increasing in income rank. While our findings support theory highlighting the racialized persistence of neighborhood status (e.g. Sampson, 2012; Sharkey, 2013), we do note that neighborhood change in recent decades – a period at the heart of much recent gentrification scholarship – is distinctly different in magnitude and spatial patterning to prior eras of neighborhood change in Denver.

Denver is a particularly compelling case to study neighborhood change due to the city's unique ethnic and racial history, and it being regarded as a forerunner of central-city gentrification (Federal Reserve Bank of Cleveland, 2013). Although Denver does not have the intense and protracted history of racial segregation as many northern US cities, we still observe the emergence of a strong racialized neighborhood structure. Assessing how the representativeness of Denver's history of neighborhood change and gentrification requires further comparative work. Through the construction of the long-term longitudinal data required to study neighborhood change (see Kirk & Laub, 2010; Sheehan, Cantu, Powers, Margerison-Zilko, & Cubbin, 2017) and our new measurements of elusive historic building patterns from Zillow's Transaction and Assessment Dataset (ZTRAX), we propose a blueprint for the new data that are required to understand long-term neighborhood change across urban contexts.

2. Neighborhood theory

In its simplest form, we view gentrification as referring to substantial increases in the social and economic status of neighborhoods. Neighborhood change studies tend to articulate a perspective of either *change* or *persistence*. The depiction of *change* is evident in studies emphasizing the spatial reorganization of jobs (Scott, 2018), neoliberal and pro-business urban policy (Hackworth, 2018; Wyly & Hammel, 1999), and the dynamics of housing depreciation and profitability (Hackworth & Smith, 2001; Smith, 1987) as mechanisms of change. In contrast, studies underscoring the *persistence* of neighborhood status typically highlight the entrenched nature and broad impact of racial inequality, and the confinement of widespread gentrification to a select set of urban contexts (Brown-Saracino, 2017; Hwang & Sampson, 2014). Our goal is, therefore, to better understand and measure patterns of neighborhood change and persistence.

Theoretical accounts of *change* suggest that profit-driven waves of gentrification and cycles of neighborhood investment may lead to recurring patterns of gentrification and change (Smith, 1987). This is partly because real estate and housing have long been key outlets for capital investment. Further, as housing has become increasingly valued as a commodity, the growing

financialization of real estate and entrepreneurial urban planning may be accelerating neighborhood change processes (see Aalbers, 2016; Hackworth, 2007). Industrial restructuring may also have a profound impact on neighborhoods. By affecting the workers' preferences for particular locations, the cyclical spatial reorganization of jobs may also have spillover effects on neighborhoods (Scott, 2018). The movement of jobs to the suburbs in the mid-twentieth century and the return of high-skilled and service work to central city areas in recent decades, for example, drove changes in the characteristics of those places. Testing these hypotheses is difficult, however, as there are few sources of building or longitudinal neighborhood data that contain the spatial or temporal detail to systemically examine these processes.

Claims that neighborhoods are instead highly *persistent* highlight the embeddedness of neighborhoods within local racialized hierarchies. In the US context, experimental analyses show that perceptions of neighborhood status are more tightly coupled with perceptions of racial composition than direct indicators of 'neighborhood quality' or socioeconomic status (Sampson, 2012). Thus, the persistence of neighborhood status, and their inequality-generating effects may be a reflection of both the racialized concentration of poverty and durable perceptions of neighborhoods based on their racial composition (Hwang & Sampson, 2014).[3] These theoretical accounts are not only supported by investigation of neighborhood perceptions and the persistence of segregation, but also implied by findings of gentrification as a relatively concentrated phenomenon that is less prevalent than is often claimed (e.g. Maciag, 2015).

Conflicting views on neighborhood change partly reflect disagreement over the definition and measurement of change. We know that neighborhood characteristics continually fluctuate, but the degree to which these changes are considered to be meaningful and significant lead to divergent conclusions (Brown-Saracino, 2017). Idiosyncratic neighborhood change, for example, may not be particularly meaningful if neighborhoods continue to exhibit more abstract forms of persistence in their stratification as, for example, "minority neighborhoods" or "ethnic enclaves" (Delmelle, 2017; Wei & Knox, 2014). Further, even if change had an agreed upon definition, the cross-

[3] This ranking of neighborhoods (or stigmatization for lower income minority neighborhoods) within cities have wide ranging effects on residents through segregation, the racialized concentration of poverty, and the likelihood of inward investment or migration (Massey & Denton, 1989; Sharkey, 2013; Wilson, 1987).

sectional nature of census data poses a major obstacle to measuring such change over time. Thus, most neighborhood studies tend not to extend beyond a thirty year timeframe (Delmelle, 2016; Ellis, Wright, Holloway, & Fiorio, 2017).

We examine how much neighborhoods have changed over time by constructing the data necessary to assess long-term shifts in the relative status or income of Denver neighborhoods. We do this by constructing a longitudinal neighborhood sequence from 1940-2016. As our focus is not directed toward changes in neighborhood inequality per se, we mainly focus on changes in the rank ordering of neighborhoods in terms of their median incomes over time. As mentioned, focusing on neighborhood *rank* helps avoid the conflation of changes in neighborhood status with wider distributional shifts in income, and permits us to identify more meaningful forms of neighborhood change in Denver.

3. Describing neighborhood change in Denver

Over the last eight decades, how might we expect neighborhood change to have played out in Denver? While Denver resembles many major US cities in its post-war suburban growth and in its substantial Black and Hispanic in-migration, the city is distinct in its 'entrepreneurial' city planning and the activities of the Denver Urban Renewal Authority (DURA). From the late 1950s, DURA set out to "eliminate central Denver's slums" and "help rehabilitate and redevelop blighted areas" of the city (Denver Urban Renewal Authority, 2008). DURA and related development organizations not only aimed to attract business and regenerate Hispanic and low-income neighborhoods by funding the development of public amenities such as universities (Page & Ross, 2017), but also to raze "downtown neighborhoods … to be replaced by skyscrapers, freeways and the other trappings of a truly 'modern' city" (Denver Comprehensive Plan, 2000, p.20). Thus, we may expect neighborhood socioeconomic change to be closely coupled with both racial and ethnic segregation, and patterns of new building throughout the city.

To form a picture of these changes, we begin by describing the spatial and social structure of Denver neighborhoods from 1940-2010. Table 1 presents the average characteristics of tracts for 1940, 1980, and 2010 for all tracts (Col. 1), tracts within 3 kilometers of the Central Business District (CBD) in Column 2, tracts 3-5 kilometers from the CBD (Col. 3), and tracts more than 5 kilometers from the CBD (Col. 4). To provide an overview of the city, we focus on the total population, indoor floor area, and the Black and Hispanic share of neighborhoods over these eight decades. While the total population, and the Black and Hispanic characteristics are measured from

the decennial census, indoor floor area is measured from ZTRAX and provides a new proxy for building and real estate changes over time. We discuss these data sources in much more detail in Section 4.

	Distance from Denver CBD			
	All Tracts	Less than 3 km	3 to 5 km	More than 5 km
	1	2	3	4
Population				
1940	3,443	4,978	3,724	2,037
1980	3,827	3,156	4,099	4,118
2010	4,008	3,448	4,041	4,409
Indoor floor area (square footage)				
1940	1,238,078	1,849,214	1,213,311	791,133
1980	3,290,547	4,133,783	2,649,659	3,173,509
2010	4,546,131	6,179,985	3,262,518	4,353,806
Black share				
1940	0.02	0.03	0.02	0.01
1980	0.17	0.22	0.16	0.15
2010	0.15	0.15	0.14	0.16
Hispanic share				
1940	0.03	0.07	0.02	0.01
1980	0.14	0.16	0.19	0.08
2010	0.30	0.22	0.38	0.30
Obs. (tracts)	88	26	28	34

Table 1. Average characteristics of tracts by distance from Denver's CBD

Note: Denver Central Business District (CBD) refers to the Denver Civic Center. Distance from the CBD is measured from the centroid of tracts to the Civic Center.

Changes in the average population and indoor floor area of buildings in tracts provides insight into how the general form of the city has changed since the '40s. Column 1 shows that while the total population of city neighborhoods grew by only around 16%, the built or indoor area of the city grew almost fourfold from just over 1.2 million square feet to more than 4.5 million square feet. The growth in population and indoor area appears to have been particularly pronounced in 1940-1980 era. This is most evident for indoor floor area which grew by 165% from 1940 to 1980 but by only 40% over the 1980-2010 period. Although these retrospective building

data overestimate actual building growth, they illustrate the sheer scale of new building within the city, even within a context of relatively modest population growth.[4]

By decomposing these metrics by their distance from the central-city, we can investigate the likelihood of post-WWII suburbanization or more recent central-city development as impacting neighborhoods. It is evident from Table 1 that there were substantial changes in the numbers of people living in different areas of the city. Over the 1940-1980 period, tracts within three kilometers of the CBD experienced a 37% decline in total population. Population decline in the central-city stands in contrast to tracts within 3-5 kilometers of the CBD, which experienced modest population growth, and tracts 5 kilometers or more from the CBD which doubled in population. This pattern of central-city decline and peripheral growth from 1940-1980 *are not*, however, mirrored in indoor area changes: there was substantial growth in indoor area in tracts both proximate and far from Denver's CBD. Thus, while central city neighborhoods were depopulating (or being depopulated) in the post-war period, substantial building efforts continued. This divergence of population and building in central-city areas is distinct from more outlying neighborhoods, which were attracting both people *and* new building.

The 1980-2010 period was marked by a less dramatic reversal of these trends. While the indoor area of all tracts continued to grow over the 1980-2010 period, the most pronounced growth was in neighborhoods proximate to the CBD. The population decline of these CBD neighborhoods also reversed, and their growth rate (9.3%) was slightly higher than that of more outlying neighborhoods (7%). Thus, we observe periods of rise, decline and stagnation within the spatial structure of Denver over these seven decades. This is most notable in the decline of central city neighborhoods and the growth of peripheral areas over the 1940-1980 period and renewed central-city growth from 1980 on.

These shifts in population and building co-occurred with changes in racial and ethnic composition. Column 1 shows that the Black and Hispanic population of the city grew considerably over this period. The average Black share of tracts was 2% in 1940, grew to 17% by

[4]As they do not capture buildings which have been torn-down and replaced, the retrospective ZTRAX data underestimates the presence of historical buildings. In themselves, however, they do provide a direct measure of when contemporary structures were erected. Thus data provide a reliable indicator of building development, but mainly fall short in distinguishing newly developed land from redeveloped land.

1980, and remained largely stable up to 2010. Columns 2-4 also show that while the Black population increased throughout the city, growth was most heavily concentrated in central-city tracts where the average Black share reached 22% in 1980. Interestingly, as the Black share remained largely stable in tracts three or more kilometers from the CBD from 1980-2010, the Black share of CBD tracts fell from 22% to 15%. Thus, while Denver and its CBD experienced substantial Black in-migration in the post-war period, neighborhoods near the CBD appear to have "Whitened" somewhat since 1980.

In growing from 3% to 30% on average, the Hispanic share of tracts has also grew sharply over the 1940-2010 period. Although the Hispanic share was highest in tracts within 3 kilometers of the CBD in 1940 (7%), these tracts experienced the most modest growth over the following 70 years. While the Hispanic share of CBD tracts grew to 22% by 2010, more outlying tracts had average Hispanic shares ranging from 30-40%. This disjuncture the residential geography of Black and Hispanic households provides a valuable opportunity to examine how these population-specific patterns relate to gentrification and neighborhood change. As there are clear correlations between building, population, ethnic and racial change, we rely on statistical approaches to better understand the individual associations between these characteristics and changes in neighborhood status and income over time.

4. Building longitudinal data to study neighborhood change

We constructed our long-term neighborhood data by designing an innovative spatial allocation procedure to integrate three main data sources: the 1940 complete count census, the Longitudinal Tract Database covering the 1970-2010 decades, and the ZTRAX database.[5] In our analysis, we focus on the city of Denver as it was defined in 1940. Although much of the new growth occurring in metropolitan Denver from 1940-2010 was in surrounding counties and suburbs, those places did not have substantial populations in 1940. Thus, we take the more reserved approach of studying change within Denver's 1940 boundaries, leaving alternative approaches to future research efforts.

In addition to the technical challenges of studying places over time, neighborhoods are also difficult to define. While it is challenging (perhaps impossible) to precisely demarcate a neighborhood (Spielman & Logan, 2013), we follow other geographers in using census tracts as our main neighborhood unit of analysis (Delmelle, 2016, 2017; Ellis et al., 2017). Although census

[5] The ZTRAX data have been shared with us through a data agreement between CU Boulder and Zillow.

tracts tend to be larger than what might typically be considered a neighborhood (2,500-8,000 people), they are designed to be coherent spatial units and are thus, suitable for our purposes.

4.1. Key data sources

The 1940 Census: We measure the baseline characteristics of 2010 census tracts using the 1940 complete count census. These non-anonymized data have been made available through a collaboration between the Minnesota Population Center and Ancestry.com, and contain the individual characteristics required to describe neighborhoods in 1940 with respect to income, race and ethnicity, and demographic structure. Our strategy to compare neighborhood change from 1940 on is to assign the 1940 dwellings to 2010 census tracts. By doing this, we can compare socioeconomic, demographic and land-use change within a consistent set of boundaries over our study period.

We utilize two main geographic identifiers from 1940 census: the street address of households and their reported enumeration district. The restricted complete count 1940 census contains the full street name and address for each household. Additionally, the 1940 census contains the enumeration district (ED) of households, which is an area typically encompassing up to 20 blocks. Although historical street addresses are challenging to locate in space, enumeration districts can be more easily located using historical digitized and georeferenced maps.[6] We found these two sets of identifiers to be sufficient to assign very high proportions of 1940 households to 2010 tracts.

The Longitudinal Tract Database (LTDB): Although census tracts are primary enumeration units for the U.S. decennial censuses, their boundaries are split, consolidated and changed from census to census in ways which can severely obstruct demographic analyses over time (Schroeder, 2007; Ruther et al., 2015). The LTDB, constructed by Logan et al. (2014), uses estimation techniques to reallocate data from the census and other sources within 2010 tract boundaries back to 1970. We also link the 2010 data to the 5-year estimates from the 2016 American Community Survey so that we can also characterize recent change within the city. Thus, our primary task was to devise a strategy to link 1940 households to the LTDB. It is worth noting that while there are other tract databases available, the quality of the LTDB appears to be at least as reliable as these other products (Logan, Stults, & Xu, 2016).

[6] These maps can be accessed in the National Archives Catalog.

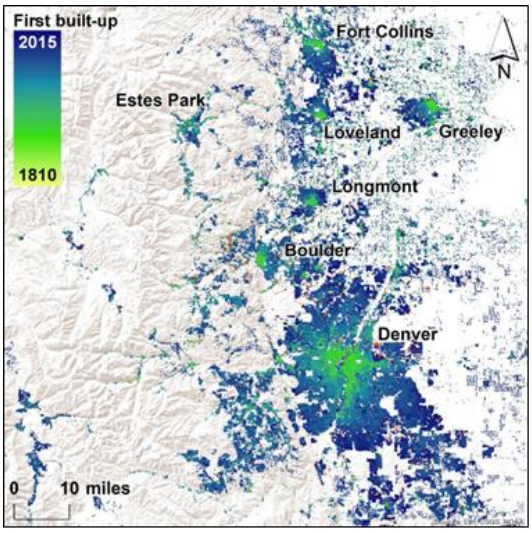


Figure 2. Year-built for each structure in greater Denver area from ZTRAX

ZTRAX from Zillow: Zillow's ZTRAX database is a new and impressive source of geospatial housing and building data. The database includes information from more than 374 million public records and assessor data for approximately 200 million parcels in over 3,100 counties in the U.S. ZTRAX contains contemporary information on housing transactions, home values, rental estimates, spatial location, home- and property-related information for existing homes and certain other properties across the United States. From an historical perspective, these data also contain information on the year in which buildings were constructed or remodeled. These data stretch back to the 19th century. For this analysis we rely on the year of construction and the total indoor area of buildings. Through a rasterization procedure, we created surfaces of the inter-decadal land coverage and indoor floor area of buildings at a resolution of 250m x 250m. We do this by sequentially subsetting the original ZTRAX data, and generating raster layers of the building characteristics at different time points (Leyk & Uhl, 2018). Figure 2 maps these characteristics for the broader Denver region.[7]

4.2. Tract allocation procedure

[7] There is a bias in the retrospective ZTRAX data in that areas where buildings have been torn down or undergone major redevelopment will have their built years recorded as more recent. Our preliminary analyses suggest, however, that ZTRAX data are of sufficient quality in Denver to study building trends across time, and in some respects our work is a first trial for the use these data in this kind of analysis.

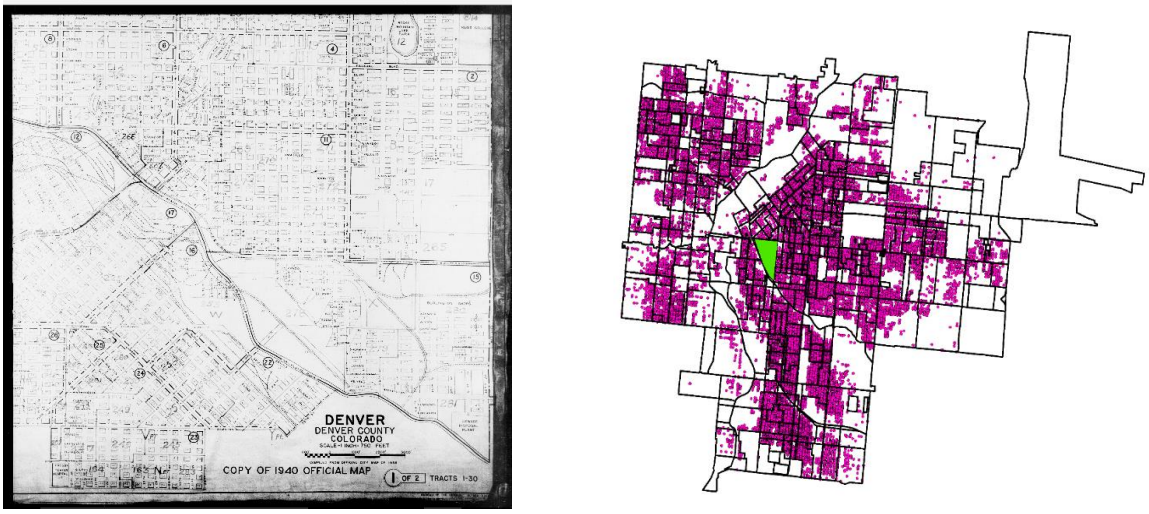
We devised a multi-stage procedure to link the 1940 census geography to the LTDB. The 1940 census contains geographic identifiers in the form of enumeration districts (ED) and street addresses, through which it is possible to link 1940 census records to census data from later years. EDs and street addresses are typically at a finer scale of geography than the 2010 census tracts within which they would be nested and are, as such, suitable for intertemporal linkage. If all 1940 EDs were fully nested within a single 2010 census tract, we could rely solely on the enumeration district scale to link the 1940 census data to 2010 census tracts. However, because a substantial portion of EDs partially overlap with later census tracts, we needed to employ a sequential address matching technique to correctly assign 1940 household address records to 2010 tract boundaries.

We began by georeferencing the enumeration district boundaries from historical maps for Denver County in 1940 (Figure 2). The mapping of these 1940 EDs are presented in Figure 3 along with the position of the geolocated 1940 dwellings. Using these georeferenced EDs, we could identify which EDs were fully nested within 2010 census tracts. If an ED was fully nested within a 2010 tract we could directly assign all corresponding households to a contemporary tract. If a 1940 dwelling was in a non-nested ED, we used address matching to derive a more precise dwelling location to make the assignment to a 2010 census tract. We undertook our address matching within the statistical software R using the 'ggmap' package and the Data Science Toolkit spatial data source, itself based on OpenStreetMap data (Kahle & Wickham, 2015). We conducted our allocation procedure as follows:

1. Directly assign dwellings in fully contained 1940 EDs to a 2010 tract ("Direct Assignment").
2. Use a geolocation procedure based on contemporary addresses to more precisely locate dwellings within non-nested EDs.
3. Verify the accuracy of geolocation by examining whether the census-recorded ED of the dwelling matches the ED within which the dwelling was geolocated. If the EDs match, then assume that the dwelling was correctly geolocated ("Verified Geolocation").
4. If a dwelling was geolocated to a location outside of its true ED then assign the dwelling the coordinates of the previous 1940 census record that was geolocated within its correct ED ("Backward Assignment").

5. If the census and georeferenced EDs still do not match after Backward Assignment, then assign the dwelling the coordinates of the next dwelling with a correctly matching ED field ("Forward Assignment").

The Backward and Forward Assignment procedures exploit the fact that the ordering of the 1940 census records provides insight on neighboring dwellings. That is, dwellings enumerated next to one another in the census also tended to be proximately located in space. This contiguity will be particularly strong within cities where buildings were more compact. Thus, the Backward and Forward Assignment procedures make corrections to the geolocation of dwellings by exploiting neighboring records for which we have geolocated with a relatively high degree of confidence.



A. Map of Denver EDs in 1940

B. Geolocated dwellings (purple) and EDs in Denver County in 1940

Figure 3. Mapping Denver in 1940

Note: The 1940 enumeration district maps can be obtained from the National Archives online repository.

Table 1 describes our sample across different stages of the allocation procedure. The second row of Table 1 shows that 61% of the 303,136 people and the 102,623 dwellings in Denver County in 1940 were located within an ED that was nested within a 2010 tract. Thus, our geolocation procedure focused on the remaining 39% of dwellings located in non-nested EDs. By comparing the reported census ED to the ED as implied by its location, we determined that our Verified Geolocation procedure increased the share of assigned dwellings from 61% to 86%. We were able to increase our successful assignment rate to 99% using our Backward Assignment

technique, and we used Forward Assignment to locate the remaining 1% of addresses within their correct 1940 ED, and assign these cases to a 2010 census tract.

		1 Cumulative Population	2 Cumulative Dwellings	3 Population share assigned	4 Income per capita	5 Share non-Hispanic, White
1	Direct Assignment	183,263	62,672	61%	$900	92%
2	Verified Geolocation	265,302	88,624	86%	$965	93%
3	Backward Assignment	297,952	101,058	99%	$960	93%
4	Forward Assignment	303,136	102,623	100%	$960	93%

Table 2. Summary statistics of allocation from 1940 study area to 2010 census tract

One concern may be that these different allocation procedures could introduce bias into the analysis due to disproportionate misallocation of, for example, lower income households. Columns 4 and 5 of Table 1 compare the average household income and White share of the population in our database at different stages of the allocation procedure. The mean annual household income of the Denver Study Area was reported as around $960 dollars in the 1940 census and 93% of the city was recorded as non-Hispanic and White. Row 1 of Table 1 suggests that lower income households were easier to locate in the Direct Assignment phase of this procedure. This is evident in that the average income of the sample was $60 lower than the city average following Direct Assignment. This discrepancy is driven by the fact that lower income EDs in 1940 tended to be smaller on average and were more likely to be nested within 2010 tracts. Following the Verified Geolocation procedure, the average income of the assigned sample jumps from $900 to above the city average to $965. This confirms historical evidence from other cities suggesting that historical geolocation tends to be more precise for higher income dwellings (Connor, 2017).

We conclude that our procedure for allocating 1940 households to contemporary tracts is both reliable and representative. Across different stages of our analysis, the racial share of the sample remains quite similar to the city as a whole. Further, as we assign almost all 1940 dwellings to a 2010 tract, the characteristics of our sample identically match those of the total population. As we can allocate almost all 1940 households to a 2010 tract and can verify our spatial allocation procedure, we believe our data are a compelling source from which to study long-term neighborhood change.

4.3. Analytical strategy & variables of interest

We are interested in the rate at which neighborhoods experience substantial increases in income and status relative to other Denver neighborhoods, and what types of neighborhoods experience these upward transitions. We assess these changes by focusing on four sets of attributes: income rank; race and ethnicity; population and indoor floor area; and spatial location. We measure the status of neighborhoods by using median household to compute percentile ranks for every tract in each decade:

$$(1) \qquad Income\ rank_{it} = \frac{(rank\ of\ income - 1)_{it}}{(n-1)}$$

where the numerator is the income rank of each tract *i* in time *t* in terms of their median household income and the denominator standardizes for the total number of tracts in our Denver data. This allows us to generate a ranking of neighborhoods in each period, where the highest income neighborhood is assigned a value of 1, the lowest income neighborhood a 0, and the median neighborhood an approximate score of 0.5.

We measure changes in total population and building patterns in two ways. We use the ZTRAX data to compute decadal changes in the total indoor floor area of building within census tracts. Changes in the total indoor floor area of buildings is a reliable proxy for new building. In addition to measuring these building changes, we also measure the total population of tracts for each year we observe in our data. By controlling for both population and building characteristics within our analysis, we have a means of distinguishing between effects of both residential population change and new building investment.

Finally, we measure the racial and ethnic composition of census tracts and the distance of tracts from the CBD. For race and ethnicity, we observe the Black and Hispanic shares of census tracts in each of our years of interest. Unfortunately, the 1970 Census data do not contain detailed information on the Hispanic population. Thus, instead of dropping 1970 from the analysis, we undertake a simple linear interpolation for 1970 based on the 1940 and 1980 margins. We use the Denver Civic Center as the approximate location of the CBD and calculate the distance of each tract centroid to this location. This measure of spatial location provides valuable insight on the degree to which recent gentrification and change is concentrated in the central-city when compared to prior decades.

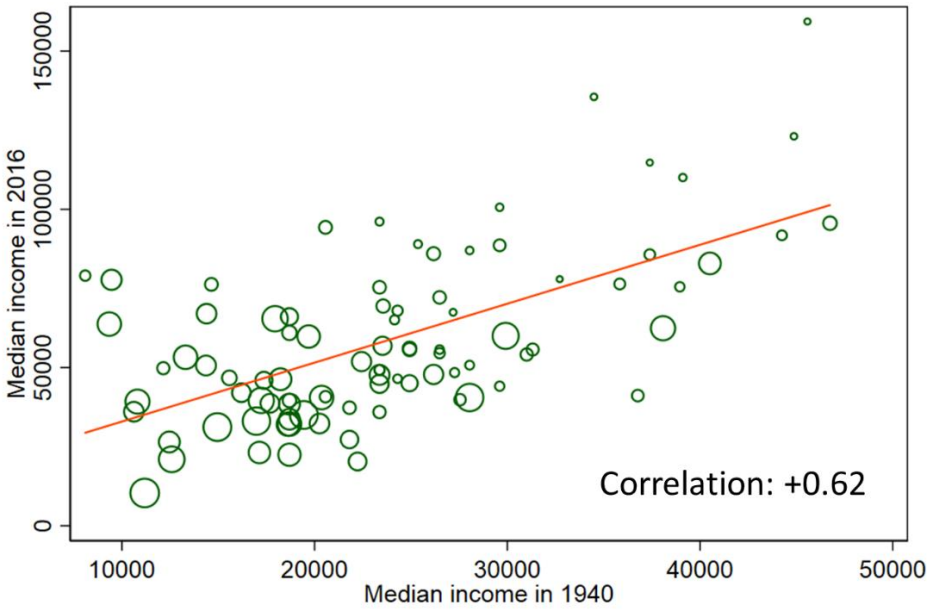
5. Neighborhood persistence

We begin by examining the income and status of neighborhoods over time, and the population and built characteristics typically associated with change and persistence. We first describe the intersection of neighborhood income persistence (see Figure 1) and the racial and ethnic composition of neighborhoods. We then use a panel regression framework to determine whether the likelihood of a neighborhood experiencing a substantial increase in status (or of being gentrified) is correlated with its built, population and locational characteristics. We use this approach to assess the degree to which neighborhood change is largely idiosyncratic and 'random' or if, instead, neighborhood characteristics such as its racial composition or proximity to the CBD are important determinants of change or persistence.

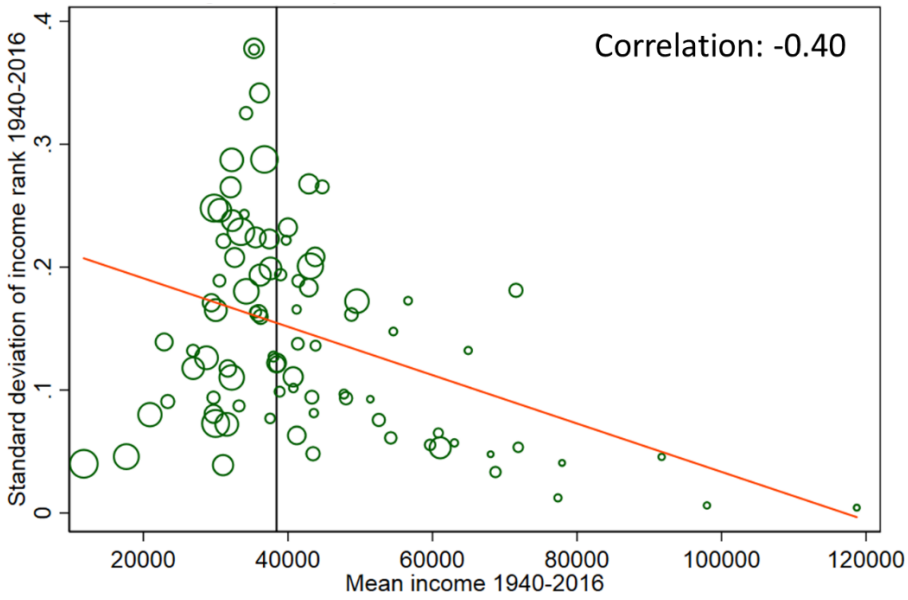
5.1. Race, ethnicity and neighborhood persistence

In Figure 4A, we begin by examining persistence in the ranking of neighborhoods by plotting the median incomes of neighborhoods in 1940 against their corresponding 2016 levels, and stratifying neighborhoods according to their racial and ethnic composition. We weight the points so that tracts with higher average Black and Hispanic population shares across these decades have larger symbols. As shown previously, median income levels are highly correlated over time (+0.62), suggesting that neighborhoods were situated in generally similar positions in both 1940 and 2016. Thus, we add to this finding by examining whether persistence at high- or low-income levels correlates with racial and ethnic composition.

Figure 4A shows a strong relationship between the Black and Hispanic share of neighborhoods and their average income levels. Most notably, neighborhoods with high incomes in 1940 and 2016 (top right) tend to have very small Hispanic and Black population shares relative to the rest of the city. Low-income neighborhoods (bottom left), in contrast, tend to have much larger Black and Hispanic shares. Thus, it is clear from our descriptive analysis that neighborhood income levels are strongly correlated with racial and ethnic composition. Given that the income levels of Black and Hispanic households tend to be below the average, this relationship may not appear to be surprising. We later provide evidence, however, that this correlation of racial composition and neighborhood income is not solely driven by the income levels of Black and Hispanic households.



A. Persistence in income from 1940-2016



B. Variation in income by average income from 1940-2016

Figure 4. Persistence in income rank from 1940-2016

Note: We measure median household income from the 1940 Census and the 5-year American Community Survey and adjust dollar values to 2010 levels. Symbol sizes are proportional to the average Black and Hispanic share of tracts from 1940-2016, with larger points reflecting larger Hispanic and Black shares.

Although the general income structure of neighborhoods appears to be quite persistent over time, some neighborhoods have moved substantially up and down the neighborhood hierarchy. To assess whether change and persistence tends to be more concentrated among high- or low-income neighborhoods, Figure 4B plots the averaged median household income of tracts over the 1940-2016 periods against the standard deviation of the *income ranks* of those neighborhoods. We do this to assess whether neighborhoods are more or less likely to change in rank position based on their position within the neighborhood income distribution.

We can identify two clear trends in Figure 4B. First, the relationship between these two measures is downward sloping and has a correlation of -0.40. This indicates that changes in income rank are relatively less likely among high-income neighborhoods. It is particularly notable that these high-income, generally persistent neighborhoods have very small Black and Hispanic population shares (bottom right). The small standard deviations in the income rank of these neighborhoods suggests that these high-income, largely White neighborhoods are much more likely to hold their position, or to change less over time, than lower-income neighborhoods.

The second notable feature of Figure 4B is that there is evidence of persistence at lower income levels. A small cluster of neighborhoods in the bottom left corner of this graph have both low median incomes throughout our period of analysis and small standard deviations in income rank. Thus, these neighborhoods appear to exhibit persistently low household incomes across many decades and have among the highest Black and Hispanic population shares in the city. Thus, from Figure 4B we observe a set of highly persistent higher income White neighborhoods and a smaller set of lower income disproportionately Black and Hispanic neighborhoods. Thus, racial composition appears to be not only correlated with average neighborhood income levels, but also the propensity for average neighborhood incomes to change over time.

5.2. Estimating determinants of neighborhood change

Which types of low-income neighborhoods are more likely to improve in status or income over time? While our descriptive evidence, thus far, suggests that racial and ethnic composition are linked to persistence at higher and lower income levels, neighborhood racial composition is correlated with characteristics ranging from location, initial income position and the income levels of specific populations. To better identify which factors are most salient for neighborhoods experiencing substantial increases in relative income or status, we use an OLS panel framework of the following form:

$$(2) \quad Mobility_{i,t-t+30} = \beta_k X_{kit} + Decade_t + Tract_i + Top\ quartile_{it}$$

where the outcome variable is whether tract *i* moved up a full income quartile between time *t* and *t + 1* by our *k* neighborhood characteristics of interest, which we measure in time *t*. That is, for each decade we predict the chances of a neighborhood gaining substantial ground in terms of status or relative income by its characteristics at the beginning of the decade. To account for decade specific shifts in the rate of neighborhood change, we include dummy variables for the base year and test the robustness of our estimates to tract-level fixed effects, which help account for unobserved neighborhood characteristics (Allison, 2009). As it is impossible for a top quartile tract to move up income quartiles, we include time-varying dummy for whether tract *i* was in the top income quartile in time *t*.

We present our estimates from these models in Table 3. Models 1-3 refer to the full neighborhood panel for the 1940-2016 period. Model 1 presents estimates from the basic panel model, Model 2 adds tract fixed effects so that the variation in outcomes largely derives from changes *within* tracts over time, and Model 3 includes a set of controls for changes in the absolute income levels of the total, Hispanic, and Black populations in tracts over time (see below). For comparability, all independent variables have been transformed into standard units with a mean of zero and a standard deviation of one.

Does the rate of neighborhood income growth or gentrification change over time? The history of central-city and suburban development in US cities lead us to hypothesize that neighborhood change rates may vary in magnitude and form over time. To gain insight on this issue, we examine the *decade* coefficients, where the estimates are relative to the 1940-1970 period. Thus, negative estimates reflect lower probabilities of moving up income quartiles compared to the 1940-1970 period. Models 1 and 2 of Table 3 show that relative to 1940, neighborhoods were more likely to move up income quartiles over the 1970-2000 period. This may not be wholly surprising, as the 1940-1970 period is longer in time than the subsequent decadal snapshots, which mechanically permits more change to occur. What is notable, however, is that despite being considerable shorter in time, the coefficient for the 2000-2016 period is similar and not significantly different from 1940-1970. Thus, 2000-2016 period exhibits unusually high rates of change.

While controlling for other neighborhood characteristics, to what extent do racial and ethnic composition correlate with neighborhood income or status improvements? Column 1 shows

that higher Hispanic and Black population shares are strongly negatively correlated with improvements in neighborhood income. A standard deviation increase in the Black and Hispanic share of the neighborhood at the beginning of a decade is associated with a 3.5 to 6.3 percentage point decrease in the probability of a tract moving up one income quartile. As the racial composition of neighborhoods may be correlated with unobserved characteristics (such as location within the city), we estimate this model with tract-level fixed effects. Even with the inclusion of this stringent control, however, there is no attenuation in the negative effect of Black and Hispanic share on moving up income quartiles.

What could account for these negative Black and Hispanic share effects? One might suspect that as our rank measure is ultimately based on income, constrained growth may simply reflect the lower personal incomes of in-migrating Black and Hispanic residents. We attempt to rule out this possibility in Model 3 by including controls for the median absolute incomes of the Black, Hispanic and total population of tracts. By comparison of Models 1 and 3, however, it is evident that these median income controls only moderately reduce the Black and Hispanic share coefficients. This suggests that constrained income improvements in neighborhoods with higher minority shares does not just reflect income differences between Black and Hispanic households and the rest of the population. Thus, a substantial portion of these effects likely represent general barriers to neighborhood income growth such as a lack of inward investment or the in-migration of higher income residents into Black and Hispanic neighborhoods.

There are two other notable factors related to improvements in neighborhood income rank. Across each model, a standard deviation increase in total tract population is associated with a significant 3 to 5 percentage point reduction in the probability of moving up income quartiles. Thus, more sparsely populated places are more likely to experience gains in income rank relative to other tracts. We also find a strong positive association between distance from the Central Business District and improvements in income rank, suggesting that places with fewer residents or those with lighter frictions to new neighborhood development (e.g. suburban areas) are more susceptible to changes in status over time.

We draw three main conclusion from this regression analysis: (1) improvements in neighborhood status or gentrification varies significantly over time, and these improvements are, on average, more likely to occur in places with (2) fewer total residents and which are further from the CBD, and which have (3) smaller Black and Hispanic population shares. These findings

suggest that while neighborhood changes fluctuate across time, neighborhood stratification is strongly linked to racial and ethnic residential patterns. Further, the strong negative effects of population size suggest that more established neighborhoods (as proxied by total population) are also less likely increase in income rank over time.

Model	(1) Upward mobility	(2) Upward mobility	(3) Upward mobility
Income rank	-0.51***	-0.69***	-0.55***
	(0.08)	(0.11)	(0.11)
Hispanic share	-0.063***	-0.14***	-0.051***
	(0.01)	(0.03)	(0.02)
Black share	-0.035***	-0.097***	-0.033**
	(0.01)	(0.03)	(0.02)
Population	-0.038***	-0.032	-0.049***
	(0.01)	(0.02)	(0.02)
Indoor floor area	-0.015	-0.024	-0.018
	(0.01)	(0.03)	(0.01)
Distance from CBD	0.059***	-	0.038**
	(0.01)		(0.02)
Decade (Reference = 1940-1970)			
1970-1980	-0.085**	-0.085**	-
	(0.04)	(0.04)	
1980-1990	-0.11***	-0.11***	-0.14***
	(0.04)	(0.04)	(0.04)
1990-2000	-0.11***	-0.11***	-0.12**
	(0.04)	(0.04)	(0.05)
2000-2016	-0.016	-0.016	-0.062
	(0.04)	(0.04)	(0.06)
Constant	0.39***	0.49***	0.34***
	(0.04)	(0.05)	(0.05)
Observations	436	436	349
R^2	0.192	0.392	0.217
Adjusted R^2	0.171	0.217	0.182
Tract fixed effects	No	Yes	No
Top quartile control	Yes	Yes	Yes
Median income control	No	No	Yes

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Panel regression of upward income transitions for neighborhoods

Note: These estimates are derived from n linear probability panel model. All independent variables are standardized into standard units with a mean of zero and a standard deviation of one. The 1970 data do not contain ethnic- and race-specific income data, and thus, we are missing these years in our analysis.

6. Spatial and temporal heterogeneity in neighborhood change

Moving beyond our focus on the average trends in neighborhood income transitions since the ‘40s, we now investigate whether the characteristics of changing neighborhoods have also shifted

historically. Understanding the nature of historical change is important as there is widely held view that gentrification today has accelerated compared to the neighborhood changes of the past, and is also distinctive in its concentration in central-city areas and non-White neighborhoods. Our remaining analyses, therefore, focus on identifying heterogeneity in gentrification and neighborhood change processes across time and space. We first examine which *areas* of the city have experienced substantial improvements in income rank across time, before establishing whether the types of places that are changing differ today than in the past.

6.1. Examining where neighborhoods are changing over time

Figure 5 maps which census tracts moved up at least one income quartile in three snapshots across the 1940-2016 period. From our investigation, we identify three discrete periods of neighborhood income rank changes that roughly span the 1940-1980, 1980-2000, and 2000-2016 periods. These periods are characterized by quite distinctive general rates and geographies of change. Although one might question whether these periods can be generalized beyond Denver, it is notable these periods closely follow historical trends which have been observed across many US cities.

The first period of spatial neighborhood change spans the 1940-1980 decades. In this period, improvements in neighborhood income rank were heavily concentrated at the edge of the city. As these edge places were more sparsely populated and had land which was less intensively built upon, we label this era as one of "Peripheral Development." From our data, we calculate that 9% of lower income neighborhoods moved up at least one quartile per decade over this period.[8] While we are reasonably confident that the spatial pattern of change is accurate, we suspect that as we do not observe new suburbs and lack strict decadal snapshots within the 1940-1970 period, 9% is likely a lower-bound estimate for upward neighborhood income transitions.

The second period we observe spans the years from 1980-2000 and reflects what we describe as "Neighborhood Immobility." In contrast to the 1940-1980 decades, the spatial patterning of neighborhood income rank increases from the '80s on is mixed between central-city and peripheral areas. What is even more notable, however, is that neighborhoods appear to have been generally stagnant in terms of their rank ordering. The decadal rate of neighborhood income rank growth drops from 9% over the 1940-1980 period to 4.5% in the '80s and '90s. Further, if 9% is indeed an underestimate, this decline in mobility was probably more pronounced than what

[8] As we do not observe neighborhoods in 1950 and 1960, this estimate is likely a lower bound.

we observe here. Thus, the '80s and '90s were characterized by a spatially diffuse pattern of change that was confined to a relatively small number of places.

The final period of change we identify spans the 2000-2016 years, which heavily overlaps with the period of focus for much recent gentrification scholarship. This period is striking in that increases in neighborhood income rank are, first, characterized by a substantial increase on earlier decades: the decadal rate of upward income transitions roughly tripled from 4.5% over the 1980-2000 period to 16% from 2000-2016. From our estimates, this rate of neighborhood rank change is unprecedented in the history of the city. The second key feature of this period is the degree to which upward transitions are concentrated around Denver's Central Business District, while there is no evidence of upward change occurring elsewhere in the city. These patterns are so distinct that they almost appear to be the reverse of those observed in the Peripheral Development period. Thus, the 2000-2016 period appears to have been one of "Central-city Resurgence."

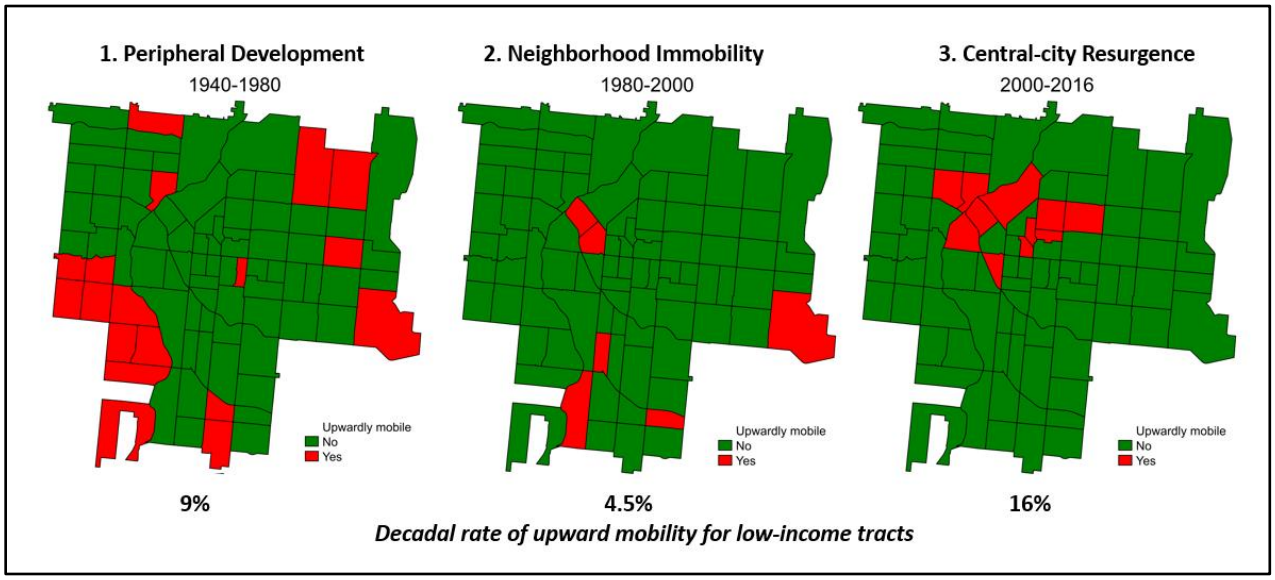


Figure 5. Spatial patterns of neighborhood change from 1940-2016

Note: Upward mobility refers to a tract moving up one income quartile. The rate for low-income tracts is calculated from all tracts at the median or below, while the maps show upward income quartile movement for all tracts. Tracts in red moved up income quartiles.

When taken together with our earlier findings, these analyses highlight that neighborhood persistence and change play out in a distinctly spatial fashion. While there is a distinct social patterning (i.e. by race and ethnicity) in terms of which neighborhoods change, we are showing a distinct and historically varying spatial imprint of change focused first on peripheral and suburban

development, and a later renewed force of central-city change. It is also notable that even in the '80s and '90s when upward income transitions were relatively rare, the changes that do occur are adjacent to neighborhoods that grew in income rank in period decades, perhaps suggesting the presence of local spillover effects.

6.2. Examining which neighborhoods are changing over time

Our final analysis sets out to determine whether the characteristics that predisposed low-income neighborhoods to change are the same today as they were in the past. Do, for example, the Black and Hispanic population shares of neighborhood have the same constrained relationship with income rank growth today as they did 50 years ago? We answer this question by estimating six separate linear probability models for each of our decadal snapshots:

$$(3) \quad Upward\ mobility_{i,t-t+1} = Income\ rank_{i,t} + Hispanic\ share_{i,t} + Black\ share_{i,t} + Population_{i,t} + Indoor\ floor\ area_{\ i,t} + Distance\ from\ CBD_{\ i,t}$$

where we estimate the probability that neighborhood *i* moved up a full income quartile between time *t* and *t + 1* by our neighborhood characteristics, which we observe in time *t*. We can interpret these estimates as being the time-varying neighborhood characteristics that most strongly relate to income rank improvements over time. As top quartile tracts are unable to move up, we restrict the sample to tracts in the bottom three quartiles.

In Figure 6, we plot the estimates from these models. Each panel graphs the estimated coefficient for a single variable of interest at the start of time period *t* with reference to the probability of a neighborhood moving up at least one income quartile over the subsequent period *t* to *t+1*. For the 1940-1970 estimates, for example, the Black share of the tract is measured in 1940, and for the 2000-2016 estimates, the Black share is measured in 2000. The x-axis of each panel refers to the decade in question, while the y-axis plots the coefficient derived from each regression. The red line signifies zero and if the confidence interval of a coefficient crosses this line, the estimate is not significantly different from zero.

We begin by investigating how the baseline income rank of neighborhoods correlate with movement up at least one income quartile. The first panel (P1) shows that from 1940-1980, higher ranked neighborhoods were significantly less likely to move up income quartiles. Despite weakening over time, the negative association between income rank and upward movement persists through the 1980s and 1990s, confirming our earlier descriptive finding that neighborhoods in higher income quartiles are particularly resistant to change. The 2000-2016

period is one exception, however, as this is the only period in which there appears to be no relationship between initial income rank and subsequent rank improvements. Thus, recent neighborhood change appears to be peculiar in being more distributed across neighborhoods of different income levels.

Over the 2000-2016 period, we also observe substantial shifts in the relationship between the racial and ethnic characteristics of neighborhoods and the probability of moving up income quartiles. In the second (P2) and third panels (P3), we plot the coefficients for the Black and Hispanic share. Across the full 1940-2000 period, the point estimates for the Black and Hispanic share are always negative, indicating that neighborhoods with larger minority population shares are significantly less likely to increase in income rank. Given the small sample size in each year of observation (n=88), it is not surprising that confidence intervals are wide. Once again, however, the major deviation in this trend is the 2000-2016 period, where the effect of the Hispanic share is zero and the Black share is *positively* associated with increases in income rank. Thus, the 2000-2016 period appears to be the first in 80 years where the presence of Hispanic and Black households are weakly or even positively associated with increases in neighborhood income rank.

The associations between indoor floor area and population with income rank increases also vary over time. In Panel 4 (P4), there is no strong association between total population from 1940-1990 and the probability of moving up income quartiles. From 1990 on, however, there is a negative relationship between total population and substantial income rank increases. This relationship is linked to the central-city focus of post-1990 neighborhood change. As shown in our earlier tract descriptive statistics (Table 1), central-city tracts were less populated on average by 1980 than more outlying neighborhoods. This strong negative association between total population and income rank growth may indicate that the depopulation of Denver's central-city through outmigration and the city policies of the mid to late twentieth century may be related to the gentrification of central-city neighborhoods in the early twenty first century.

It is also notable that the indoor floor area estimate behaves differently to the measure of total residential population. Over the 1940-1970 period, there is a strong negative effect of indoor floor area on the probability of a neighborhood moving up income quartiles. This suggests that the neighborhoods that increased in income rank tended to have land which was being used less intensively. This 1940-1970 period falls within the timeframe which we referred to as Peripheral Development, and this relationship reflects the focus of neighborhood development in more

outlying areas which had a greater abundance of undeveloped land which could be converted into newer peripheral or suburban neighborhoods.

Finally, from Panel 6 (P6) we can investigate whether distances from the CBD is directly associated with income rank increases. Our estimates suggest that this relationship is quite strong as even controlling for the economic, racial, demographic and built characteristics of neighborhoods, there are significant and time-varying effects of distance from the CBD on the probability of a neighborhood moving up income quartiles. Although we find no independent effect of location from 1940-1970, we do find a strong positive association over the 1970-2000 period between a neighborhood's distance from the CBD and increases in income rank.

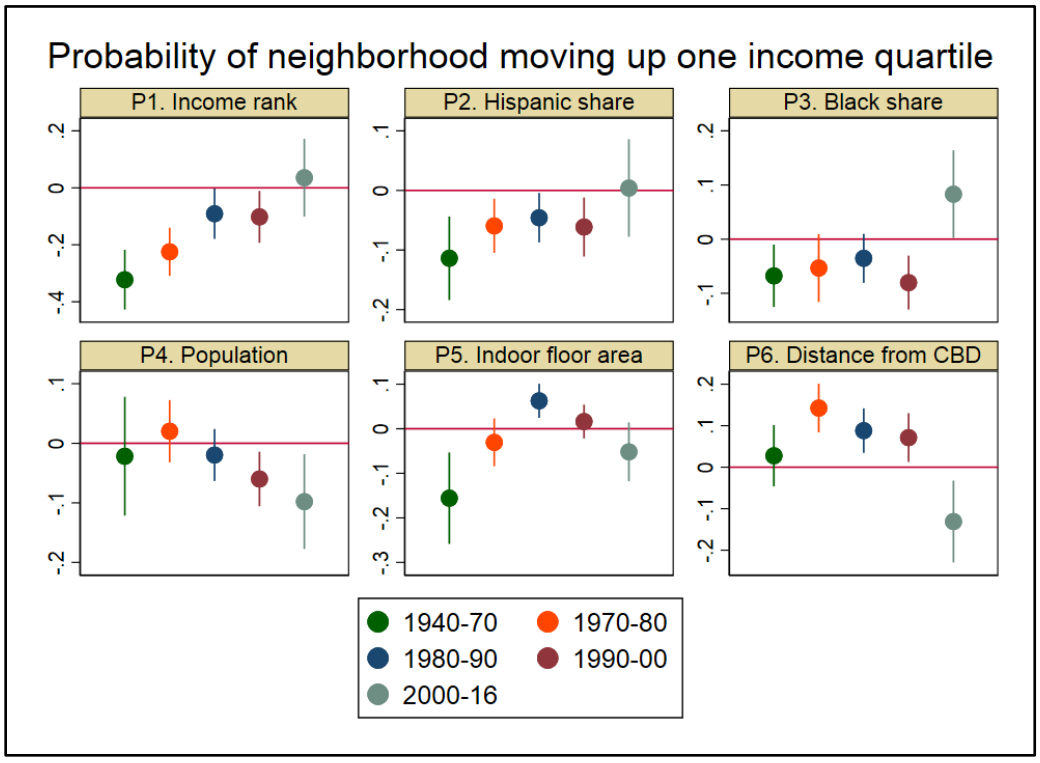


Figure 6. Predictors of upward neighborhood mobility by decade

Note: The Hispanic share is linearly imputed for 1970. Confidence intervals are at the 10% confidence level. These estimates are derived from linear probability models but look very similar to the estimates derived from a logistic model.

Once again, however, the 2000-2016 period departs from earlier trends as distance from the CBD is strongly negative, highlighting the resurgence of central-city neighborhoods. Thus, even controlling for differences in the characteristics of central-city and outlying locations, we find

evidence of independent effects of spatial location and improvements in neighborhood income rank. The likely explanation for these significant and time-varying distance effects is that the factors affecting the switch in residential and investment preferences from suburban to central-city locations over recent decades are not well measured by the neighborhood characteristics in our data (e.g. racial composition, population and built environment).

We draw two main conclusions from these analyses. First, when viewed over the long-run, neighborhood change has an identifiable period-specific structure characterized by quite dramatic shifts in the characteristics of neighborhood gentrification and development over time. This finding provides clear support for neighborhood theory emphasizing shifting geographical patterns of neighborhood change and gentrification (e.g. Hackworth & Smith, 2001). Second, while the racial composition of neighborhoods has exerted strong effects on the income ranking of places from the 1940s to the end of the twentieth century, the post-2000 era of change seems to be different. Not only have central-city areas become the focal locations for relative increases in income levels, but recent changes appear to somewhat transcend the racial and ethnic composition of neighborhoods, which have been the dominant traditional features of neighborhood persistence.

7. Discussion and conclusion

The gentrification of U.S. cities has led to diverging perspectives with respect to the prevalence and distinctiveness of recent neighborhood changes. Gentrification is conflictingly depicted as both an unstoppable force that is increasingly endemic to US cities, and a more concentrated phenomenon that occurs within a more resilient set of neighborhood structures (Brown-Saracino, 2017; Hwang & Sampson, 2014). The absence of longitudinal neighborhood data poses a significant barrier to distinguishing between these perspectives. In this article, we addressed this issue by constructing a new longitudinal dataset on Denver neighborhoods to answer two key questions.

First, is neighborhood status highly persistent over long time periods? Over the 76 years covered by our data, we find the income levels of neighborhood to be highly persistent in that relative to one another, neighborhoods appear to be situated in similar positions at the beginning and end of our eight decades of analysis. We find Denver's neighborhood structure to be heavily anchored by the resistance of high-income, typically White neighborhoods to change, and persistence at lower income levels for neighborhoods with larger Black and Hispanic populations.

Our findings, therefore, support hypotheses that the neighborhood structure of cities are both highly persistent and racialized (Hwang & Sampson, 2014; Sampson, 2012).

Second, do neighborhood changes today substantially differ from those in the past? In deriving a three-period schema, we demonstrate that the resurgence of neighborhoods in central Denver since 2000 is unprecedented in both its rate and spatial patterning when compared to the prior 60 years of neighborhood change. These recent patterns of gentrification are particularly peculiar in that they are affecting Black and Hispanic neighborhoods to a greater extent than in any prior period we observe in our data. This reconfiguration of Denver's neighborhood geography (and similar changes occurring in other cities) require a greater comparative historical focus to better understand the mechanisms generating historical and spatial discontinuity in neighborhood change patterns.

Viewing neighborhood changes from a long-term perspective, as we do, has highlighted several key challenges and directions for urban theory. Perhaps most notably is how best to incorporate historical (dis)continuity and period effects into neighborhood theory and analysis. The immediate post-war period, the Great Migration from the South, White-flight, and central-city decline have all been the focus of much important research (see Boustan, 2016). Further, emerging analyses are now attempting to ascertain the long-run impact of "Redlining" beginning in the 1930s and post-war Urban Renewal policies (Aaronson, Hartley, & Mazumder, 2017; Collins & Shester, 2013). At least in Denver, many of the neighborhoods affected by these policies and population movement are now gentrifying, and thus raise an immediate question of whether mid-twentieth century policy primed the pump for contemporary gentrification. This issues raises the fundamental theoretical question of what timeframe should we expect neighborhood change processes to unfold? That is, should neighborhood change be viewed as a decade-on-decade process, or do we need to greatly expand the temporal focus of neighborhood change and continuity to incorporate earlier eras of urban transformation?

The methodology we present here provides new opportunities to better understand these core neighborhood issues. By integrating contemporary census data with records from the 1940 census and building characteristics from the new ZTRAX database, we present a reliable and representative strategy for assembling the data required to study long-term neighborhood change. With ongoing efforts to digitize the historical enumeration boundaries of US cities (see Logan & Zhang, 2018), we envision an extension of these approaches to cities throughout the United States.

Given the importance of urban historical development and the issues of temporality that we have just raised, we view these comparative analyses as a high priority for neighborhood research. One fundamental challenge still facing us is the incorporation of suburban areas, many of which did not exist in a meaningful sense in 1940 and which were coarsely enumerated as a result. Given growing concerns on the suburbanization of poverty in the US, appropriately incorporating suburban development into long-term neighborhood analyses should be an important future goal.

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