Title
Structure and Segregation: The Importance of Age Structure in Households, Neighborhoods and the Population for Residential Patterns in the United States, 1940 – 2015

Author
Sullivan, John W

Publication Date
2020

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Structure and Segregation: The Importance of Age Structure in Households, Neighborhoods and the Population for Residential Patterns in the United States, 1940 – 2015

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Sociology

by

John William Sullivan

2020

ABSTRACT OF THE DISSERTATION

Structure and Segregation: The Importance of Age Structure in Households, Neighborhoods and the Population for Residential Patterns in the United States, 1940 – 2015

by

John William Sullivan

Doctor of Philosophy in Sociology

University of California, Los Angeles, 2020

Professor Jennie Brand, Chair

This dissertation examines the ways that age shapes residential patterns in the United States. Sociologists have learned much about residential segregation since the founding of the discipline. However, few directly consider age as an element of segregation itself or as an important factor shaping racial segregation. I address these gaps by studying *age* as a dimension of residential segregation and by focusing on how the *age structure* in households, neighborhoods and the population is associated with segregation by age and by race. I use US Census data to study segregation in neighborhoods and metropolitan areas from 1940 to 2015. In the three chapters I explore segregation by age, longitudinal aging patterns in census tracts and the connections between age structure, neighborhood aging patterns and racial segregation. I find that age indeed structures residential patterns in the United States and is due greater attention in the sociological segregation literature and in public debates about generational change.

The dissertation of John William Sullivan is approved.

Judith Seltzer

Ka Yuet Liu

Anne Pebley

Jennie Brand, Committee Chair

University of California, Los Angeles

2020

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Acknowledgements

Many people helped me complete this dissertation. I first thank my parents, Tim and Beth, and my partner, Krista. Their love, patience and support were ever present, particularly as the years dragged on and the finish line seemed far away. I also remember those that died while I was in school, my grandmother Therese, my great aunt Jody and my auntie Anne.

The neighborhoods of St. Paul and Minneapolis, MN showed me that residential segregation shapes metropolitan areas in the United States. The causes and consequences of segregation and inequality in those cities were present long before I became aware of them. I have benefited from the prosperity of the Twin Cities and know that many others have been left out. I hope the events of this spring will produce real equity and shared prosperity in my hometown. The seeds of this dissertation were planted in an undergraduate paper I wrote for a geography course at the University of Minnesota. After a brief stint with an Oakland non-profit and with the guidance of Dom Apollon and Yvonne Liu and the support of Doug Hartmann and Toben Nelson, I made it to UCLA. I won't forget the levity of friends, who as I left Minnesota for graduate school, warned that "LA is terrible", I had *UCyaLAter'd* and, worse still, *bruin*ed my life. I always felt that I won the California lottery, a free education at an elite institution, what a privilege.

At UCLA, Robert Mare helped greatly to advance my vague interests into an actionable outline of the papers I present here, particularly, the second paper. The Mare-Seltzer working group and the weekly CCPR seminars set an important rhythm. I thank my committee chair Jennie Brand for taking me on as an advisee late in the game. I also thank Judith Seltzer, Anne Pebley and Ka-Yuet Liu for serving on my committee. I took a class from each one of my four committee members. Their instruction gave me a foundation in methods, theory and practice without which I would not have been able to conduct my dissertation research. I thank Michael Tzen, without his help I would still be stuck on some strange statistics or computing problem. I thank staff in CCPR and Sociology, particularly, Ana Ramirez, Lucy Shao, Steven Johnson, Irina Tauber and Wendy Fujinami, for managing the logistics of my training and funding. I am grateful that the Sociology Department and Rob supported my employment with the Census Bureau. Though it didn't help me finish quickly, it did provide a community of colleagues and research and career opportunities for which I am very grateful.

I am grateful for the infrastructure that makes demographic research possible. I could not do my work without the products of the US Census Bureau and IPUMS/NHGIS. Further, my research would have been much more tedious without data products, documentation and code from the Longitudinal Tract Database, the USA Mortality Database, ICPSR, NBER and a number of individuals. I am grateful to the organizations that funded my training and research in social demography, specifically, the NICHD, the UCLA Sociology Department, the California Center for Population Research and the Treiman Fellowship. Further, I am grateful to the authors of the methods texts that I frequently referenced while doing this work, particularly, Preston, Heuveline and Guillot; Woolbridge; Treiman; Powers and Xie; and Long and Freese.

The gap between young and old
Exists because it's what we're told
The older generation or the youth of today
Views and actions defined by age
…
A gap is nothing, an empty space
In your mind defined by age
Fill the space - Defined by age
-RP

Vita

Education

M.A. 2014 University of California, Los Angeles, Sociology

B.A. 2009 University of Minnesota, Twin Cities, Sociology

Publications

Bartholomew, T. T., Gundel, B. E., Sullivan, J. W., Pérez-Rojas, A. E., & Lockard, A. J. (in press). Pre-treatment counseling experiences, stressors, and support differences between transgender and cisgender university students seeking mental health care. Journal of Clinical Psychology.

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John Sullivan. "Discoveries" section contributor. 2009. Contexts, 8(2), 8(3), 8(4).

Positions

Administrator, Federal Statistical Research Data Center, US Census Bureau
University of California, Los Angeles, 2014 –

Postdoctoral Research Associate in Population Studies, Brown University
Los Angeles, CA, Fall 2020 –

> Age is the central variable in the demographic model. It identifies birth cohort membership. It is a measure of the interval of time spent within the population, and thus of exposure to the risk of occurrence of the event of leaving the population, and more generally is a surrogate for the experience which causes changes in probabilities of behavior of various kinds. *Age as the passage of personal time is, in short, the link between the history of the individual and the history of the population.* (Ryder 1964, p. 449).

> "Diverse population elements inhabiting a compact settlement thus tend to become segregated from one another in the degree in which their requirements and modes of life are incompatible with one another and in the measure in which they are antagonistic to one another. Similarly, *persons of homogenous status and needs unwittingly drift into, consciously select, or are forced by circumstances into, the same area*. The different parts of the city thus acquire specialized functions (Wirth 1938, p. 15)."

> "…the careful student discloses the results of individual research with diffidence; he knows that they are liable to error from the seemingly ineradicable faults of the statistical method, to even greater error from the methods of general observation, and, above all, he must ever tremble lest some personal bias, some moral conviction or some unconscious trend of thought due to previous training, has to a degree distorted the picture in his view (DuBois [1899] 1967, p. 2-3)."

Chapter I

Introduction: Bridging Residential Segregation and Age Stratification

Residential segregation, the extent to which members of different groups live in different geographic areas, exists along various dimensions, at many geographic scales and draws a great deal of scholarly attention. Segregation both denotes and influences the social distance between groups. Social interaction between groups in shared spaces, like residential neighborhoods, may cultivate the development of mutual goals and the expression of common interests (Blau 1977). Existing research primarily focuses on segregation by race or by income and prioritizes residential mobility as the mechanism driving change in segregation and neighborhood composition.

Racial and economic segregation in American metropolitan areas is typically severe. Racial segregation generally rose from 1940 to 1970, but declined from 1970 or 1980 to 2010 (Cutler, Glaeser and Vigdor 1999; Iceland, Weinberg and Steinmetz 2002; Logan and Stults 2011). Residential segregation, particularly between blacks and whites and between Latinos and whites, is linked to a number of factors, including past and ongoing racial discrimination that limits the ability of minorities to access certain neighborhoods, differences in income distributions and the ability to translate income into neighborhood attainment, fair housing legislation, post-war patterns of suburbanization, individual preferences to live near family members or same race neighbors and dynamic interaction between individual preferences and neighborhood composition (Massey and Denton 1993; Ellen 2000; Charles 2006; Clark 1992; Spilembergo and Ubeda 2004; Schelling 1971; Card et. al. 2007). Economic segregation in the United States is lower than racial segregation. Between 1960 and 1970, income segregation was fairly stagnant, but grew from 1970 to 2000 (Fischer et al. 2004). The rich are more segregated from the non-rich than the poor are from the non-poor, income segregation is higher among homeowners and households with children (Reardon and Bischoff 2011; Fischer et al. 2004; Owens 2016). Segregation by race and by income are linked to numerous inequities, including access to services and high quality schools, exposure to crime, disparate health, educational and labor market outcomes and impediments to social mobility (Sharkey and Elwert 2011; Chetty et. al 2014; Sharkey 2016).

These research currents, though fruitful, leave our understanding of other dimensions of residential segregation underdeveloped and additional pathways through which segregation may be attenuated or exacerbated, underexplored. I situate my dissertation research within these gaps in two ways, by studying *age* as a dimension of residential segregation and by focusing on how the *age structure* in households, neighborhoods and the population is associated with segregation by age and by race. Age impacts many aspects of our lives and clearly race and income stratify where we live. The ways and extent to which age impacts residence are less clear.

Age is a central consideration in demographic and sociological research. It grades vital events like mortality and fertility, structures social roles and relationships, defines physical, biological and legal capacities and identifies cohort membership. As individuals grow older, they are reallocated to or transition between different social roles defined by relationships with others and with institutions, such as child, parent, worker or voter (Ryder 1965; Elder, et. al. 2003). Despite social and economic inequities that arise from race, class or gender, people of the same age share practical and symbolic challenges, physical and biological capacities and the broad perception of their age by others (Abramson 2016). The moment of one's birth provides a "link between the history of the individual and the history of the population" (Ryder 1964 p. 449). Individuals in the same birth cohort experience the same historical conditions at the same ages, share a position relative to those born before and after, and have the potential to collectively respond to their shared circumstances (Mannheim 1951).

As an attribute of a population, age structure–how many people there are at each age–reveals much about the population's past vital rates, its current characteristics and its future size and composition (Coale 1964). Age structure emerges from the aggregated behavior and experiences of individuals (e.g. how many children they have, how long they live), but also structures opportunities for individuals, shapes the character of societies and supports institutions "in the sense that particular functions are dependent for their performance on the presence of particular categories of persons" (Ryder 1964, p. 462).

Age stratification theory highlights this multifaceted role age plays in social life, presenting age as both a characteristic that shapes the lives of individuals and as an element of social structure that emerges from and conditions individual experience (Riley 1972; Dowd 1987; Uhlenberg and Dannefer 2007). Age-graded roles and events do not occur in a vacuum, but in a historical context characterized by, among other things, an age structure. In this sense, age signals *agency* and works as an element of social structure that constrains and enables the actions of an individual. How old one is situates the individual in meaningful social groups that shape experiences. How "old" the population is can contour the character of a society and the opportunities available to individuals.

Age stratifies societies by contouring an unequal distribution of positions, rewards, abilities and expectations. The importance of age can be felt as we experience the roles and capacities implied by how old we are or when we abut limiting practical conditions imposed by the age structure of the population. The interaction between individual lives and population age structure shapes labor, marriage, and housing markets (Easterlin 1987; Johnson 1980; Raymo and Iwasawa 2005; Myers and Pitkin 2009), interregional migration rates (Plane and Rogerson 1991), the prevalence and character of types of familial relationships (Laslett 1973; Watkins, Menken and Bongaarts 1987) and government policies (Preston 1984; Demeny 2015).

Past studies of residential segregation connect age to residential stratification in a supporting role, for example, by observing how an individual's neighborhood preferences and probability of moving change with age (Johnson, et. al. 2005; Sampson and Sharkey 2008; Painter and Lee 2009; Boustan and Shertzer 2013). Others consider the residential mobility behavior or the segregation of different types of households, for example, single adults living alone (Marsh and Iceland 2010) or married couples with children (Iceland, et. al. 2010; Goyette et. al. 2014). Few, however, ask how and to what extent age and age structure shapes residence. I present three papers in which I posit that age organizes where we live, both as a characteristic along which we may sort ourselves and as an element of households, neighborhoods, and population structure that can pattern residential opportunities, presenting avenues for or barriers to integration.

I first measure and model residential segregation between older adults and younger people from 1940 to 2015 in American metropolitan areas. As an attribute of individuals, age shapes the degree to which individuals live apart from people older or younger than themselves. I consider the role of age structure at the metropolitan and household level and reconsider explanations of age segregation from previous studies. Does age segregation arise from neighborhood choices that reflect age-graded preferences (e.g. the desire to live near peers or in proximity to certain amenities) or capacities (such as the ability to afford certain types of housing)? Does composition influence age segregation, particularly, the age structure of the population (how many older adults they are) and of households (how common it is for old and young people to live in the same household)?

I then trace aging patterns in neighborhoods over five decades to determine whether the population of a neighborhood “ages” as a cohort or if specific age groups (but different individuals) come to occupy a neighborhood consistently over time. This longitudinal view offers the opportunity to understand how aging characterizes neighborhoods in the long-run, not just at a single point in time. To what extent are neighborhood aging patterns related to other neighborhood characteristics? How might aging patterns influence racial segregation?

I conclude by connecting changes in the age distribution, racial group differences in age structure and the aging dynamics of neighborhoods to racial segregation. Changes in segregation or neighborhood composition due to demographic pressures may be misattributed to changes in prejudicial attitudes or housing market discrimination. Declines in segregation may inspire undue optimism about shrinking social distance between groups if some portion of those changes are due to demographic pressures.

Intergenerational Conflict and the Health and Welfare of Older Adults

Recent news articles draw attention to where, how and with whom members of the growing population of older adults are living. Headlines introduce the "ruppies" or the "broken hipsters," those aging, largely white, baby boomers choosing to return to or move to central cities for the first time (WSJ 2013; NYT 2015). Others express concern for how the elderly will fare, asking, "*What will happen to older adults in the central cities?"* and *"Which cities will become "age-friendly?"* (The Atlantic 2014; AARP 2015) or highlighting the construction of diverse living arrangements that allow for intergenerational contact or co-residence and meet the needs of older adults (The Atlantic 2015; Star Tribune 2015; WSJ 2016). My focus on how age stratifies residence can speak to long-running concerns about intergenerational interaction, racial inequality and the well-being of older adults.

A large literature considers the consequences of urbanization, industrialization and educational expansion for the structure, roles and interactions of family and kin networks (Wirth 1938; Burgess and Locke 1960; Parsons 1964; Goode 1970; Thornton and Fricke 1987; Ruggles 2007). The proximity or co-residence of family members, particularly, older parents and their adult offspring, is related to transfers of resources and care. Family members who live near one another, see each more often and provide more care than those that live further apart (Klatzky 1972; Compton and Pollak 2009). Changes in the extent to which older and younger people live apart from one another may reflect changes in parental control, expectations and responsibilities for familial support (through residential proximity or co-residence), changes in the socio-economic foundations of independent living (for young adults and older adults) and, ultimately, the importance of age as an element of residential stratification.

In the late 1960s, concern over intergenerational conflict was coined the "generation gap" and referred to a purported cultural and ideological gulf between young adults and older people. A generation that had come of age during the Great Depression and fought in a World War struggled to understand a generation that grew up in more stable times and fought for social change and visa-versa. Despite the differences between young people and older people in the 1960's, "public investment in America's families and youth were embraced by older generations who wanted their children and grandchildren to achieve the American Dream" (Frey 2015).

Since the 1960's, the population of the United States has grown older and more racially diverse, transitioning from a society with many young people and fewer older people toward one with a much more even distribution of population across ages and no single racial majority. The Census Bureau expects that by 2023, less than half of the US population under 30 will be white, by 2033 the population over 65 will exceed the population under 18 and by 2050 the population of non-whites will exceed that of whites. For decades, poverty has fallen among older adults, but risen among children (Preston 1984; Frey 2015) and "over the next generation or two, an older, largely white and affluent population will be increasingly replaced by today's disproportionately poor minority children (Lichter 2013). These trends portend a new generation gap, one not just with the potential cultural implications Coale noted,[1] but one defined both by age and race, specifically, between racially diverse young people and a large, predominantly white population of older adults.

As changes in racial or income segregation may reflect changes in the differences between racial or economic groups, changes in age segregation may indicate growth or

[1] "A world population with the age composition of a health resort is a mildly depressing prospect. Such a population would be presumably conservative, cautious and full of regard for the past. A young, vigorous, forward-looking population perhaps appears more attractive, but in the long run the world can keep its youth only by tolerating premature death." (Coale 1964, p. 57).

contraction in the social distance between older people and younger people. Racial differences between largely white baby boomers and increasingly diverse recent birth cohorts may create intergenerational conflict (Attias-Donfut 2000). Older adults may have difficulty relating to and lack a personal connection with the members of the younger generation outside of their own families. Aging baby boomers may prioritize lower taxes and investments in services that benefit the elderly, like Medicare and the maintenance of social security benefits, over investments that directly support children and young adults, like funding for public schools or subsidies for childcare (Uhlenberg and Dannefer 2007; Winkler 2013).

Preston (1984) notes that in the early 1980s, public expenditure benefiting older adults greatly exceeded spending on children. Indeed, ethnic divisions are inversely related to public good expenditure (Alesina, Baqir and Easterly 1999), though some experimental evidence suggests this may work through shared in-group norms and social networks rather than hetergenous preferences for public goods or preferences for co-ethnics (Habyarimana, et. al 2007). Older adults may also be unwilling to provide political support for policies like, Deferred Action for Childhood Arrivals, the DREAM Act or TANF, that favor young people and families with children, particularly, those that are non-white and low-income. As they have in previous elections, voters 65 and older in the 2016 US presidential election, preferred the Republican candidate to the Democratic candidate, while voters 18-29 expressed the opposite preference (Pew Research Center 2016).

Residential age segregation may have implications for the health and welfare of older adults. Older adults often experience limited physical mobility, restricted budgets and diminished social networks, in part, due to the deaths of spouses, relatives and friends. As recent events make quite clear, older adults are also more susceptible to viruses and face greater mortality risk from COVID-19 infection than younger people. Burgess (1960) feared that older adults living in central city neighborhoods faced a future of loneliness, isolation and elevated death and suicide rates. Indeed, social isolation and loneliness among older adults are concerning issues (Wenger et. al 1996) and are associated with increased mortality risk (Steptoe et. al. 2013; Holt-Lundstad et. al 2015), low self-rated physical health (Cornwell and Waite 2009) and low mental health (Abramson 2016). Age segregation may foster discrimination against older adults in a youth-focused society (Hagestad and Uhlenberg 2005; Portacolone 2016) and may decrease opportunities for intergenerational supervision "eyes on the street" in city neighborhoods and parks (Jacobs 1961; Sennett 1970) and support in daily tasks or health emergencies (Klinenberg 2002). Age integration offers opportunities for generations to exchange knowledge. The young can teach the old about technology and the old may pass along lessons learned from long lives. However, age segregated living arrangements can be beneficial for older adults, particularly the wealthy (Abramson 2016). Many older people choose to live in age-restricted communities, like senior apartments or assisted living facilities, where peers, community events, safety and health services are readily at hand (Portacolone 2016). The benefits that come from living with peers in group quarters were seriously and tragically complicated during the COVID-19 Pandemic, as older adults in group quarter faced particularly high infection and mortality rates. Despite the potential for intergenerational contact in age-integrated contexts, older adults may become socially isolated in neighborhoods with few peers, high crime or low collective efficacy (Klinenberg 2002; Portacolone and Halpern 2014; Portacolone 2016). Furthermore, changes in community activity patterns due to COVID-19 may place older adults at both great risk of social isolation and at great risk of serious viral infection. The meaning of age segregation is almost certainly changed by the COVID-19 Pandemic and the myriad changes it has brought to the health risks of daily activities, intergenerational co-residence and contact and social interaction in a community. Unpacking these implications and direct consideration of the pandemic is beyond the scope of this dissertation, but surely the way that the pandemic has changed aging and living arrangements for older adults will be a important avenue of future study.

I focus my dissertation research primarily on the period from 1940 to 2015. This offers a frame rich with social and demographic change in the United States. The post-war "baby boom" temporarily interrupted a long-run decline in fertility and household size, though its influence continues to reverberate today (Reher 2015). Widely available industrial employment ushered in decades of an accessible middle class and high marriage rates, though its subsequent decline would be linked to falling marriage rates and increasing non-marital childbearing, especially, among those without a college education (Cherlin 2016). Booming central city populations peaked in the 1950s and generally declined until the 1980s as suburbs grew and a stark pattern of racial segregation came to characterize many metropolitan areas (Massey and Denton 1993; Baum-Snow and Hartley 2016). Changes in living arrangements resulted in households that were less "age diverse" than those in the past. Declining multigenerational co-residence, increasing prevalence of living alone (especially, among older adults) and growth in the proportion of older adults living in group quarters (like nursing homes) contributed to declining household age diversity (Ruggles 2007; McGarry and Schoeni 2000; Klinenberg 2012). Falling fertility, declining mortality in older ages and the aging of large cohorts concentrated more of the population in old age than at anytime in the past (Preston 1984; Reher 2015) and public and private sources of income helped more older people live independently for longer (Costa 1999; McGarry and Schoeni 2000).

Overview of Chapters

Many cities have neighborhoods that seem to cater to a certain age group. Bohemian inner-city neighborhoods and apartment districts around universities teem with young adults. Retirement communities concentrate older adults in the same area and wealthy neighborhoods with many detached single-family homes may appear to have a large number of older adults. Is *this type of residential organization by age pervasive or idiosyncratic? Has it changed over time?*

In the first paper of my dissertation, I take age as a dimension of residential segregation. I examine segregation between children and older adults and between adults and older adults in metropolitan areas in the United States from 1940 to 2015. Segregation by age is generally low, though it has varied over time and place. It rose from 1940 to 1970, but declined thereafter. To understand variation in age segregation, I pay particular attention to demographic characteristics neglected in previous studies, the age distribution of the population and of households, and reassess the role of other characteristics. I attempt to distinguish demographic or compositional factors from others that may influence segregation by age. From 1940 to 2015, the characteristics of the American population, households and metropolitan areas changed considerably. Some of these changes worked to increase age homogeneity within households, notably, a decline in the prevalence of multigenerational households (households in which a child or adult live with an adult 65 or older) and an increase in living alone. These factors prove important for changes in the degree of segregation between generations.

Long-term residents of many cities can recall a time when neighborhoods now seen as hip haunts were not characterized by young adults and trendy bars. Likewise, in neighborhoods where one might wonder if the older residents really needed all the space in their single-family homes, young children may have roamed decades earlier. *Are neighborhoods places where people age-in-place or temporary residences specialized to different stages of life?*

In the second paper, I consider how the age distribution of individual census tracts changes or remains stable over multiple decades. I assess the prevalence and correlates of two idealized models of population succession. In the first, the population of a neighborhood is characterized by a cohort aging pattern, the neighborhood's age distribution changes as would a stationary cohort. In the other, the age distribution remains constant over time, as a static distribution of neighborhood amenities attracts residents of certain ages year after year. I find that the latter type is considerably more common than the former and that neighborhoods in which the population ages as a cohort have some distinct characteristics.

Patterns of racial residential segregation are often entrenched; however, different groups may come to occupy the same space, overlapping briefly or for decades. In some cases, generational change and racial change may operate hand in hand. For example, groups that had not previously been present in a neighborhood may fill vacancies created by the deaths or housing downsizing of older residents. Likewise, the large generation of "millennials" living in the gentrified neighborhoods today are one generation removed from the baby boomers that led a wave of central city gentrification in the 1980s. *Do differences in the age distribution of the population and of racial groups influence changes in the racial composition of neighborhoods? Is a neighborhood's long-term age distribution connected to racial segregation?*

In the third paper, I apply my findings about age structure and neighborhood population dynamics from the first two papers to examine residential segregation by race. Racial segregation is generally much higher than segregation by age, is closely linked to various forms of inequality, implicated in a number of adverse outcomes and, as such, draws the majority of scholarly attention. The trend in racial segregation is similar to that of age segregation, rising from 1940 to 1970 and declining slowly thereafter. I find that differences in the age distribution are associated with both tract level racial diversity and metropolitan area level segregation. Furthermore, the cohort aging pattern of neighborhood population succession presents durable barriers to racial integration, though it also holds inherent pathways to integration.

In the following section, I discuss how population age structure, household composition, neighborhood aging patterns and residential mobility relate to residential segregation. I follow this with an overview of the data and samples I use throughout the dissertation. I then present each of the three papers separately and conclude.

Background

My dissertation explores the ways that the age structure of households, neighborhoods and the population are related to segregation by age and by race. In the sections that follow, I discuss population age structure, household composition and neighborhood age dynamics as they relate to segregation patterns. I also discuss the primacy of residential mobility in the segregation literature.

Population Age Structure

Age structure at the population or metropolitan area level may shape segregation between groups in a number of ways. First, if we consider age itself as a dimension of segregation, the age distribution describes the relative distribution of the groups between which segregation may exist. As more of the population is concentrated in the ages 65 and older, there are more opportunities for older adults to share neighborhoods with younger people, segregation between the young and the old may fall as a result. Conversely, a growing population of older people, like a growing population with a shared ethnic or national origin, may allow for the emergence of group specific enclaves, like age-restricted retirement communities. *In the first paper, I assess how the age distribution of the population (particularly, the proportion of the population 65 and older) is associated with segregation by age.*

Age structure may also influence segregation through age-specific rates of demographic events. There is an age gradient to many demographic events that influence where an individual chooses to live, how long they are likely to remain there and who they might live with. Residential mobility, moving from one residence to another, peaks in young adulthood and declines thereafter. Marriage and childbearing generally occur in early adulthood and historically, prompt the formation of a new household. Preferences for urban residence and racial diversity in a neighborhood appear to peak for whites during young adulthood, prior to having children. Likewise, demand for certain types of housing units and other neighborhood amenities is not uniform over the life course. Mortality is age-graded, and as individuals die, they can create housing vacancies.

Group differences in age distributions may attenuate or exacerbate racial segregation, even in the absence of actual changes in preferences or inequality, working through natural increase or age-graded residential mobility patterns. Neighborhoods with young non-white populations and older white populations are likely to experience faster growth in the non-white population than the white population. That is, high white mortality and low mortality and high fertility among non-whites account for increasing minority concentration and aggregate segregation between racial and ethnic groups (Simpson, Gavalas and Finney 2008; Bader and Thomas 2016). Differences between the black and white population in age distribution and age-specific propensities to move to suburban neighborhoods exacerbated segregation between these groups. The concentration of the white population in middle adulthood (years followed by low residential mobility) combined with a higher propensity to move to suburban neighborhoods increased black-white segregation in American cities in the 1970s and 1980s (Frey 1984). As large cohorts of Millennials entered young adulthood, they surged into central city neighborhoods that had experienced decades of decline in the white population (Myers 2016).

Variation in the relative size of cohorts may work to modify demand and preferences in housing markets in ways that can influence segregation. In the same way that bulges in generational size effected labor markets and family dynamics (Easterlin 1987), relative cohort size may influence the spatial distribution of population through effects on housing demand. Competition among a particularly large cohort may encourage some seeking housing to modify their preferences. For example, whites with preferences for same race neighbors may relax these preferences and purchase housing in more diverse areas when faced with a large group of peers also ready to purchase housing. *In the third paper, I consider how the age distribution and differences in age distribution between racial groups are associated with racial segregation.*

Household Composition

Most individuals live in households and as a key context in demography, “understanding segregation dynamics requires not only consideration of the dueling forces of discrimination and preference for own-group neighbors emphasized in the segregation literature but also an awareness of changes in household organization and the distribution of groups across household types” (Ellis et. al., 2011, p. 551). Households that are heterogenous in terms of the characteristic along which segregation is measured, will lower segregation between those groups measured at a higher level of aggregation. For example, multi-racial households join individuals of different races in the same household. Indeed, the prevalence of multiracial households in a metropolitan area is negatively associated with racial segregation between members of those groups. Without the increase in multiracial households observed in the 1990s, racial segregation between blacks and whites in the year 2000 would have been higher in many places than was actually observed (Ellis et. al 2011). Similarly, the age structure of households may influence age segregation. Households are generally less age diverse today than they were in the past. Households that join individuals from different generations, for example, when a child lives with a grandparent, will lessen segregation between children and older adults measured at the neighborhood level. A nuanced understanding of age segregation must consider patterns in living arrangements that drive changes in household age diversity. *In the first paper, I explore the ways that the age structure of households influences segregation by age.*

The extent to which household types live in different places may influence segregation between groups. Segregation between different types of households does occur, but is generally low. In White's (1987) examination of residential segregation, household type appears low on the hierarchy of metropolitan differentiation, being less spatially organized than race and social status. Single parent households and people living alone are moderately segregated from other types of households. Single adults living alone are spatially concentrated, primarily in central city neighborhoods (White 1987; Yi 2016; Marsh and Iceland 2006). From 2000 to 2010 non-family households exhibited generally low levels of segregation from family households (Marsh and Iceland 2006; Owens 2016).

Group differences in the prevalence of certain household types may also influence segregation, as segregation by household type may interact with segregation along other dimensions. Households with children are more segregated by income and by race than households without children. Income segregation is half as large among households without children as it is among households with children (Owens 2016). White households with children are less likely to live in racially integrated neighborhoods (Ellen 2007; Iceland et al. 2010; Marsh and Iceland 2010) and are more sensitive to the racial composition of their neighborhoods than are households without children, moving out at higher rates with a higher percentage of black neighbors (Goyette, Iceland and Weininger 2014). Black single adults living alone are more segregated from white married couple households than they are from all whites (Marsh and Iceland 2006).

Dynamics of Neighborhood Age Distribution

Neighborhoods, like any population, change through births, deaths and migration. Residents leave the neighborhood when they die or move away and new residents enter the neighborhood as they are born or move in. However, neighborhoods may vary in the degree to which the different components of population change influence population succession. Age-specific migration flows characterize the patterns of population succession in some neighborhoods. Consider a neighborhood close to a university. Year after year, it has a relatively youthful age distribution. Young people are drawn to this neighborhood by its proximity to the university and amenities catering to students. While most move away upon or shortly after graduation, incoming cohorts of students soon take their place.

A cohort aging process may instead shape the age distribution of other neighborhoods. Consider a subdivision of single-family homes built on the fringe of a metropolitan area. Families with young children are the first to move to the neighborhood, attracted by affordable single-family homes and other amenities. The families remain in the neighborhood for many years. Their children grow up, start families of their own, but stay close to home. The original residents remain in their homes until they grow old and pass away. The age distribution of this neighborhood will cycle with the aging of cohorts, growing old as large cohorts age and growing younger as these cohorts die off and create vacancies to be filled by new families or as younger residents have children. *In the second paper, I identify these neighborhood types and describe their characteristics.*

A neighborhood characterized by age-specific migration may have more opportunities for stable racial integration. Consistent population turnover will produce more frequent vacancies, providing opportunities for individuals from diverse groups to find housing. Whites who moved into stably integrated neighborhoods in the 1980s and 1990s were younger, more likely to be childless, unmarried and renters than whites who moved to segregated areas (Ellen 2000). Additionally, segments of the age distribution may vary by race. For example, the university neighborhood could be located in a racially homogeneous area. The persistent influx of a student body that largely differs in racial composition from the surrounding neighborhood keeps the university area “integrated.” A neighborhood characterized by cohort aging may be less diverse and less likely to experience racial change on account of a lower rate of housing turnover and an intergenerational connection between residents. However, racial change may proceed slowly or cyclically, with neighborhoods diversifying as vacancies created by dying older cohorts are filled by members of other groups. Vacancies in historically white neighborhoods undergoing racial change are created both by emigration of white residents and mortality of aging whites. Racial change can continue as vacancies can be filled by minority group members, especially, in periods where white demand for changing neighborhoods is low or falling. Further, to the extent that these types of neighborhoods have many owner-occupied housing units, residents may be more sensitive to racial change and the neighborhoods more likely to become segregated if racial change does occur (Ellen 2000). *In the third paper, I consider the association of neighborhood age dynamics, group differences in age structure and racial segregation.*

Residential Mobility as the Mechanism of Neighborhood Change

"Whether one thinks that discrimination still shapes residential real estate markets or considers the evidence of preference studies sufficient to explain persistent segregation, residential mobility is the mechanism that produces changes in the spatial separation of groups" (Ellis et. al., 2011 p. 551). The prominence of residential mobility in segregation studies is both long running and valuable, especially, in efforts to understand the rise and relative persistence of black – white segregation in the Post-War United States. Park's (1952) invasions-succession model described how neighborhood composition may change as one group "invades" (moves into) an area and the incumbent group moves out. Likewise, Wirth argued that a mobility-driven sorting process, "persons of homogenous status and needs unwittingly drift into, consciously select, or are forced by circumstances into, the same area (1938, p. 15)" generates socio-demographic differences between neighborhoods.

Two especially prominent theories, spatial assimilation and place stratification theory, frame much research into residential segregation (Charles 2003). Both theories ultimately rely on residential mobility to change patterns and levels of residential segregation. Spatial assimilation theory posits that individuals use their socioeconomic resources to move to neighborhoods with desirable characteristics. Inequality between racial groups in the distribution of income then explains group differences in neighborhood attainment. Place stratification theories emphasize the efforts of advantaged groups to isolate themselves from disadvantaged groups or groups they wish to avoid. Discrimination presents barriers to mobility for segregated groups. As long as barriers remain in place limiting residential mobility, segregation between groups will persist.

Wilson (1987) attributed increases in the concentration of poor blacks in American cities during the 1980s, in large part, to the movement of middle class blacks out of poor, inner city neighborhoods into non-poor, largely white neighborhoods. Mobility in avoidance of the poor and non-white populations produced severe racial segregation in American cities (Massey and Denton 1993). Net migration flows, demonstrate the importance of mobility patterns for persistent black-white segregation and resegregation in temporarily integrated neighborhoods (Quillian 1999). A branch of the literature considers how the probability of residential mobility varies given the characteristics of one's current neighborhood or how one's individual characteristics predicts the type of neighborhood in which they live (Alba and Logan 1993; Pais, South and Crowder 2012). Residential mobility is the primary mechanism producing segregation in Schelling-type models that link individual preferences to macro level residential patterns (Schelling 1971; Bruch and Mare 2006).

A focus on residential mobility leaves out other demographic considerations that may influence neighborhood change and segregation even in the absence of the movement of individuals. In this dissertation, I seek to understand the influence of some of these factors on segregation, specifically, age structure in the population, neighborhoods and households.

Data and Samples Used in the Chapters

In each of the three papers in this dissertation, I use two forms of data from the US Census Bureau for the years 1940-2015, tabulations of individuals and microdata records. The tabulations are based on full Census counts and primarily aggregated to the census tract level. The microdata records are individual level samples of the Census records prepared and distributed by IPUMS. I use the tract level tabulations to determine the age distribution for the population and its racial sub-groups and to calculate measures of segregation at the tract level. I use the microdata to generate metropolitan area estimates of a number of variables that are not available in the full count tabulations (e.g. median income, household composition and proportion foreign-born). For the years 1970 – 2010, I adjust the population of census tracts to account for boundary changes over time using a program developed by Brown University's Longitudinal Tract Database project.

The primary historical frame of this study covers the period from 1940 to 2015, however, data constraints limit some portions of the analysis to the period 1940 to 2010 and 1970 to 2010. In 1940, the Census Bureau had divided 60 major cities into census tracts. Census tracts are administrative units used by the Census Bureau and typically contain 3,000 to 4,000 people. Tract boundaries are relatively stable, but do change over time. In some cities, the areas subdivided into tracts were exclusively within the borders of the central city, but in others, tract coverage spread into some inner ring suburbs. From these 60 cities, I construct a sample of 49 metropolitan areas that I can consistently identify from 1940 to 2015. In a few cases, I combine metropolitan areas that, though separate in 1940, became part of a unified metropolitan area shortly thereafter.[2] The 49 metropolitan areas that I follow, range in population size and include

[2] In a few cases I combined metropolitan areas that though separate in 1940, became part of the same metropolitan area shortly thereafter. For example, San Francisco, Oakland and Berkeley, CA are listed separately in 1940 documentation, but widely considered to be part of a single metropolitan area. Likewise, I join Camden, NJ and Philadelphia, PA and St. Paul and Minneapolis, MN. I exclude cities that are later absorbed into other metropolitan areas. For example, I exclude Elizabeth, Jersey City and Paterson, NJ as they are later absorbed into the NY metropolitan area.

many of today's major metropolitan areas. Areas that grew in population in the second half of the 20th century (primarily cities in the South and Southwest) are notably absent.

Since 1940, many small areas have grown into large cities and the vast majority of metropolitan areas have expanded outward from a single central city to encompass surrounding areas. Census Bureau definitions of metropolitan areas and the boundaries of those areas have changed over time to accommodate this growth. This presents a potential issue for longitudinal analysis of metropolitan areas (Logan, Stults and Farley 2000). Comparing a metropolitan area over time when its boundaries have expanded compares different geographic areas and may introduce bias. Outlying areas that may have been sparsely populated and had little relationship to a central city, may grow and become a part of a metropolitan system over time. Further, new additions may add large populations to the metropolitan area. To account for this and to assess the robustness of the metropolitan area estimates I use in the models, I define metropolitan areas in a number of ways.

First, I follow the 49 areas subdivided into tracts in 1940 in the county-level boundaries that the Census Bureau used to define each area in 1940. For example, in 1940 the Census Bureau defined the Dallas metropolitan area as the population living in Dallas County, TX. In all subsequent years, I track the population of Dallas, but only within Dallas County, even though the Census Bureau's definition of the Dallas metropolitan area had expanded over time to include 11 additional counties by 2010. In this way, I compare the same geographic area over time. Under this definition strategy, five central cities are perfectly contained in the county or counties I use to define them throughout the entire analysis period. For example, I define Denver, CO as Denver County, CO, which is composed entirely of the city of Denver. Metropolitan area fixed-effects entirely capture this characteristic and avoid bias in the estimation of the other independent variables.

The second sample fits the group of 49 metropolitan areas from the first sample into their 1960 county-level boundaries as defined by the Census. For most metropolitan areas, this definition includes more outlying counties than the 1940 boundaries. Many of these counties had small rural populations in 1940, but had grown and suburbanized since. In the case of Dallas, the 1960 definition adds two additional counties. The third sample is composed of all metropolitan areas as defined by the Census Bureau in 1960. This sample includes more metropolitan areas (for example, the growing cities of the south and southwest, like Miami, FL and Phoenix, AZ) than the 1940 sample, but is limited by the fact that no portion of these additional metropolitan areas had been subdivided into tracts in 1940. I mapped the metropolitan areas and their boundaries used in the IPUMS variable (METAREA) to the tract level data.[3] The fourth sample is a collection of metropolitan areas as defined by IPUMS. This is a much larger group of metropolitan areas and includes many smaller cities. The boundaries of these areas are not constant over time, but expand with the Census Bureau definitions.

Incomplete Division into Census Tracts and Other Missing Data

Each of the 49 central cities in the first sample was almost completely divided into tracts in 1940. However, the balance of the metropolitan county was often un- or incompletely subdivided into tracts. My measure of age segregation includes only the area subdivided into tracts, however, I use IPUMS records from the entire metropolitan county to estimate values of the independent

[3] As I discuss later, the division of metropolitan areas into census tracts was not complete until 1970. This somewhat undermines the variable boundary sample design, as the additional counties added to metropolitan area definitions may not be divided into tracts and thus do not figure into the tract level measure of segregation.

variables. To account for this, I count the number of tracts in each metropolitan area and the proportion of the metropolitan county's population living outside areas subdivided into tracts (using full population counts aggregated to the county level). The number of tracts rose steadily from 1940 to 1970, but stabilized thereafter as tract coverage in metropolitan counties became virtually complete. Likewise, the average proportion of the metropolitan county population living outside areas subdivided into tracts declined from nearly 20% in 1940 to about 0.05% in 1970 (Table 2.1).

Missing data and measurement error raise some concerns for my analysis. The tract level data are largely complete, however, there are some gaps. A small number of counties are missing from the tract level tabulations in some years.[4] These records are dropped from the analysis when they are missing. County level information is not available in public-use microdata after 1950. While IPUMS has been able to assign many records to counties, a number of areas have no assigned records in some years. Even when some records can be assigned to counties, this is often incomplete. Records that can be assigned to counties skews toward city core populations. On account of this, measurement error will be lower in my first sample, which follows only core counties over time, than in the other samples that include outlying areas.[5] I could use a multiple imputation model to fill in metropolitan area characteristics for the years and areas in which they are missing.

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[4] Records are missing for Aiken County, SC (outside Augusta, GA) in 1950 and 1960 and Erie County, NY (Buffalo, NY) from 1940 – 1960. In 1950, records are missing for also missing for Atlantic City, NJ, Des Moines, IA, Savannah, GA and Macon, GA. It seems the Census Bureau did not release tract level data for these counties in these years.

[5] The IPUMS variable (METAREA) is missing for all records in 1960 and 2014. I make a simple linear interpolation (1960) and extrapolation (2014) to impute values for the IPUMS derived estimates in the IPUMS metropolitan area sample and the non-metropolitan and unassigned samples. These are not used in the analysis, but the imputed figures do appear in some of the time series plots. For example, one can see the straight line in Figure 1 between 1950 and 1970 in the plot of within household variance in mean age for the IPUMS sample of metropolitan areas. I only impute (with linear interpolation) one variable in the models for all observations in 1950 (monthly rent). Otherwise, observations are dropped from the models when they are missing values of any of the independent variables.

The 2015 tract level tabulations and micro-data records come from the 2010-2015 5-year ACS sample. ACS estimates can be subject to large measurement errors, especially, on small geographic scales like the census tract and in low-income areas of central cities. Despite this short coming, I am buoyed in using these data by the fact that the only tract level measures I take from the ACS are broad categorizations of the age distribution; other measures are on the county level. Though subject to variability, age distribution has high to medium reliability on the tract level in the ACS, considerably better than measures of median income (Folch et. al. 2016). It should be noted that segregation measurement with the Dissimilarity Index of ACS estimates, overstates segregation in areas with small minority population and few census tracts (Napierala and Denton 2017).

Chapter II

Age Segregation in American Metropolitan Areas, 1940 – 2015

Abstract:

Today, a greater proportion of the United States population is 65 and older than ever before. Yet, households in which younger people live with older adults are less common than in the past. These and other trends in living arrangements are underexplored demographic mechanisms in the study of residential age segregation and important to distinguish from other factors that may influence segregation. Neighborhood level segregation between children and older adults (65 and older) and between adults (25 to 44) and older adults is low to moderate in American metropolitan areas and rose gradually from 1940 to 1970, but generally declined from 1970 to 2015. Headship among adults 25 to 44 is associated with increases in age segregation, while growth in the elderly population is associated with decreases in age segregation. Metropolitan area characteristics used in previous studies of age segregation exhibit mixed effects over this period.

Introduction

Age is a central consideration in demographic research. It identifies cohort membership, grades vital events and structures social roles, relationships and physical, biological and legal capacities (Abramson 2017; Elder, et. al. 2003; Ryder 1964). How old one is situates the individual in meaningful social groups that shape experiences and how "old" the population is can contour the character of a society and the opportunities available to individuals (Dowd 1987; Riley et. al. 1972; Uhlenberg and Dannefer 2007). Studies of residential segregation generally focus on segregation between groups defined by race or income. Segregation between people of different ages receives considerably less attention. The spatial separation of old and young has implications for individual well-being and intergenerational interaction and support.

Neighborhood level age segregation is less severe than that by race or income. However, it varies over time and across place. Segregation between retirement age adults and younger people increased between 1940 and 1970, remained relatively stable between 1970 and 1990 and declined or remained stable between 1990 and 2010 (Cowgill 1978; Fischer et. al. 2004; Winkler 2013). Levels and trends in US age segregation are largely similar to those in Canadian cities (Moos 2014; Okraku 1987; Sequin et. al. 2008). Previous studies consider how various metropolitan area characteristics influence age segregation, but neglect to account for demographic or compositional factors, particularly, changes in the population age distribution and household composition. Age segregation is likely sensitive to these characteristics to a greater degree than is racial or income segregation. Today, older adults enjoy more years of healthy and solvent independence than they did in the past. As older adults constitute a growing proportion of the population, there are more opportunities for older and younger people to share neighborhoods. Has age segregation likewise declined? Changes in living arrangements, particularly, declining multigenerational co-residence, in which younger people and older adults live in the same household, have made households less age diverse than in the past. Has age segregation likewise increased?

I use US Census data on American metropolitan areas from 1940-2015 to measure segregation between children (0 to 19) and older adults (over 64 years old) and between adults (25 to 44) and older adults. I present a regression model to assess the influence of age structure and living arrangements on segregation and to re-assess earlier findings with a longer time series and in a framework that accounts for these and other characteristics of cities, the population and households.

Family and Racial Change

Social scientists have long debated the effects of the spatial separation of generations on the structure and interactions of families. Some argued urbanization and industrialization incentivize individualism, prioritize small households, emphasize the conjugal bond over intergenerational bonds and erode familial obligation (Bengtson 2001; Burgess and Locke 1960; Goode 1970; Parsons 1964; Thornton and Fricke 1987; Wirth 1938). Burgess claimed residential mobility within the city had similar detrimental effects on families. As young adults leave their parent's homes in working class central city neighborhoods to form families in the suburbs, they weaken ties between generations and "upset the customary program of reciprocal services," (Burgess 1960, p. 284). Age segregation would decrease intergenerational contact, polarize the social networks, activities and opinions of old and young and abandon the elderly in the city core to face loneliness, isolation and elevated death and suicide rates (Burgess 1960). Other perspectives emphasize that living apart from one's parents and other older adults may be a pre-condition for social change. Young adults who live independently have increased opportunities for autonomy, self-reliance and privacy, and conversely, older adults have less control over younger people (Laslett 1973; Ruggles 2007; Thornton and Fricke 1987). Declining parental control during the event rich years of young adulthood, may allow for social change, particularly, the rise of interracial and same sex unions (Rosenfeld 2007).

The age and racial distribution of the U.S. population are becoming increasingly linked, “over the next generation or two, an older, largely white and affluent population will be increasingly replaced by today’s disproportionately poor minority children” (Lichter 2013). Cohorts born under different historical conditions may develop conflicting values and norms (Ryder 1965). As such, racial differences between largely white baby boomers and increasingly diverse recent birth cohorts may create intergenerational conflict (Attias-Donfut 2000). Older adults may have difficulty relating to today’s children and their parents, on account of racial and class differences between the groups.

In his 1984 address to the PAA, Samuel Preston, warned about a divergence in the economic conditions of children and the elderly. Divergence between the characteristics of the young and the old is concerning in its implication for political support of programs that benefit children, “given the inevitably increasing voting power of the elderly, as the population ages, the legislative agenda may well shift toward the needs of the majority of territory with population stagnation and decline, from a minority of territory with continuing population growth” (Morrill 1995 p. 65). Older adults may be unwilling to support policies like Deferred Action for Childhood Arrivals or the Dream Act, that favor investment in today’s children, who increasingly look less like them and their own children. Investments that directly support children may be seen as being made at the expense of services that benefit the elderly, like healthcare and social security (Winkler 2013). Already, federal spending in the near and long-term greatly favors older adults over children (Committee for a Responsible Federal Budget 2017).

Individual Consequences of Age Segregation

Neighborhoods offer an opportunity for positive intergenerational interaction that may not be found in other contexts like, school or work. Younger and older people both may benefit from age-integrated environments. Social interaction in shared space may cultivate mutual goals and the expression of common interests (Blau 1977). Greater age segregation may decrease opportunities for intergenerational interaction and supervision ("eyes on the street") in city neighborhoods and support in daily tasks or health emergencies (Jacobs 1961; Klinenberg 2002; Sennett 1970). Further, age segregation may increase the social distance between older adults and younger people, fostering discrimination against older adults in a youth-focused society (Hagestad and Uhlenberg 2005; Portacolone 2015).

However, age segregation is not so clearly a social ill. Most intergenerational contact occurs within families and intergenerational relationships may have become stronger and more important over time (Bengtson 2001; Mare 2011; Uhlenberg 2005). Some older adults choose to live in age-restricted communities, like senior apartments or assisted living facilities, where peers, activities, safety and health services are readily at hand (Portacolone 2015). Age segregated living arrangements may help older adults avoid loneliness. These living arrangements are often beneficial for older individuals, particularly, the wealthy (Abramson 2017). Social isolation and loneliness among older adults are concerning issues (Wenger et. al 1996) and are associated with increased mortality risk (Holt-Lundstad et. al 2015; Steptoe et. al.

2013), low self-rated physical health and low mental health (Cornwell and Waite 2009; Abramson 2017). Despite the potential for intergenerational contact, older adults may become socially isolated in neighborhoods with few peers (Portacolone and Halpern 2014; Portacolone 2015). Likewise, communal living situations for young adults, like dormitories, fraternities and sororities, are common in residential neighborhoods surrounding universities and offer many of the same benefits as those for older adults. Spatial concentration of certain age groups, particularly young children and older adults, allows for targeted and relevant neighborhood level health and community service provision (Cagney 2006). Even in age diverse neighborhoods, public safety concerns or low neighborhood efficacy may inhibit intergenerational contact and support (Klinenberg 2002).

The Ecological Model

The Chicago school's "ecological model" aimed to explain the spatial distribution of social and economic characteristics in the early 20th Century American city. Among its contributions, the well-known typology of urban zones presents a series of concentric rings emanating out from the Central Business District (CBD). Though originally focused on class, race/ethnicity and physical characteristics of the built environment, the model had an implicit life cycle component (White 1987) and was extended to describe the spatial distribution of age groups and family types (Burgess and Locke 1960). For example, the CBD is characterized by non-family households, predominantly, single men between 35 and 54 years old. As one moves outward "family disorganization" declines, with large "Matricentric Families" occupying the outer suburban ring. There is some contemporary evidence for spatial differentiation by household type. Indeed, single adults living alone are spatially concentrated, primarily in central city neighborhoods

(Marsh and Iceland 2006; White 1987; Yi 2016). However, from 2000 to 2010 non-family households exhibited generally low levels of segregation from family households (Marsh and Iceland 2006; Owens 2016).

The Chicago urban ecologists interpreted variation in neighborhood age distributions, particularly, the concentration of older adults in the inner core of central cities, as largely an outgrowth of selective migration and resource-based differences in individuals' ability to secure places in spatial hierarchies (Park, Burgess and McKenzie 1928; Wirth 1938). Much like the spatial assimilation theory of racial and ethnic segregation, segregation should emerge as groups with unequal resources compete for scarce and valuable housing. As groups experience upward economic mobility, they translate those gains into better housing in better neighborhoods. Populous and growing cities have a greater potential for spatial differentiation through increased housing competition and a process called 'succession.' In the context of age segregation, succession drives neighborhood change as upwardly mobile young adults move from old housing units in the urban core to newer housing units on the periphery, leaving income constrained older adults behind (Guest 1972).

A number of studies tested hypotheses about age segregation derived from the ecological model. Population size, growth and housing cost appear strongly associated with age segregation, working to increase the segregation of older adults (Cowgill 1978; La Gory, Ward and Juravich 1980). The age of housing stock is negatively associated with age segregation (La Gory, Ward and Juravich 1980). Following World War II, many American metropolitan areas grew rapidly on their suburban fringes. Levittowns, and similar communities, opened large swaths of housing to a particular type of household, working or middle-class white families with young children. Post-war suburbanization may have increased age segregation as young families secured homes in the suburbs while older adults on limited incomes "aged in place" in central city neighborhoods (Cowgill 1978; La Gory, Ward and Juravich 1980).

However, by the 1970s and 1980s, segregation of older adults was no longer accurately defined by a distinction between the city core and its periphery. After experiencing years of depopulation, some central city neighborhoods gained population, particularly among young, educated and upper income whites (Baum-Snow and Hartley 2016; Myers and Pitkin 2009). Furthermore, the income and wealth of older adults changed considerably over the period 1940 – 2015. In 1940, Social Security and other old age assistance programs were just beginning to improve the economic welfare of older adults. Private and public pensions (which were quite rare in earlier years) came to cover a larger portion of the workforce. These programs and large-scale homeownership contributed to large improvements in the financial well-being of older adults, allowing many the opportunity to live alone or outside of the homes of their children. At least during the period from 1940 to 1970, the economic conditions of young adults improved as well. However, income stagnation, tough labor markets and declines in pension provision since the 1980s have tempered some of the gains for both young adults and older adults.[6] Many older adults lived in newly constructed housing built specifically for elderly residents, much of it on the edges of cities (Chevan 1982). The suburban pioneers of the 1940s and 1950s began to enter older adulthood and the suburbs "aged" as many remained in the suburban areas in which they had raised families (Fitzpatrick and Logan 1985).

[6] The ratio of income for the population 25-44 to the population over 65 rose to a peak in 1960 and 1970 (when young adults were doing the best compared to older adults), but has fallen, fairly steadily to 2015 when this ratio is about 1.5 (the incomes of adults 25 to 44 are 50% greater than those of adults 65 and older).

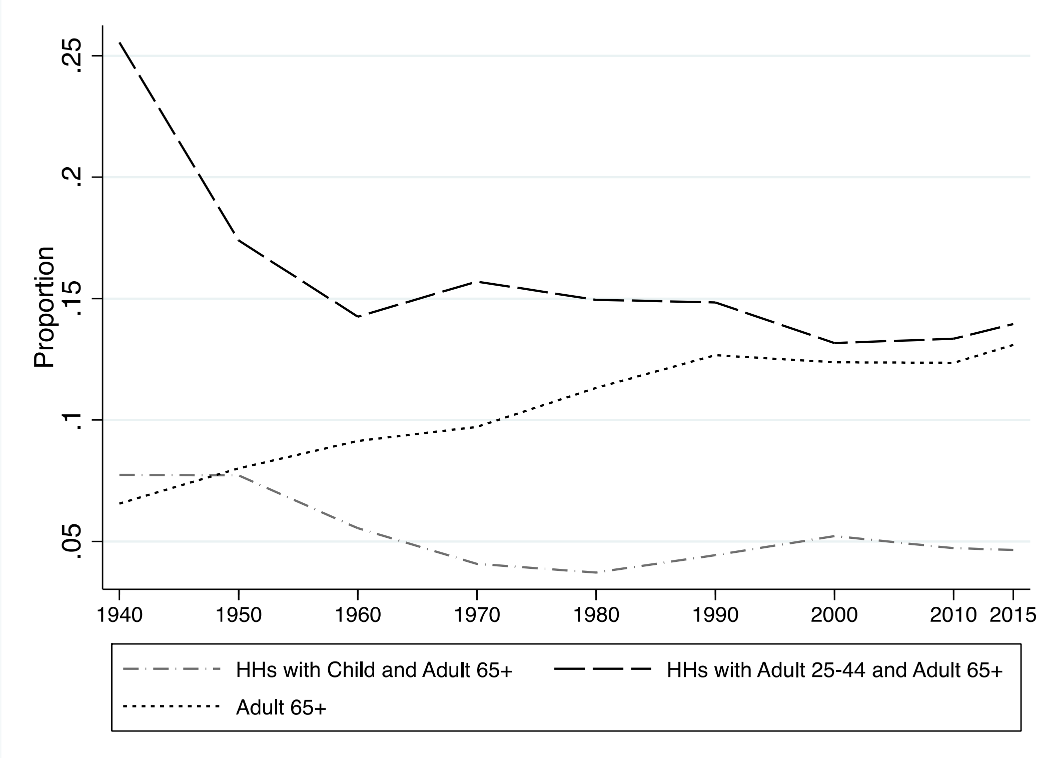
Changes in Age Structure and Living Arrangements

During the 19th and 20th centuries life expectancy rose among older adults, increasing the number of years they were "available" to live with or near their children and grandchildren, though, generally falling fertility decreased the probability that an older adult would live with a child or grandchild (Bengtson 2001; Uhlenberg 2005; Watkins et. al. 1987). The proportion of the U.S. population age 65 and older increased considerably, nearly doubling between 1940 and 2015 from around 6.5% to around 13% in metropolitan areas. *As the proportion of the population in older adulthood has increased, I expect age segregation decrease.*

A number of changes in living arrangements have worked to decrease age diversity within households. Between 1850 and 2010 the proportion of adults 65+ living with their own adult offspring dramatically declined from more than 50% in 1850 to less than 20% in 2010 (Fry and Passel 2014; Ruggles 2007). In 2012, in 10% of households with children a grandparent was also present (Ellis and Simmons 2012). About 8% of metropolitan households in 1940 contained a child and an adult 65, this fell to a low of 3% in 1980 and rose to 5% of households in 2015.[7] A much higher proportion of households contained an adult 25 to 44 and an older adult, nearly 25% in 1940, but falling to about 14% in 2015.[8] This decline is attributed to expansion of the economic opportunities for younger generations arising from increases in their education and income, declines in the economic and symbolic power of fathers (Ruggles 2007) and declines in old age poverty and employment driven by social security (Costa 1999). Figure 2.1 plots these measures of multigenerational households and the proportion of the population 65 and older in a sample of metropolitan areas.

[7] May also include the presence of a middle generation.
[8] No individuals under 20 present.

Figure 2.1 Multigenerational households and population 65 and older, 1940-2015



Household level co-residence necessarily implies co-residence in any higher order geographic unit across which we might measure residential segregation. For example, multi-racial households join individuals of different races in the same household. Without the increase in multiracial households observed in the 1990s, neighborhood level segregation between blacks and whites in 2000 would have been higher in many places than was actually observed (Ellis et. al 2012). Similarly, households in which a child lives with a grandparent or other older adult, will dampen neighborhood level segregation between children and older adults. *I expect the rate of multigenerational co-residence to be negatively associated with segregation between individuals of different ages.*

Boarding and lodging, in which, young, often unmarried, adults pay to live in the home of an unrelated, older couple (often with no young children living at home), has also become less common (Kreider and Vespa 2015; Modell and Hareven 1973). Living alone has become much more common especially among the population 65 and older, who, in part due to Social Security income, can afford to live alone (McGarry and Schoeni 2000). Between 1940 and 1980, the proportion of older adults in metropolitan areas living alone rose from about 10% to about 30%.

Group quarters often concentrate people of similar ages in the same location. Increases in specialized institutions for elder care like nursing homes or assisted living facilities, college dormitory residence among young adults and the prison population may be positively associated with age segregation. Group quarters living among older adults in nursing homes, senior apartments or age-restricted condominiums may be particularly important. Residence in group quarters among women 65 and older rose from 3.7% in 1940 to 9.9% by 1990 (McGarry and Schoeni 2000), though it appears to have since declined.

The age distribution of the US population is increasingly even, transitioning from a pyramid to a narrow rail, yet the age composition of households has fluctuated, growing increasingly different from that of the population. Figure 2.2 plots three measures of evenness, a diversity index, an entropy index and a dissimilarity index. The top line shows a high and steadily rising diversity index for the full age distribution. This shows that the population is increasingly evenly spread across different ages. The lower two lines, plot measures of segregation by age across households. They each show that as the population has become more evenly distributed across ages, individuals of different ages are less evenly distributed across households. Figure 2.3 plots variance around mean age within and between households in a sample of metropolitan areas. Within household variance peaks with the baby boom peak in 1950, but falls its lowest point in 1980, as multigenerational co-residence was near its lowest point. From 1950 to 1970 there was a rapid increase in the diversity of household age distributions (between household variance). Age diversity within households has fluctuated since, but the age composition of households is increasingly different from the age distribution of the population.

Figure 2.2 Population age diversity and age segregation across households, 1940-2015

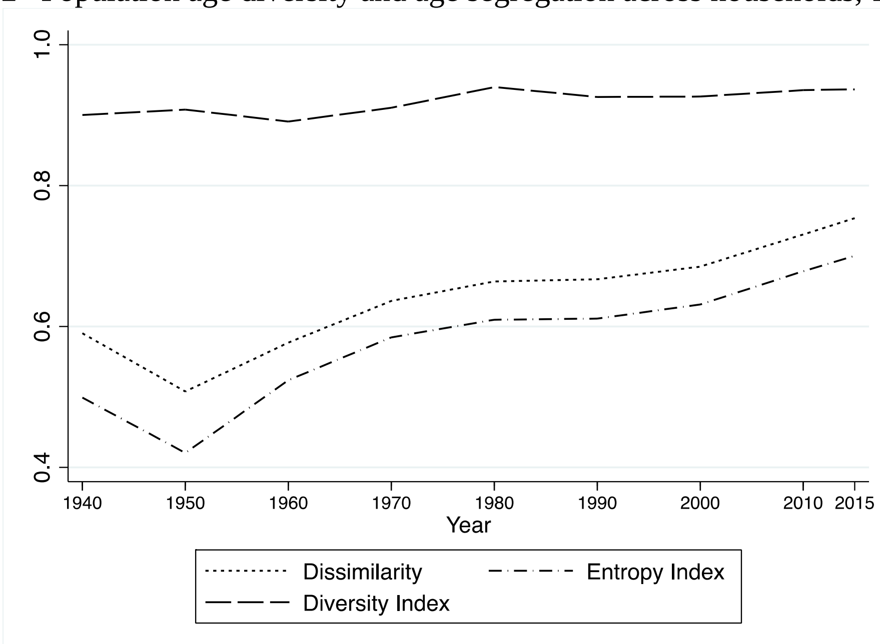
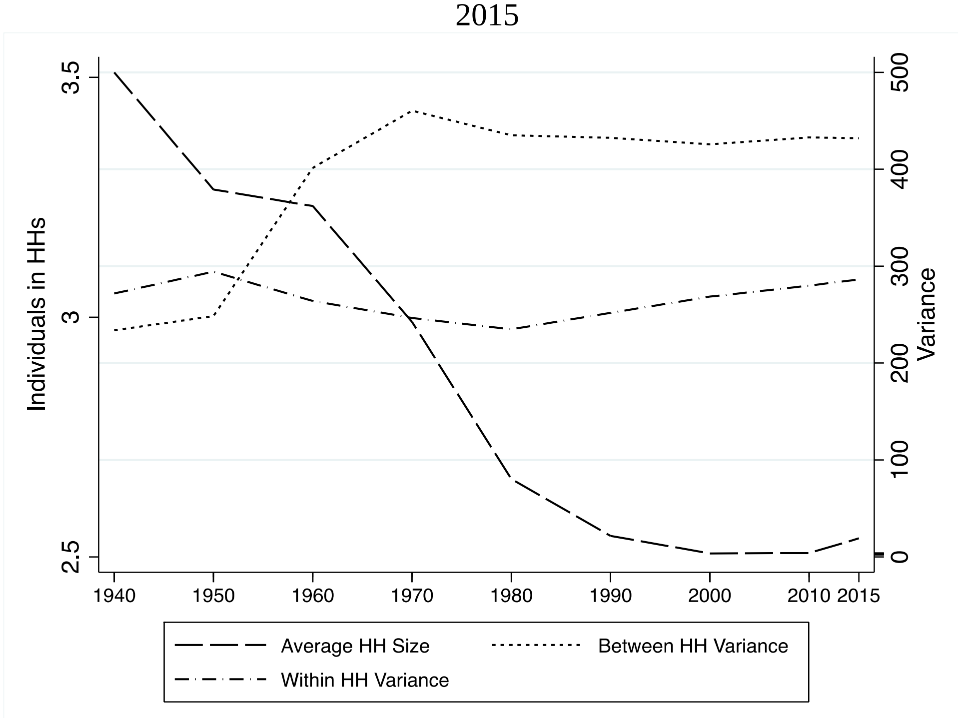


Figure 2.3 Variance of mean age within and between households; average household size, 1940-2015



Life Stage and Neighborhood Preferences

Age segregation may also emerge if individuals prefer to live near others in a similar stage of life or simply share location and housing preferences with peers (Chevan 1982). Preferences for certain types of housing units, low crime rates, proximity to schools and tolerance of racial diversity in one's neighborhood may vary at different points in an individual's life. For example, central city neighborhoods attract those in their early 20's, but many people move to the suburbs as they marry, bear children and approach their 50's (Boustan and Shertzer 2013; Sampson and Sharkey 2008). Young people, 25-34, are more likely to live in urban zip codes with high non-white populations, few college graduates and "transgressive" cultural scenes (Silver and Nichols Clark 2016). Housing changes are linked to changes in life stage and household composition (Kulu and Steele 2013; Mikolai and Kulu 2018; Rossi 1955). People often live in rental housing in young adulthood, transition from renting to home ownership during adulthood and downscale their housing consumption in older ages (Beer and Faulkner 2011).

Household Formation

In the mid-20th century, marriage was a normative precedent to moving into a home of one's own and having children. Industrial employment was widely available to those with less than a college degree and could support a family and homeownership. Marriage rates rose between 1940 and 1970, but began to decline as economic and normative support for marriage began weakened (Cherlin 2016). Household headship rates among adults 25 to 44 follow a fairly similar trajectory, peaking in 1980 and generally falling since.

Long-run changes in household formation and fluctuations in the size of birth cohorts can impact labor market outcomes (Easterlin 1987) and send "pulses of demand" through housing markets. In periods, where great numbers of young people seek to form their own households, age segregation may rise as young adults' demand housing independent from their parents'. In 1970, the population of young adults (25-34) was 6 times larger than it was in 1960 (Myers and Pitkin 2009). Age segregation may rise with rates of household formation, if household heads ages 25-44 are less income constrained than older adults and prefer housing different or distant from that of their parents and other older adults. *I expect household formation among adults 25 to 44 will be positively associated with age segregation.*

Data and Methods

I use two forms of US Census data from 1940 to 2015, census tract level tabulations of population and microdata records.[9] The tract level tabulations are based on full census counts. The microdata records are individual level samples of Census records prepared and distributed by the IPUMS project **(**Ruggles et. al 2015**)**. I use the tract level tabulations to measure age segregation and to determine the age distribution of metropolitan areas. I use the microdata to estimate metropolitan area characteristics.

In 1940, the Census Bureau had divided 60 major cities into census tracts. Most of these cities have since expanded outward. Census Bureau boundary definitions of individual metropolitan areas have changed over time to accommodate this growth. Sparsely populated, outlying areas that may have had little relationship to the labor market of a central city may be

[9] From 1940 to 2010, I use the decennial census, the figures for 2015 are from the 2011-2015 American Community Survey 5-year estimates. Tract level tabulations for 1940-1960 come from the Elizabeth Mullen Bogue File distributed by NHGIS (Minnesota Population Center 2016), tabulations from 1970-2010 come from a combination of the Geolytics NCDB and the LTDB (Geolytics; Logan, Xu and Stults 2012), tabulations from 2015 come directly from American Fact Finder (US Census Bureau).

incorporated into a metropolitan system over time. Annexation and boundary changes may abruptly alter the size and composition of a metropolitan area. This presents a potential issue for longitudinal analysis of metropolitan areas (Logan, Stults and Farley 2004). To account for potential bias this may introduce, I define metropolitan areas in a number of ways.

From the 60 cities divided into tracts in 1940, I construct a sample (*1940 sample*) of 49 metropolitan areas that I can consistently identify from 1940 to 2015.[10] This sample includes many contemporary major metropolitan areas, but excludes areas that grew in population in the second half of the 20th century, including a number of retirement destinations in Florida and the Southwest. I follow these areas in the county-level boundaries that the Census Bureau used to define each area in 1940. For example, in 1940 the Census Bureau defined the Dallas metropolitan area as the population living in Dallas County, TX. In all subsequent years, I track only Dallas County, even though the metropolitan area expands to include 11 additional counties by 2010.

The second sample (*1960 sample*) is composed of all metropolitan areas as defined by the Census Bureau in 1960 with boundaries held at their 1960 definitions. This sample is larger and includes many of the places omitted in the 1940 sample. The third sample (*Metarea sample*) is a collection of metropolitan areas as defined by IPUMS. The boundaries of these areas are not held constant, but change over time with the Census Bureau definitions. These two samples are limited by the fact that the additional metropolitan areas not included in the 1940 sample had not been subdivided into tracts in 1940 and thus have missing values for segregation measures until they are subdivided into tracts (largely complete by 1970).

[10] I combined some metropolitan areas that though separate in 1940, became part of the same metropolitan area shortly thereafter.

Measures of Age Segregation and Metropolitan Area Characteristics

From the tract-level tabulations, I calculate segregation on the census tract level using the dissimilarity index and the entropy index between individuals in two pairs of age groups, children (0 to 19) and older adults (65 and older) and adults (25 to 44) and older adults. The dissimilarity and entropy index are common measures of segregation, both ranging from 0 to 1, with values closer to 1 describing more severe segregation.

The dissimilarity index, D, calculates the evenness of the distribution of two groups, *O* and *C*, over tracts *i* in a metropolitan area. The common interpretation of the dissimilarity index is the proportion of the metropolitan area's population that would have to move in order to achieve an even population distribution. The entropy diversity index, E, calculates each tract's level of diversity in reference to a group, *M*. The entropy diversity index is calculated for all tracts and for the entire metropolitan area. The Thiel Information Theory Index is then calculated, where t_i is the population of tract *i*, *T* is the metropolitan area population and E_i and *E* are the tract and metropolitan area entropy diversity values.

$$D = 1/2 * \sum_{i=1}^{n} |(o_i/O - c_i/C)| \quad (1)$$

$$E_i = \sum_{m=1}^{M} \pi_m * ln(1/\pi_m) \quad (2)$$

$$H = \sum_{i=1}^{n} [t_i(E - E_i)/ET \quad (3)$$

To reassess expectations from the ecological model, I measure the size of the metropolitan area (log of the total number of households), the percentage growth of the area's population and, as a measure of suburbanization, the proportion of the metropolitan area's population living outside of the central city.[11] I estimate housing affordability as the log of the ratio of median annual rent to median annual wage income (pre-tax and transfer income in the year prior to the year of Census collection for the population 16 and older with non-zero wages, adjusted to 2014 dollars). I calculate the relative income of adults and older adults as the ratio of the total income of adults 25 to 44 to the total income of adults 65 and older.

To account for changes in age structure and living arrangements, I find the proportion of the population 65 and older and calculate two measures of multigenerational households; the proportion of non-group quarters households with a child and older adult present (may also include households with a middle generation present) and the proportion of non-group quarters households with an older adult and a younger adult present (does not include households with any individual 19 or younger present). To capture changes in the population living in nursing homes, assisted living facilities and other group quarters, I calculate the proportion of the adult population living in group quarters.[12] I also measure the proportion of the population that owns their home and the headship rate among adults 25 to 44. Table 2.1 presents descriptive statistics about the sample. On average, metropolitan areas in the 1960 and metarea sample have smaller

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[11] I find this figure by subtracting the population of the metropolitan area's chief city (from scans of the printed records of the Census of Population for 1930-1960 and from tabulations distributed by NHGIS for 1970-2015) from the total population of the county or counties used to define the metropolitan area. This method overstates the proportion suburban in areas that have multiple urbanized central cities.

[12] Though a small fraction of the total population, the population living in group quarters are highly age segregated. The definition of group quarters does vary over this study period, for example, from 1940-1970, group quarters are housing units with five or more individuals unrelated to the householder, in 1980 and 1990, this threshold rose to 10 and in years since, group quarters is a special designation of housing units. Though I expect these changes to have minimal effects on my conclusions, I expect that my measures of group quarters will be more inclusive in early years of the study than in later years.

populations, larger land area, are more suburban, have higher rates of home ownership and have grown faster than areas in the 1940 sample.

Table 2.1 Descriptive statistics for metropolitan area samples, 1940-2015

	1940 Sample		1960 Sample		Metarea Sample	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Metropolitan Area Characteristics						
Log Total Households	12.496	1.04	11.997	1.09	12.200	1.10
County Untracted (%)	0.049	0.13	0.046	0.12	0.087	0.13
Land Area (sq. mi.)	881.424	1060.24	1751.434	2680.76	2859.210	3799.85
Population Growth (%)	0.071	0.12	0.136	0.19	0.177	0.24
Suburban (%)	0.456	0.25	0.531	0.22	0.557	0.22
Home Ownership (%)	0.539	0.12	0.620	0.10	0.632	0.08
Ratio Rent to Income	-1.404	0.21	-1.405	0.21	-1.434	0.21
Number of Tracts	328.765	436.96	246.653	403.13	248.277	378.63
Metropolitan Areas	54		191		184	
Observations	383		1054		1185	
Demographic Structure						
Relative Income (25-44 to 65+)	2.130	0.79	2.116	0.77	2.195	0.81
Group Quarters (%)	0.029	0.01	0.031	0.02	0.031	0.02
Headship 25-44 (%)	0.492	0.06	0.502	0.04	0.501	0.04
65 and older (%)	0.108	0.03	0.111	0.03	0.112	0.03
Multigen. (child) (%)	0.052	0.02	0.045	0.02	0.045	0.02
Multigen. (adult) (%)	0.160	0.05	0.141	0.04	0.141	0.04
Dependent Variables						
Dissimilarity (0-19 to 65up)	0.244	0.05	0.242	0.06	0.238	0.06
Dissimilarity (25-44 to 65up)	0.212	0.06	0.223	0.06	0.221	0.06
Entropy Index (0-19 to 65up)	0.068	0.03	0.069	0.04	0.067	0.04
Entropy Index (25-44 to 65up)	0.051	0.02	0.058	0.03	0.057	0.03

Specification of a Regression Model of Age Segregation

I estimate models at the metropolitan area level for two segregation measures from 1940 to 2015. The first, estimates segregation between all children (0 to 19) and older adults (65 and older), and the second, between, adults (25 – 44) and older adults. I first estimate a model that includes only a dummy set for time.[13] This model provides the mean of the segregation index in each year

[13] Models in which I treat time a 3rd degree polynomial give similar results, but fit less well and the time parameters are less intuitively interpreted. I also estimate these models after residualizing *y* and the vector of explanatory variables with b-spline smoothed measures of population size (Rohr and Levi Martin 2018). The results are largely similar to those presented here.

with no adjustments for metropolitan area or demographic characteristics. In Model 2, I adjust the secular trend for differences in the characteristics of metropolitan areas and add covariates for population size, land area, the proportion of the population living outside of areas subdivided into tracts, population growth, proportion of the population living in suburban areas, home ownership and housing affordability. In Model 3, I add additional covariates for the proportion of the population 65 and older, proportion living in group quarters, proportion of households that are multigenerational and the headship rate among adults 25 to 44. To account for non-linearity in the relationship between the older adult population and segregation introduced by the inclusion of a number of retirement destination cities in the 1960 and metarea samples, I also include a quadratic term for proportion 65 and older in models estimated on the 1960 and metarea samples. I estimate all models with and without fixed effects and refer to these as *a* and *b*, respectively. The fixed effects control for time-invariant characteristics of metropolitan areas, like topography, city plans or housing stock that could be related to age segregation. As a robustness check, in Model 4, I regress the entropy index on the independent variables from Model 3b. In all models, I include controls for the proportion of the metropolitan area population that lived outside tracted areas to account for the uneven and incomplete division of metropolitan areas into tract between 1940 and 1970. The full model including metropolitan area fixed effects, where the subscripts, *t* and *j*, index time and metropolitan area, and **X** includes the full set of time-varying metropolitan area covariates, takes the form:

$$Y_{tj} = \beta_0 + Year_j + \beta \mathbf{X}_{tj} + Metro_j + \varepsilon_{tj} \qquad (4)$$

The regression equation predicts the value of an index measure of age segregation in metropolitan area *j* in year *i* as a function of metropolitan level measures of age distribution, living arrangements and population characteristics. The term, *Year*, represents a dummy set for each time period and describes the effect of secular trends in age segregation not absorbed by the other terms. *Metro* captures the effect of any time-invariant metropolitan area characteristics. In the models for segregation between children and older adults, I use the proportion of households in which both a child and an older adult live as the relevant measure of multigenerational co-residence. In the models predicting segregation between adults (25 to 44) and older adults, I use the proportion of households that contain an adult (25 to 44) and an older adult. I estimate all coefficients with robust standard errors.

Descriptive Results

Age Segregation, 1940 - 2015

Age segregation is low to moderate in American metropolitan areas, with values of the dissimilarity index ranging between 0.08 in Macon, GA in 1940 and 0.5 in West Palm Beach, FL in 2000. Segregation is higher between children and older adults than between adults 25 to 44 and older adults. Segregation is generally higher in the 1960 and metarea samples than in the 1940 sample. Retirement destinations in Florida and Arizona have the highest segregation, while smaller metropolitan areas in the south and northeast display the lowest levels.

Changes in the Dissimilarity index of less than 0.05 over the course of a decade are generally considered to be small or represent no real change. Changes between 0.05 and 0.1 are considered moderate and changes greater than 0.1 are considered large, however, small changes, year after year, can constitute a significant trend (Logan and Stults 2011). Figures 2.4 and 2.5

plot the mean dissimilarity index for the 1940 sample between children (0 to 19) and older adults (65 and older) and between adults (25 to 44) and older adults. The dashed lines represent 95% confidence intervals around the mean. Segregation between children and older adults increased monotonically, though gradually, from 1940 to 1970, rising from about 0.2 to 0.3. Segregation declined gradually, thereafter, falling to around 0.225. The figures show a small increase in segregation after 2010. The pattern for segregation between adults 25-44 and older adults is largely similar to that between children and older adults, however, segregation is slightly lower. The increase in segregation between adults and older adults from 1940 to 1970 appears to have been more rapid and the subsequent decline to have slowed or stopped by 1990, consistent with other findings (Winkler 2013).

Figure 2.4 Segregation between children (0-19) and adults (65 and older), 1940-2015

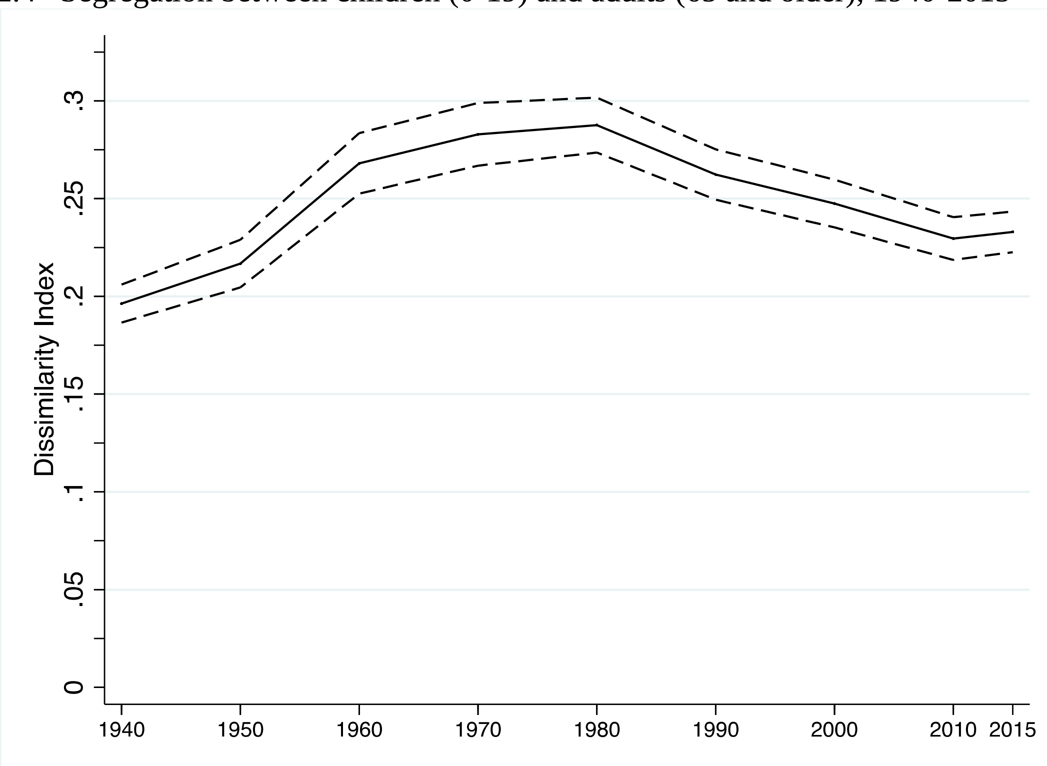
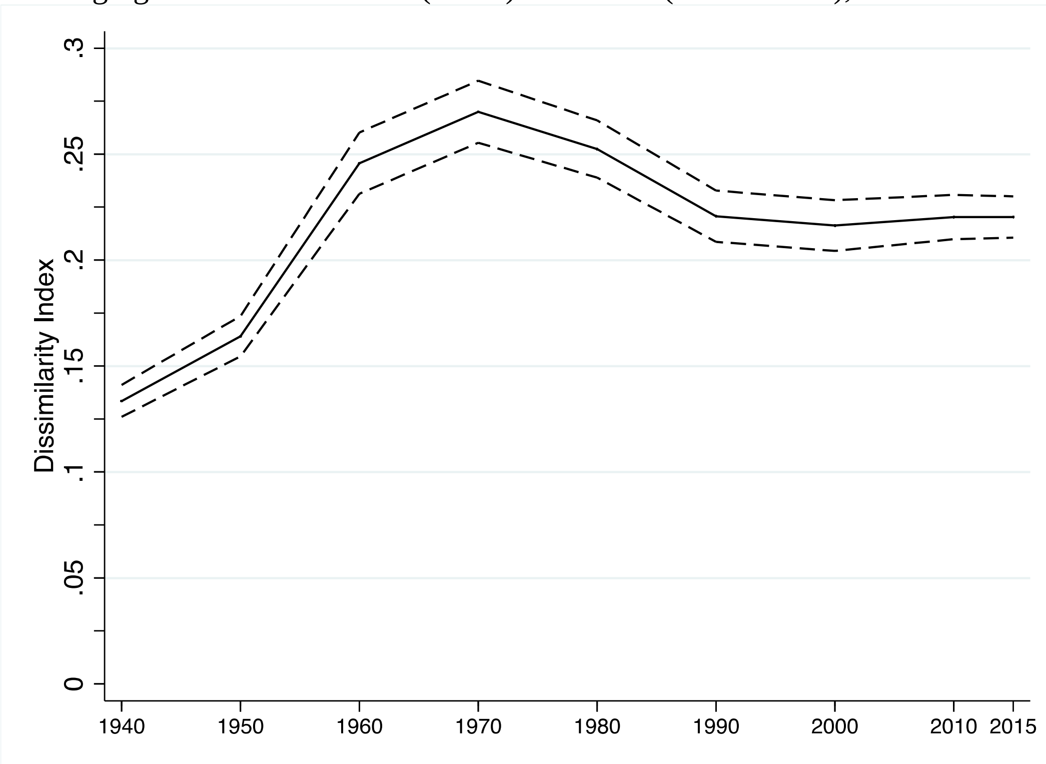


Figure 2.5   Segregation between adults (25-44) and adults (65 and older), 1940-2015



Results of the Regression of Metropolitan Area Age Segregation

Segregation Between Children (0 to 19) and Older Adults (65 and older)

Model 1 describes the temporal trend in segregation between children and older adults (Table 2.2). In each year, segregation is higher than in the reference year, 1940. The coefficients are highest for 1970 and 1980, corresponding with the peak in segregation in these years. These results are largely consistent across all samples. Time dummies alone, explain nearly 30% of the variance in age segregation in the 1940 sample, but only 15% in the 1960 and metarea samples.

Model 2 adds a series of metropolitan area covariates. In both the OLS and fixed effects specifications, the secular trend is largely robust to the additional covariates, though they provide sizable improvements in explaining the variance in segregation between metropolitan areas, though the improvements in *within* variance are more modest across all samples. Models 3a and

3b add the final set of covariates for the demographic structure of the metropolitan areas. Across all samples, Model 3a diminishes the size of most coefficients on the year dummies with some no longer statistically significant at the 0.05 level. Across all samples, there is a small positive and statistically significant association between population size and segregation. There is a negative association between suburbanization and segregation. In all samples, the coefficients on home ownership and housing affordability are positive and significant. The headship rate among adults 25 to 44 and the proportion of households that are multigenerational are consistently positive. The linear effect of proportion 65 and older is consistently negative, the quadratic term (in the 1960 and metarea samples) is consistently positive.

Including metropolitan area fixed effects in Model 3b largely explains the secular trend in segregation. Across all samples, most time dummy coefficients are diminished in size and few are statistically different from 0. Though diminished, the coefficient on population size remains positive and significant in the 1940 and metarea samples. The coefficient on housing affordability is diminished, but remains significant across all samples. Home ownership remains positive and significant across all samples, as does headship among adults 25 to 44, though the coefficient decreases in size and the standard error increases. These coefficients are fairly similar in magnitude across all samples. The coefficient on proportion 65 and older, is large, negative and statistically significant in all samples. The quadratic terms in the 1960 and metarea samples are positive and significant. In these samples, the relationship between proportion of the population 65 and older and segregation turns positive as the proportion of the population 65 and older exceeds 0.15. In each model, population growth, suburbanization, the income ratio of middle-aged and older adults, group quarters and multigenerational co-residence are not statistically significant.

In all samples, Model 3b does a better job of explaining the changes in segregation within metropolitan areas over time than the difference in segregation between metropolitan areas. This difference is smallest in the 1940 sample and largest in the 1960 sample. Across all samples, most of the variance in segregation can be explained by the secular trend and basic characteristics of the metropolitan area. Demographic structure explains considerably less of the variance in segregation.

I re-estimate Model 3b with the entropy index as the measure of segregation. The results are largely consistent with the principal findings of Model 3b, though with some differences. The entropy index generally produces smaller values than the dissimilarity index when describing residential segregation. As a result, all coefficients are smaller in Model 3b. However, most coefficients are signed in the same direction (and when they are not the coefficient is not statistically different from 0 at the 0.05 level). The majority of coefficients exhibit the same significance determination in the 1940 and 1960 samples, though there are more differences in the metarea sample.

Table 2.2 Models of segregation between children (0-19) and adults (65 and older) in metropolitan areas, 1940-2015

	Model 1			Model 2			Model 3						Model 4		
	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	FE (*b*)	1960 Sample OLS (*a*)	FE (*b*)	Metarea Sample OLS (*a*)	FE (*b*)	1940 Sample FE (*b*)	1960 Sample FE (*b*)	Metarea Sample FE (*b*)
1950	0.0184	0.0133	0.0219**	0.0140	0.0208*	0.0389***	0.0327*	0.0256	0.0434**	0.0138	0.0517***	0.00437	0.0140	0.00823	0.000781
	(0.0110)	(0.0106)	(0.00779)	(0.00989)	(0.00941)	(0.00814)	(0.0138)	(0.0150)	(0.0135)	(0.0121)	(0.0118)	(0.00991)	(0.00802)	(0.00562)	(0.00542)
1960	0.0591***	0.0631***	0.0605***	0.0718***	0.0762***	0.100***	0.0851***	0.0594*	0.0903***	0.0479**	0.0978***	0.0267	0.0242	0.0168	0.00943
	(0.0102)	(0.00735)	(0.00709)	(0.0106)	(0.00899)	(0.00842)	(0.0179)	(0.0238)	(0.0160)	(0.0179)	(0.0160)	(0.0146)	(0.0123)	(0.00867)	(0.00841)
1970	0.0876***	0.0937***	0.0801***	0.0915***	0.0791***	0.0951***	0.0758***	0.0614*	0.0727***	0.0499*	0.0748***	0.0123	0.0203	0.0127	-0.00521
	(0.0113)	(0.0109)	(0.00777)	(0.0116)	(0.0107)	(0.00925)	(0.0194)	(0.0298)	(0.0161)	(0.0203)	(0.0162)	(0.0175)	(0.0156)	(0.0107)	(0.0108)
1980	0.0867***	0.0746***	0.0693***	0.119***	0.0830***	0.0796***	0.0744***	0.0686*	0.0455**	0.0492*	0.0355*	0.0125	0.0225	0.0152	-0.00186
	(0.00833)	(0.00708)	(0.00674)	(0.00872)	(0.00926)	(0.00877)	(0.0171)	(0.0299)	(0.0145)	(0.0192)	(0.0146)	(0.0179)	(0.0156)	(0.0103)	(0.0111)
1990	0.0646***	0.0505***	0.0444***	0.0816***	0.0507***	0.0501***	0.0487**	0.0485	0.0131	0.0358	0.00595	-0.00207	0.0121	0.00583	-0.0118
	(0.00786)	(0.00687)	(0.00654)	(0.00872)	(0.00933)	(0.00838)	(0.0155)	(0.0278)	(0.0137)	(0.0190)	(0.0136)	(0.0185)	(0.0145)	(0.0104)	(0.0120)
2000	0.0461***	0.0401***	0.0282***	0.0621***	0.0416***	0.0389***	0.0213	0.0261	-0.000684	0.0240	-0.00968	-0.0170	-0.000111	-0.000669	-0.0199
	(0.00770)	(0.00671)	(0.00622)	(0.00858)	(0.00918)	(0.00845)	(0.0155)	(0.0270)	(0.0136)	(0.0191)	(0.0133)	(0.0196)	(0.0144)	(0.0107)	(0.0128)
2010	0.0287***	0.0228***	0.0110	0.0435***	0.0215*	0.0192*	0.00242	0.00649	-0.0212	0.00726	-0.0308*	-0.0348	-0.00878	-0.00874	-0.0280*
	(0.00717)	(0.00656)	(0.00604)	(0.00897)	(0.00947)	(0.00863)	(0.0153)	(0.0268)	(0.0138)	(0.0193)	(0.0135)	(0.0206)	(0.0142)	(0.0108)	(0.0135)
2015	0.0359***	0.0243***	0.0133*	0.0481***	0.0268**	0.0159	0.0168	0.0211	-0.0104	0.0242	-0.0243	-0.0198	0.000451	-0.000197	-0.0207
	(0.00674)	(0.00608)	(0.00588)	(0.00883)	(0.00953)	(0.00892)	(0.0143)	(0.0240)	(0.0129)	(0.0182)	(0.0126)	(0.0198)	(0.0124)	(0.0101)	(0.0130)
Log Total HHs				0.0165***	0.0194***	0.0190***	0.0187***	0.0106*	0.0215***	0.00703	0.0212***	0.0124*	0.00561*	0.00581*	0.0106**
				(0.00185)	(0.00153)	(0.00143)	(0.00200)	(0.00423)	(0.00159)	(0.00369)	(0.00148)	(0.00514)	(0.00245)	(0.00225)	(0.00349)
Cnty. Untracted (%)				0.0440*	-0.0211	-0.00952	0.0525*	0.0619**	0.0153	0.0788***	0.00328	0.0223*	0.0340***	0.0369***	0.0106
				(0.0221)	(0.0164)	(0.0107)	(0.0230)	(0.0210)	(0.0150)	(0.0141)	(0.0100)	(0.0110)	(0.00883)	(0.00795)	(0.00589)
Land Area (sq. mi.)				1.93e-06	1.41e-06*	1.70e-06***	1.24e-06		1.92e-06***		1.43e-06***				
				(1.56e-06)	(5.60e-07)	(4.28e-07)	(1.51e-06)		(4.76e-07)		(4.10e-07)				
Population Growth				0.125***	0.108***	0.0378***	0.0513	0.0512	0.0571***	0.00835	0.0155*	-0.00577	0.0154	0.000176	-0.00558*
				(0.0214)	(0.0163)	(0.00905)	(0.0270)	(0.0260)	(0.0116)	(0.00996)	(0.00691)	(0.00472)	(0.0133)	(0.00624)	(0.00278)

Table 2.2, cont.

	Model 1			Model 2			Model 3						Model 4		
	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	FE (*b*)	1960 Sample OLS (*a*)	FE (*b*)	Metarea Sample OLS (*a*)	FE (*b*)	1940 Sample FE (*b*)	1960 Sample FE (*b*)	Metarea Sample FE (*b*)
Suburban (%)				-0.0697***	-0.0279***	-0.0485***	-0.0396***	-0.0127	-0.0148*	0.00934	-0.0322***	0.00938	-0.00495	0.00946	0.00676
				(0.00820)	(0.00699)	(0.00746)	(0.00824)	(0.0181)	(0.00658)	(0.0168)	(0.00701)	(0.0169)	(0.00797)	(0.00770)	(0.00814)
Home Ownership (%)				0.0499*	0.0234	0.0460	0.0881***	0.113*	0.0843***	0.107***	0.0718***	0.0969**	0.0616**	0.0501**	0.0321
				(0.0223)	(0.0235)	(0.0261)	(0.0204)	(0.0434)	(0.0204)	(0.0314)	(0.0215)	(0.0330)	(0.0192)	(0.0159)	(0.0193)
Ratio Rent to Income				0.0763***	0.110***	0.134***	0.106***	0.0648***	0.137***	0.0343**	0.152***	0.0331*	0.0314**	0.0143*	0.0113
				(0.0116)	(0.0104)	(0.0102)	(0.0125)	(0.0181)	(0.0107)	(0.0131)	(0.0107)	(0.0149)	(0.00999)	(0.00691)	(0.00915)
Relative Income							-0.0106	-0.00581	-0.0129*	0.00235	-0.00960	0.00653	-0.00354	0.000662	0.00284
							(0.00614)	(0.00651)	(0.00566)	(0.00523)	(0.00551)	(0.00484)	(0.00325)	(0.00253)	(0.00299)
Group Quarters (%)							0.145	-0.375	-0.179*	-0.0495	-0.154	-0.123	-0.269*	0.00332	0.0303
							(0.166)	(0.234)	(0.0821)	(0.106)	(0.0923)	(0.159)	(0.106)	(0.0627)	(0.114)
Headship 25-44 (%)							0.519***	0.349*	0.680***	0.335***	0.703***	0.336**	0.244**	0.203***	0.195**
							(0.0876)	(0.131)	(0.0725)	(0.0921)	(0.0780)	(0.114)	(0.0707)	(0.0528)	(0.0738)
65 and older (%)							-0.424**	-0.557**	-1.956***	-1.677***	-2.037***	-1.549***	-0.200**	-0.707**	-0.611*
							(0.141)	(0.171)	(0.404)	(0.366)	(0.355)	(0.353)	(0.0719)	(0.256)	(0.269)
Sq. 65 and older (%)									7.979***	5.576***	8.283***	5.250***		2.928**	2.668**
									(1.617)	(1.285)	(1.444)	(1.227)		(1.010)	(1.010)
Multigen. (%)							0.239	-0.0970	0.539***	-0.292	0.489***	-0.224	-0.0526	-0.132	-0.128
							(0.136)	(0.219)	(0.116)	(0.186)	(0.117)	(0.196)	(0.106)	(0.0944)	(0.106)
Constant	0.196***	0.196***	0.199***	0.0759**	0.0990***	0.134***	-0.120*	0.0218	-0.123*	0.0527	-0.0864	0.00534	-0.0812	-0.0818	-0.125*
	(0.00466)	(0.00467)	(0.00439)	(0.0284)	(0.0250)	(0.0219)	(0.0586)	(0.0909)	(0.0556)	(0.0784)	(0.0529)	(0.0994)	(0.0503)	(0.0462)	(0.0620)
Observations	383	1,054	1,185	383	1,054	1,185	383	383	1,054	1,054	1,185	1,185	383	1,054	1,185
R-squared	0.293	0.140	0.157	0.614	0.557	0.551	0.679	0.657	0.626	0.529	0.625	0.539	0.668	0.442	0.406
p	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	21.35	25.08	30.75	40.34	81.28	92.10	45.10	39.78	74.26	27.56	85.67	26.49	36.81	22.62	17.52
R2 Within								0.657		0.529		0.539	0.668	0.442	0.406
R2 Between								0.413		0.188		0.342	0.249	0.165	0.252
R2 Overall								0.558		0.312		0.359	0.474	0.264	0.273
Number of id								54		191		184	54	191	184

Robust standard err.

***** p<0.001, ** p<0.01**

It is somewhat difficult to intuitively interpret these coefficients, as a unit change in independent variables measured as proportions (ranging from 0 to 1) and the corresponding change in the dependent variable, are never actually observed. In Model 3b, a change of one standard deviation in the headship rate among adults 25 to 44 (between 4 and 5.5 percentage points) is associated with a change in the dissimilarity index between 0.013 and 0.019 (association is smallest in the metarea sample and largest in the 1940 sample). The corresponding linear association for the proportion 65 and older is slightly smaller and in the opposite direction; a one standard deviation increase in the proportion 65 and older (about 3 percentage points in all samples) is associated with a decrease in the dissimilarity index of 0.017 in the 1940 sample. The quadratic terms in the 1960 and metarea samples are positive and significant. Increasing the proportion 65 and older by three percentage points from the 25th percentile is associated with a decrease of 0.011 and 0.015 in the dissimilarity index, in the 1960 and metarea samples, respectively. Increasing the proportion 65 and older by three percentage points from the 90th percentile is associated with an increase of 0.005 and 0.009 in the dissimilarity index, in the 1960 and metarea samples, respectively. These associations are on the order of those estimated for the integrative effect of mixed-race households on neighborhood level racial segregation, about 0.01 points of the dissimilarity index (Ellis, et. al. 2012) and the effect of the proportion white ethnics on desegregation in the 1970s (Sander, Kucheva and Zaszlow 2018). The effects I find for population size are similar in magnitude to the effect of log total population on racial neighborhood inequality measured with a similar index to the dissimilarity index, the Gini index (Firebaugh and Farrell 2016), but are smaller that those on black-white segregation measured over a similar time period with the dissimilarity index (Cutler, Glaeser and Vigdor 1999).

Segregation Between Adults (25 to 44) and Older Adults (65 and older)

The models in Table 2.3 predict segregation between adults and older adults. Model 1a accounts for about 40% of the variance in segregation in the 1940 sample and about 25% in the 1960 and metarea samples. The coefficients on each of the time dummies are larger than in the model of segregation between children and older adults, consistent with the visibly steeper rise and slower decline in segregation between adults and older adults. Subsequent models that add controls for metropolitan area characteristics, the demographic structure of the population and metropolitan area fixed effects greatly reduce the size and significance of the time dummies. However, across all samples, the time dummies are less diminished in magnitude and significance by the covariates than in the models of segregation between children and older adults. That is, more of the secular trend remains unexplained in models of segregation between adults and older adults than those between children and older adults.

The results of Model 3b are largely similar to the models of segregation between children and older adults, with some notable differences. Across all samples, there is a small positive association between both population size and housing expense and segregation. Home ownership is also consistently positive and significant. The coefficient on the headship rate is smaller than in the previous models and not statistically significant in the 1940 sample, with a one standard deviation change in headship being associated with a change in segregation ranging from 0.009 to 0.013. The coefficient on the proportion 65 and older is negative, significant and considerably larger than in the models of segregation between children 0 to 19 and older adults (though it is smaller in the 1960 and *metarea* samples as it is in the 1940 sample). A one standard deviation change in the proportion 65 and older is associated with a change in the value of the dissimilarity index of 0.025 in the 1940 sample. The quadratic terms in the 1960 and metarea samples are positive and significant. Increasing the proportion 65 and older by three percentage points from the 25th percentile is associated with a decrease of 0.019 and 0.018 in the dissimilarity index, in the 1960 and metarea samples, respectively. Increasing the proportion 65 and older by three percentage points from the 90th percentile is associated with an increase of 0.003 and 0.006 in the dissimilarity index, in the 1960 and metarea samples, respectively. In these samples, the relationship between proportion of the population 65 and older and segregation turns positive as the proportion of the population 65 and older exceeds 0.155 and 0.152, respectively. The effect of multigenerational co-residence (measured in this model as the proportion of households with both an adult and older adult present) is small, positive, and not statistically significant. I find no significant association between segregation and suburbanization or group quarters. Across all models, the ratio of income between adults and older adults is consistently small and positive, only statistically significant in the 1960 and metarea samples (at the 0.001 and 0.01 level, respectively). In these samples, as adults 25-44 take in more income relative to older adults, segregation rises. As in the previous models, Model 3b explains more variance within metropolitan areas than between them. When I estimate the model using the entropy index, all coefficients are signed in the same direction and the majority maintain the same significance determination.

Table 2.3 Models of segregation between adults (25-44) and adults (65 and older) in metropolitan areas, 1940-2015

	Model 1			Model 2			Model 3						Model 4		
	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	FE (*b*)	1960 Sample OLS (*a*)	FE (*b*)	Metarea Sample OLS (*a*)	FE (*b*)	1940 Sample FE (*b*)	1960 Sample FE (*b*)	Metarea Sample FE (*b*)
1950	0.0292***	0.0287***	0.0361***	-8.94e-05	0.0294***	0.0427***	0.00514	0.00160	0.0243*	0.0128	0.0335**	0.00808	0.00116	0.00365	0.000545
	(0.00871)	(0.00820)	(0.00675)	(0.00907)	(0.00791)	(0.00738)	(0.0117)	(0.0134)	(0.0115)	(0.0120)	(0.0103)	(0.0101)	(0.00666)	(0.00567)	(0.00473)
1960	0.100***	0.118***	0.116***	0.0819***	0.118***	0.138***	0.0756***	0.0602**	0.0981***	0.0754***	0.110***	0.0596***	0.0252*	0.0274**	0.0226**
	(0.00934)	(0.00665)	(0.00660)	(0.00937)	(0.00909)	(0.00852)	(0.0149)	(0.0220)	(0.0146)	(0.0192)	(0.0138)	(0.0158)	(0.0104)	(0.00909)	(0.00720)
1970	0.122***	0.142***	0.142***	0.110***	0.123***	0.145***	0.0890***	0.0751**	0.111***	0.0834***	0.123***	0.0570**	0.0329*	0.0296**	0.0193*
	(0.0103)	(0.00947)	(0.00691)	(0.0102)	(0.0106)	(0.00910)	(0.0161)	(0.0268)	(0.0148)	(0.0206)	(0.0139)	(0.0181)	(0.0130)	(0.0101)	(0.00890)
1980	0.113***	0.121***	0.119***	0.131***	0.122***	0.120***	0.0999***	0.0902**	0.108***	0.0878***	0.104***	0.0560**	0.0370**	0.0310**	0.0179*
	(0.00783)	(0.00603)	(0.00601)	(0.00848)	(0.00920)	(0.00885)	(0.0146)	(0.0286)	(0.0132)	(0.0194)	(0.0126)	(0.0182)	(0.0131)	(0.00940)	(0.00904)
1990	0.0860***	0.0868***	0.0823***	0.0902***	0.0819***	0.0826***	0.0797***	0.0690*	0.0732***	0.0703***	0.0703***	0.0359	0.0265*	0.0201*	0.00538
	(0.00702)	(0.00584)	(0.00582)	(0.00833)	(0.00912)	(0.00829)	(0.0140)	(0.0291)	(0.0125)	(0.0200)	(0.0117)	(0.0195)	(0.0131)	(0.00988)	(0.0105)
2000	0.0806***	0.0825***	0.0727***	0.0813***	0.0779***	0.0746***	0.0681***	0.0594	0.0673***	0.0670**	0.0582***	0.0259	0.0240	0.0197	0.00195
	(0.00730)	(0.00580)	(0.00557)	(0.00851)	(0.00901)	(0.00821)	(0.0139)	(0.0300)	(0.0125)	(0.0208)	(0.0115)	(0.0207)	(0.0135)	(0.0105)	(0.0115)
2010	0.0870***	0.0781***	0.0680***	0.0905***	0.0718***	0.0697***	0.0721***	0.0631*	0.0621***	0.0632**	0.0539***	0.0205	0.0265*	0.0181	-0.000668
	(0.00660)	(0.00582)	(0.00559)	(0.00879)	(0.00916)	(0.00834)	(0.0140)	(0.0295)	(0.0126)	(0.0210)	(0.0116)	(0.0215)	(0.0130)	(0.0106)	(0.0120)
2015	0.0901***	0.0770***	0.0691***	0.0945***	0.0758***	0.0684***	0.0875***	0.0791**	0.0677***	0.0800***	0.0567***	0.0352	0.0331**	0.0244*	0.00367
	(0.00582)	(0.00530)	(0.00541)	(0.00852)	(0.00912)	(0.00850)	(0.0146)	(0.0276)	(0.0123)	(0.0201)	(0.0114)	(0.0213)	(0.0119)	(0.0104)	(0.0122)
Log Total HHs				0.0123***	0.0166***	0.0169***	0.0125***	0.0126**	0.0178***	0.00952**	0.0181***	0.0148**	0.00490*	0.00617**	0.00988**
				(0.00183)	(0.00154)	(0.00152)	(0.00174)	(0.00412)	(0.00155)	(0.00341)	(0.00148)	(0.00526)	(0.00208)	(0.00197)	(0.00311)
Cnty. Untracted (%)				0.0220	-0.0311*	-0.00242	0.0370	0.0316	0.00720	0.0525***	0.0127	0.00621	0.0177**	0.0237**	0.00258
				(0.0171)	(0.0151)	(0.0104)	(0.0223)	(0.0179)	(0.0143)	(0.0146)	(0.00923)	(0.0118)	(0.00610)	(0.00723)	(0.00499)
Land Area (sq. mi.)				-3.54e-07	1.38e-06**	1.58e-06**	-1.08e-06		1.94e-06***		1.17e-06*				
				(1.43e-06)	(5.07e-07)	(5.11e-07)	(1.43e-06)		(4.36e-07)		(5.09e-07)				
Population Growth				0.187***	0.110***	0.0484***	0.0410	0.0479	0.0472***	0.0128	0.0190**	-0.000500	0.0164	0.00383	-0.00380
				(0.0215)	(0.0151)	(0.00886)	(0.0258)	(0.0272)	(0.0119)	(0.0112)	(0.00624)	(0.00488)	(0.0115)	(0.00762)	(0.00254)

Table 2.3, cont.

	Model 1			Model 2			Model 3						Model 4		
	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	1960 Sample OLS (*a*)	Metarea Sample OLS (*a*)	1940 Sample OLS (*a*)	FE (*b*)	1960 Sample OLS (*a*)	FE (*b*)	Metarea Sample OLS (*a*)	FE (*b*)	1940 Sample FE (*b*)	1960 Sample FE (*b*)	Metarea Sample FE (*b*)
Suburban (%)				-0.0604***	-0.0430***	-0.0623***	-0.0300***	-0.0306	-0.0276***	0.00554	-0.0404***	0.0123	-0.00738	0.0105	0.0104
				(0.00772)	(0.00701)	(0.00783)	(0.00714)	(0.0164)	(0.00670)	(0.0189)	(0.00719)	(0.0153)	(0.00644)	(0.00815)	(0.00628)
Home Ownership (%)				0.0951***	0.0403	0.0832**	0.125***	0.150***	0.0537**	0.143***	0.0847***	0.179***	0.0574**	0.0525***	0.0631***
				(0.0207)	(0.0231)	(0.0265)	(0.0184)	(0.0411)	(0.0198)	(0.0325)	(0.0218)	(0.0377)	(0.0169)	(0.0154)	(0.0186)
Ratio Rent to Income				0.0416***	0.0908***	0.107***	0.0677***	0.0702***	0.0962***	0.0439**	0.103***	0.0433**	0.0290**	0.0180**	0.0160*
				(0.0117)	(0.0100)	(0.00974)	(0.0119)	(0.0183)	(0.0101)	(0.0138)	(0.00959)	(0.0141)	(0.00858)	(0.00690)	(0.00725)
Relative Income							0.00504	0.00964	0.00215	0.0154***	-0.000500	0.0142**	0.00425	0.00650**	0.00589**
							(0.00542)	(0.00610)	(0.00492)	(0.00449)	(0.00448)	(0.00450)	(0.00294)	(0.00214)	(0.00220)
Group Quarters (%)							0.137	-0.311	-0.107	-0.106	-0.127	-0.237	-0.165	-0.0486	-0.0917
							(0.160)	(0.235)	(0.0827)	(0.103)	(0.0886)	(0.135)	(0.0856)	(0.0558)	(0.0723)
Headship 25-44 (%)							0.243*	0.244	0.0880	0.326***	0.0491	0.236*	0.117	0.150***	0.103*
							(0.0999)	(0.143)	(0.0780)	(0.0838)	(0.0799)	(0.0982)	(0.0639)	(0.0428)	(0.0493)
65 and older (%)							-0.899***	-0.840***	-2.635***	-1.985***	-2.695***	-2.075***	-0.308***	-0.780***	-0.866***
							(0.153)	(0.205)	(0.370)	(0.332)	(0.324)	(0.332)	(0.0783)	(0.206)	(0.204)
Sq. 65 and older (%)									9.480***	6.355***	9.496***	6.858***		3.008***	3.519***
									(1.470)	(1.196)	(1.321)	(1.139)		(0.801)	(0.715)
Multigen. (%)							-0.184	-0.104	0.215***	-0.0596	0.248***	-0.0593	-0.0170	-0.0991**	-0.109*
							(0.119)	(0.150)	(0.0543)	(0.0739)	(0.0530)	(0.0907)	(0.0576)	(0.0373)	(0.0439)
Constant	0.132***	0.133***	0.135***	-0.00161	0.0463	0.0484*	0.0182	-0.00165	0.0389	-0.202**	0.0659	-0.206*	-0.0493	-0.149***	-0.162***
	(0.00365)	(0.00361)	(0.00379)	(0.0276)	(0.0248)	(0.0228)	(0.0733)	(0.119)	(0.0510)	(0.0706)	(0.0496)	(0.0886)	(0.0555)	(0.0367)	(0.0428)
Observations	383	1,054	1,185	383	1,054	1,185	383	383	1,054	1,054	1,185	1,185	383	1,054	1,185
R-squared	0.439	0.234	0.264	0.681	0.575	0.574	0.758	0.780	0.639	0.636	0.651	0.661	0.753	0.529	0.561
p	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	62.73	85.91	90.04	54.80	95.25	101.5	64.77	56.41	80.24	54.22	97.34	44.34	46.14	37.34	38.08
R2 Within								0.780		0.636		0.661	0.753	0.529	0.561
R2 Between								0.608		0.352		0.328	0.445	0.265	0.205
R2 Overall								0.736		0.447		0.458	0.662	0.333	0.312
Number of id								54		191		184	54	191	184

Robust standard errors in parentheses
***** p<0.001, ** p<0.01, * p<0.05**

Household formation among adults 25 to 44 and the proportion of the population 65 and older exhibit opposite associations with age segregation. In figure 2.6, I use the parameter estimates from Model 3b to predict segregation between children and older adults had headship and age structure remained at the levels observed in 1940 (allowing other covariates to vary as observed). This figure shows, that all else equal, had the headship rate among adults 25 to 44 remained at the level observed in 1940, segregation between children and older adults would be consistently lower than observed, 15% lower in 2015 in the 1940 sample. Conversely, had the proportion of the population 65 and older remained at the levels observed in 1940, segregation would be consistently higher, 17% higher in 2015 in the 1940 sample. Despite the large historical decline in multigenerational co-residence and the integrative effect of multigenerational households, holding multigenerational co-residence at the levels observed in 1940 would have little effect on the trends in age segregation. In figure 2.7, I make the same predictions, but for segregation between adults and older adults, with largely similar conclusion. Had the headship rate among adults 25 to 44 remained at the level observed in 1940, segregation would be 11% lower in 2015 in the 1940 sample. Conversely, had the proportion of the population 65 and older remained at the levels observed in 1940, segregation would be 25% higher in 2015 in the 1940 sample.

Figure 2.6 Predicted segregation between children (0-19) and adults (65 and older) with headship, proportion 65 and older, and multigenerational households held at levels observed in 1940

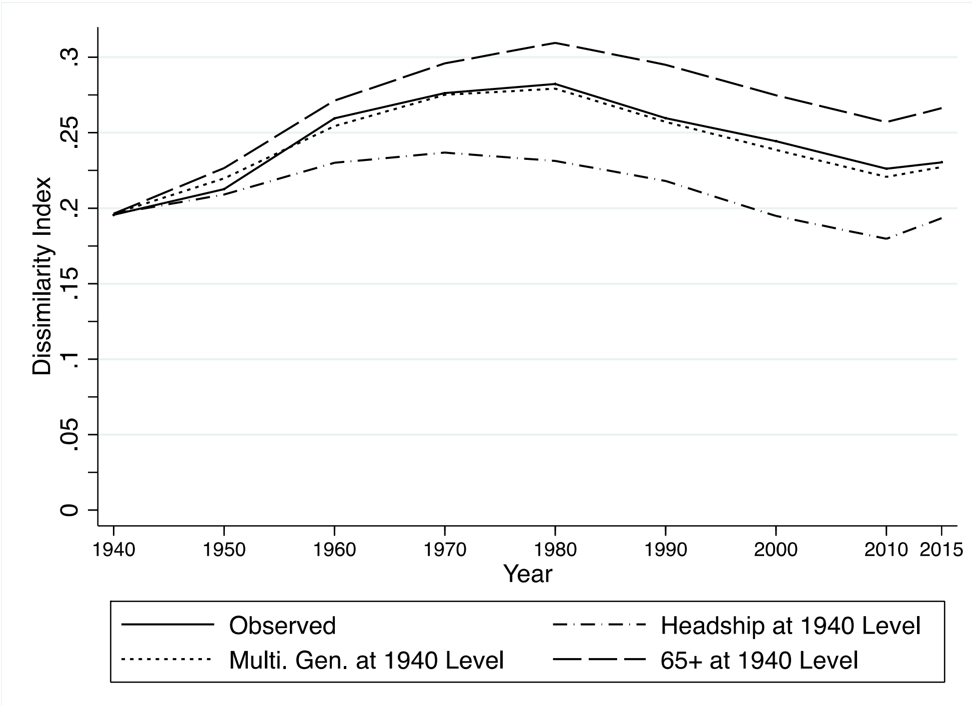
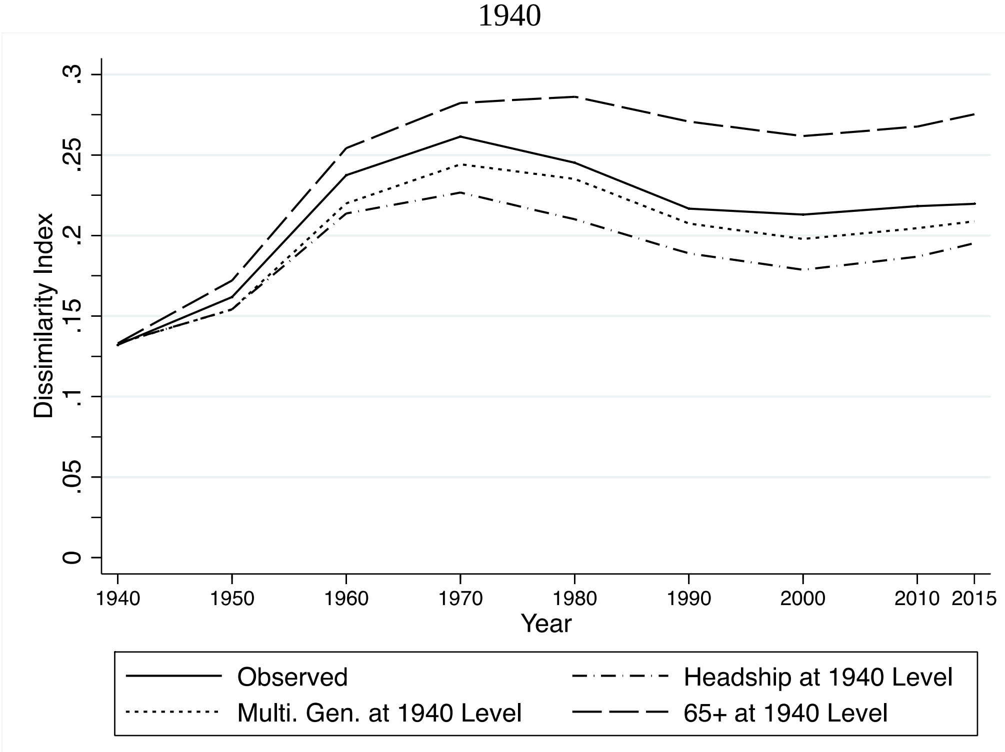


Figure 2.7 Predicted segregation between adults (25-44) and adults (65 and older) with headship, proportion 65 and older, and multigenerational households held at levels observed in 1940



Discussion

In this paper, I measure age segregation on the tract level in metropolitan areas from 1940 to 2015 and present model estimates of the associations between segregation and characteristics of metropolitan areas, the population and households. I revisit a number of considerations made in past studies, but focus new attention on how the age structure of the population and living arrangements influence segregation. Segregation between older adults and children and between older adults and young adults is low to moderate in American metropolitan areas. Older adults are slightly more segregated from children than from adults. At its peak in the 1970s and 1980s, average age segregation was about on the order of the 2010 levels of black-white or Hispanic-white segregation in Las Vegas, NV (among the least racially segregated large US cities). Despite declining multigenerational co-residence, segregation gradually rose between 1940 and 1970, but fell, thereafter. I expected households that join children and older adults or adults and older adults would be negatively associated with age segregation; however, I do not observe any association.

Countervailing Trends in Age Structure and Headship

The proportion of the population 65 and older and the headship rate among adults 25-44 are strong and consistent predictors of age segregation. The population of adults 65 and older has grown since 1940, while household headship among young and middle-aged adults rose until 1980, but slightly fell since. As growth in the population of older adults decreased age segregation, largely concurrent increases in household headship among young adults raised segregation. In general, as older adults compose a larger portion of a population, segregation declines, particularly, between adults 25 to 44 and older adults. However, this relationship is non-linear. It is negative at most values of proportion 65 and older, but turns positive for metropolitan areas above the 90th percentile of proportion 65 and older. This relationship appears to be driven entirely by retirement destinations, places that have very large older adult populations and high age segregation.

As age segregation peaked in the 1970s and 1980s, young adults formed households at rates higher than ever before. When many young adults form households of their own, age segregation increases, particularly, between children and older adults. The vast majority of the population 0 to 19 lives with at least one parent. Household formation among adults may both decrease age diversity *within households*, to the extent that these households exclude older adults, and *within neighborhoods* to the extent that they are formed in neighborhoods separate from older adults.

The period between the 1950s and the 1980s was one of divergence during which changes in living arrangements increased the variety of household types and decreased age diversity within households as the age diversity of the population increased. Trends that influence the age composition of households (rising rates of household formation, living alone and group quarters residence and declining multigenerational co-residence) may drive the rise in segregation from 1940 to the 1980s. After the peak in segregation in the 1970s and 1980s, most of these trends leveled off, yet growth in the older adult population continued, now unabated, to bring down segregation between the old and young.

Revisiting the Ecological Model and Conclusions

Studies of age segregation inspired by the ecological model found that population size, growth, suburbanization, relative income and housing costs were important drivers of age segregation. I revisit these factors over a longer time series than previous studies and in a framework that accounts for changes in the age distribution and living arrangements. I find mixed support for the associations observed in earlier studies. Larger metropolitan areas appear to have greater age segregation than smaller areas, though the size of this association is small. This is consistent with a body of prior findings that larger areas are more spatially differentiated than smaller areas along various dimensions (e.g. Cutler, Glaeser and Vigdor 1999; White 1987; Wirth 1938). I do not find a positive association between age segregation and population growth. Much of the work that found effects of growth did so for the period from 1940 to 1970, when most metropolitan areas were growing, households were becoming less age diverse and age segregation was rising. I do find consistent evidence that more expensive cities have slightly higher levels of age segregation than less expensive cities.

I do not observe a consistent positive association between age segregation and suburbanization. My sample design may somewhat undermine my measure of suburbanization and downwardly bias my estimate of the association between suburbanization and age segregation. This association may be time dependent, perhaps positive from 1940-1970, as adults 25-44 moved from city core to periphery, but turning toward zero and then negative, as suburban residents grew older. In unreported models estimated by year, I find some support for this hypothesis. I find no consistent evidence that the relative income of adults 25-44 and older adults is associated with segregation between children and older adults. However, I do find a small, positive and statistically significant association between relative income and segregation between adults and older adults. Consistent with the “spatial assimilationist” hypothesis of the ecological model, as adults earn more relative to older adults, segregation between them increases. The proportion of adults living in group quarters, like nursing homes, assisted living facilities, college dormitories, military barracks and prisons showed no significant association with age segregation.

Though much more severe than segregation by age, black-white segregation has followed a similar trend, rising from 1940 to a peak in the 1970s and 1980s and declining, thereafter. Patterns of household formation, home ownership, population size and housing cost may have similar influences on both forms of segregation. Notably, household formation among young adults, in the 1960 – 1990s, is associated with segregation by age and race, and my model results suggest these associations are to some degree separate from the effects of suburbanization.

Multigenerational co-residence is a household level component of age segregation, though I treat it as a characteristic of metropolitan areas. Measurement and interpretation of its effect on tract level age segregation is challenging and presents possible endogeneity issues for regression analysis. Decomposition techniques are available that could separate measures of age segregation into components due to the distribution of individuals of different ages across households and the distribution of households with different age compositions across tracts (Wong 2003). It is possible that the covariates I consider may differently influence the age composition of households and the sorting of households with different age compositions across tracts. A number of modeling strategies could be suited to estimate associations between covariates and these components of segregation separately.

There are a number of limitations to this study. Subsequent work should more closely examine segregation in and as it relates to retirement destinations. A more nuanced investigation of housing affordability could estimate age-specific income and housing costs and explore the influence of assistance programs that increased and stabilized the income of older adults on segregation. A careful disaggregation of the group quarters population by age composition and type of residence could be useful. Direct measurement of age-specific amenities could improve understanding of the spatial distribution of people of different ages. Some studies consider how physical and cultural amenities are related to the age distribution of an area (Silver and Nichols Clark 2016).

Growing economic and social freedom for both young and older adults may have allowed for the expression of age specific identities and the emergence of age-based residential enclaves. Indeed, from the 1940s to the 1970s, the old and the young dispersed in space, however, they have since returned to live in greater proximity. While changes in age segregation may be both a barometer and a consequence of generational divergence, they are rooted in the age structure of the population and patterns of household formation. Attempts to understand how other characteristics influence age segregation should account for these demographic factors.

Appendix

Incomplete Division into Census Tract

Each of the 49 central cities in the first sample was almost completely divided into tracts in 1940. However, the balance of the metropolitan county was often un- or incompletely subdivided into tracts. My measure of age segregation includes only the area subdivided into tracts, however, I use IPUMS records from the entire metropolitan county to estimate values of the independent variables. To account for this, I count the number of tracts in each metropolitan area and the proportion of the metropolitan county's population living outside areas subdivided into tracts (using full population counts aggregated to the county level). The number of tracts rose steadily from 1940 to 1970, but stabilized thereafter as tract coverage in metropolitan counties became virtually complete. The average proportion of the metropolitan county population living outside areas subdivided into tracts declined from nearly 20% in 1940 to about 0.05% in 1970.

Missing Data

Missing data and measurement error raise some concerns for my analysis. The tract level data are largely complete, however, there are some gaps. A small number of counties are missing from the tract level tabulations in some years. Records are missing for Aiken County, SC (outside Augusta, GA) in 1950 and 1960 and Erie County, NY (Buffalo, NY) from 1940 – 1960. In 1950, records are missing for also missing for Atlantic City, NJ, Des Moines, IA, Savannah, GA and Macon, GA. It seems the Census Bureau did not release tract level data for these counties in these years. These records are dropped from the analysis when they are missing.

The analysis panel is unbalanced, particularly, in 1950, 1960, 1970, 2000 and 2010, when at least 20% of the metropolitan areas are missing information for some of the independent variables. The dependent variable in the models can be observed for nearly all cases and values vary little between metropolitan areas that have missing values on at least one independent variable and those that do not. I impute monthly rent and home ownership in 1950, otherwise, observations are dropped from the models when missing values on any of the independent variables. This is largely due to the fact that county level information is not available in public-use microdata after 1950. While IPUMS has been able to assign many records to counties, a number of areas have no assigned records in some years. Even when some records can be assigned to counties, this is often incomplete. Records that can be assigned to counties skews toward city core populations. On account of this, measurement error is likely to be lowest in my

1940 sample, which follows only core counties over time, while the other samples include outlying areas.

General Data Concerns

The 2015 tract level tabulations and micro-data records come from the 2010-2015 5-year ACS sample. ACS estimates can be subject to large measurement errors, especially, in small areas like the census tract and in low-income areas of central cities. Despite this short coming, I am buoyed in using these data by the fact that the only tract level measures I take from the ACS are broad categorizations of the age distribution; other measures are made on the metropolitan area level. Though subject to variability, age distribution in the ACS has high to medium reliability on the tract level, considerably better than measures of median income (Folch et. al. 2016). Segregation measurement with the Dissimilarity Index of ACS estimates, overstates segregation in areas with small minority population and few census tracts (Napierala and Denton 2017).

Chapter III

Cohort Aging or Functional Specialization? The Longitudinal Dynamics of Neighborhood Age Structure, 1970-2010

Abstract:

The age distribution of individual census tracts may change or remain stable over multiple decades. This chapter makes an explicit demographic classification of neighborhood aging patterns in a sample of 50,000 census tracts observed between 1970 and 2010. I consider two ideal neighborhood types, one in which the age distribution is constant over time (*functional specialization*) and another in which the age distribution changes as if members of a cohort aged in place (*cohort aging*). Using longitudinal data on the age distributions of a large sample of census tracts from 1970 to 2010, I develop a series of models to classify tracts according to these aging patterns. I find that the functional specialization pattern is considerably more common than the cohort aging pattern. I estimate an explanatory model of aging pattern as a function of social, spatial, economic and housing characteristics and find that neighborhoods in which the population ages as a cohort have some distinct characteristics. Lastly, I propose a framework in which neighborhood aging patterns may be included in studies of racial segregation as either bulwarks against integration or pathways to stable integration.

Introduction

In this paper, I trace patterns in the age distributions of neighborhoods over five decades. Specifically, I assess the prevalence of two competing models of neighborhood population succession, one in which the age distribution of a neighborhood advances as would an aging cohort and the other in which the age distribution remains relatively stable over time. I refer to these neighborhood types as *cohort aging* and *functional specialization*, respectively.

The population of the United States is growing older and the age distribution is becoming more even. Segregation by age and household type in metropolitan areas, albeit moderate, suggests that there may be heterogeneity in the trajectory of neighborhood age distributions. Further, some cities and neighborhoods across the country have reputations as hubs for young people, destinations for retirees or great places to raise a family. Are these characterizations recent and fleeting or have they persisted for decades? There is a fair degree of continuity in the coarse age distribution of neighborhoods from one decade to the next, but how much stability is there when the same neighborhood is viewed over a longer period of time?

There is a lengthy history in sociology of developing neighborhood classification schemes and using these to explain some social phenomenon. In this paper, I draw this history closer to an explicit demographic classification of neighborhood aging patterns. I consider two ideal (in the Weberian sense) neighborhood types, one in which the age distribution of a neighborhood is constant over time (*functional specialization*) and another in which the age distribution changes as if members of a cohort aged in place (*cohort aging*). Using longitudinal data on the age distributions of a large sample of census tracts from 1970 to 2010, I develop a series of models to classify tracts according to these aging patterns. I also estimate an explanatory model of aging pattern as a function of social, economic and housing characteristics.

Lastly, I propose a framework in which neighborhood aging patterns may be included in studies of racial segregation, a proposition that I take up in the third paper.

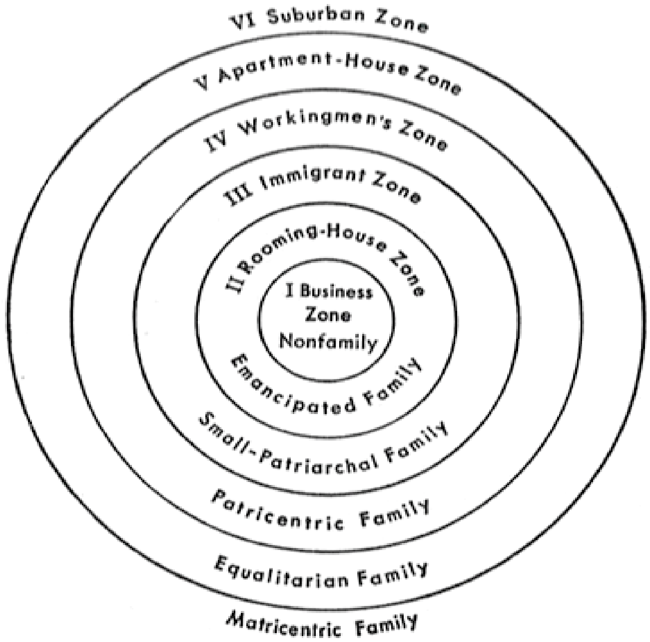
Sociological Foundations of Two Competing Models of Neighborhood Aging

Though usually subordinate to race or income, sociologists have considered the spatial distribution of age groups and household types almost since the discipline's founding. Principally concerned with race, occupation and family status, Du Bois ([1899], 1967) was the progenitor of much of the socio-spatial classifications that followed, particularly those from the Chicago School. Wirth (1938) asserted that different parts of a city possess different structural, ecological or demographic profiles and, in Durkheimian fashion, would coin these profiles "specialized functions." Burgess and Locke (1960) extended Burgess's well-known typology of urban zones model and further built on Du Bois' consideration of the spatial distribution of family types,[14] to explicitly describe the distribution of age groups and family types in metropolitan areas (Figure 3.1). In this life cycle extension, the first zone, the Central Business District, is characterized by non-family households, predominantly, single men between 35 and 54 years old. The next zone is that of the Emancipated Family, characterized by young childless adults 20-34, though predominantly 25-29. This zone is followed by one of Small Patriarchal Families, these are immigrant family households with children and displaying some level of what Burgess calls "disorganization." Patricentric Families, larger working class families that share income, occupy the next ring. Equalitarian Families, the small families of professionals, characterize the next ring. Finally, the Matricentric Family occupies the outer ring. These

[14] Burgess' model was early 20th century Chicago and Bu Bois' was Black enclaves in late 19th century Philadelphia.

suburban households have many children, but low rates of disorganization. Amenities in this zone, reinforce and support the structure and function of family.

Figure 3.1. Burgess's "Theoretical pattern of urban zones and of family types"



Burgess 1960, p. 101, figure 13.

Previous work connects characterizations of neighborhoods or cities along a single socio-economic dimension (a specialized function) to studies of racial segregation (Du Bois [1899] 1967); Taeuber and Taeuber 1965; Farley and Frey 1994; Logan, Stults and Farley 2000; South, Crowder and Pais 2011). Du Bois argued that specialized housing functioned to place workers near their employers (e.g. domestic's quarters in alleys near employers or laborer and manufacturing workers cottages outside of factories). In the context of a racially stratified occupational structure, this would, in part, produce a racially stratified system of residence. Taeuber and Taeuber (1965) ask if, "the general residential character of the area is the major determinant of the character of the occupying population" (p. 175). Farley and Frey (1994) classified metropolitan areas as manufacturing, government, military, university or retirement communities finding that these community types were associated with levels of racial residential segregation. Others make similar classifications, but also considered amenities and the cultural character of businesses (Silver and Nichols-Clark 2016), particularly, as those amenities relate to the presence of certain types of economic activities and certain classes of workers.

There is some evidence for neighborhood level differentiation or specialization by household type and age. In Montreal and Vancouver, central city neighborhoods and neighborhoods near post-secondary institutions and hospitals have had young populations since the 1950s (Moos 2014). Single adults living alone are spatially concentrated, primarily in central city neighborhoods (White 1987; Yi 2016; Marsh and Iceland 2006). From 2000 to 2010 non-family households exhibited generally low levels of segregation from family households (Marsh and Iceland 2006; Owens 2016). Certain demographic concentrations are present in metropolitan areas, for example, White's (1987) latent class analysis of 1980s metropolitan area population identified a number of neighborhood types, like child-rearing middle-class neighborhoods. Cultural amenities or businesses and institutions associated with the "scene" or character of a neighborhood may express or encourage "specialized functions" as they are associated with the distribution of age groups and household types, at least in the short-term (Silver and Nichols-Clark 2016). Large institutions, like Universities or hospitals, that remain in a neighborhood for many years may encourage a consistent population composition, for example, consistent racial integration (Ellen 2000).

Though some places may maintain a specific population composition, others may change as the characteristics of their stationary residents change. Aging policy advocates, health organizations and surely many older adults consider *aging in place* - the ability to remain in one's own home or community in old age – desirable and propose strategies to make growing old on one’s own terms widely accessible. Rogerson and Plane (1998) propose a projection model of the long-term age dynamics of neighborhoods, but this model is not tested on observed neighborhood data.

Though age is considered in some of these past typologies, few direct studies of longitudinal neighborhood aging patterns have been made. In this paper, I move toward an explicit classification of aging by looking for specific patterns (namely stability and cohort progression) in the long-run age distribution of a place. Are city neighborhoods static specialized zones or do they just appear so in a single cross-section and actually transition in lock-step with time (as would an aging cohort)? It will take a long-run view of the same neighborhoods to adjudicate between these two competing explanations. In this paper, I distill nuanced observations and theory of spatial distribution of age, aging and life course to a simplified demographic scaffold with which I classify patterns of aging in neighborhoods. Once identified, I explore the characteristics of neighborhoods by aging pattern and suggest ways neighborhood aging regimes may structure opportunities or barriers to changes in racial segregation.

Ideal Types

I focus on two simplified models of aging or population succession in neighborhoods. Under one model, individuals age in place, a cohort enters a neighborhood and does not move or does so very infrequently. The age and household characteristics of the neighborhood change as the residents of that neighborhood change, by growing older and forming families. Children born in the neighborhood remain there. Vacancies arise after a death and are filled by members of the youngest cohort. As older adults leave the population, new entrants take their place. I call this the *cohort aging* model.

Under a second model, a stable stock of age-specific amenities draws certain age groups and types of households, year after year. As individuals age out of a neighborhood's specialization, they move on to one that better suits their needs at that point in their life. As a result, neighborhoods maintain relatively consistent age profiles over time. For example, university neighborhoods offer amenities that consistently attract a population of young adults. They are close to the academic institution and often have apartments housing, bars, restaurants and retail stores that cater to young adults. Likewise, central business districts, at least historically, offered amenities, like low-rent small apartments and easily accessible shopping and transportation that drew or retained a population of older adults and unmarried singles. One can imagine various forms of these specialized neighborhoods, areas with many single-family homes and schools for families with children or bars, apartments and art galleries for young unmarried adults. A functionally specialized neighborhood may include a constant large proportion of a certain age group or a mix age groups that remains stable over time. Borrowing from Wirth (1938), I refer to this as *functional specialization*.

These two models are ideal types and I expect few neighborhoods follow one or the other of these patterns precisely. Many may be a blend of both models. In some historical periods, one of these models may better characterize a city's neighborhood than the other. In some stages of life, one of these models might better describe the relationship between age and residential location. Both models may operate simultaneously within a metropolitan area. Some parts of a community may be better characterized by stationary cohorts, the age and household characteristics of these neighborhoods changing as residents age in place and new entrants trickle in to fill vacancies. Other places in the same community may consistently attract individuals in certain stages of life. Further, it is possible that a neighborhood may appear to resemble one model for one racial group and the other model for another racial group. For example, generations of young whites may live in parts of a city that are occupied by cohorts of non-whites who are largely aging in place (Bader and Thomas 2016). Indeed, neighborhoods can serve different demographic functions for different racial groups (Finney 2013).

Neighborhoods could operate under one model only to change to the other following some sort of event. Large-scale home construction, metropolitan expansion or neighborhood redevelopment, could open parts of a community to residential patterns that are more in line with one model than the other. For example, following World War II, many American metropolitan areas grew rapidly on their suburban fringes. New housing developments opened large tracts of housing to a particular type of household, working or young middle-class white families. These new residents were largely from the same cohorts (war veterans, their spouses and their young children) and household heads were concentrated in years of declining residential mobility. Other changes to the residential landscape, those taking place within the urban core, like the "slum" and "blight" clearance of the 1950s and 1960s or similar redevelopment and investment associated with gentrification, may also "reset" the age and household distribution of a neighborhood.

From these two sketches of the long term age distribution in neighborhoods, I can develop more direct expectations for the characteristics that each type may exhibit. For example, a cohort aging pattern may be more common in areas with many owner-occupied housing units, low residential turn over, higher incomes and further from the city center. A functional specialization pattern may be more common in areas closer to the city center, with many rental units and high residential turnover. I assess the association between these and other characteristics and neighborhood type with a explanatory model.

Characteristics of the housing, zoning, planning or cultural history of communities may make an area more or less conducive to racial integration or sensitive to legal reforms intended to limit segregation (Farley and Frey 1994). For example, dormitories or barracks in university of military communities were usually integrated and because residence in these communities was often temporary or not elective, people may accept living in less homogenous communities than they might like. University communities, often have an educated populace, segregation may be lower because residents may also have progressive attitudes. Retirement communities may have high levels of segregation because of income differences between older blacks and whites that translate into different residential experiences in older adulthood and attitudes against integration.

Likewise, the neighborhood types I identify in this paper may have implications for racial segregation. Functionally specialized neighborhoods may be more stably integrated than cohort aging neighborhoods. Frequent vacancies and residential turnover may offer more frequent opportunities for racial integration. Neighborhoods classified as cohort aging may be less likely to undergo racial change than those characterized by functional specialization. Specifically, they may offer less frequent housing vacancies and be less likely to experience rapid racial turnover, but perhaps more likely to experience gradual change due to cohort replacement. Neighborhoods that maintain a mixed age distribution present avenues to long-term integration while those that age as cohort may act as a durable bulwark against integration. I expand upon these ideas and test hypotheses about the relationship between neighborhood type and racial segregation in the third paper.

The following research questions guide this paper,

1. *Are neighborhoods places of "cohort aging" or places of age-specific "functional specialization"?*
2. *How are characteristics of the housing stock and basic economic characteristics of the population associated with each pattern of neighborhood level population succession?*

Data

To assess whether a neighborhood follows a cohort aging or functional specialization pattern of population succession, I use tract level tabulations characterize census tracts in metropolitan areas according to their detailed age distribution at each decennial census from 1970 to 2010.[15] For each census tract in each decennial year, I create a 50-cell table of age-specific population counts. I divide age into ten 10-year intervals from age 0 to an open ended interval at ages 90 and older.

Census tracts can change boundaries over time. Tracts may split from one to multiple tracts, join together to create new tracts or change tract codes. It is critical to my analysis that I am able to link the same tract at each decennial census. To do this, I use tract boundary crosswalk programs from the LTDB (Logan, Xu and Stults 2012) project to adjust the population of each tract to account for boundary changes over time in order to compare the same geographic area at each point in time. I limit the analysis to the period 1970 – 2010, as programs to adjust

[15] It was challenging to find and standardize detailed age distribution information over this period. Below I list the various sources/counts I use. 1970 data from Table NT2A (Count 1). 1980 data from PB5A - SF4 (in the 1980 Census of Pop. Files raw files from the original 1980 census CD-ROM). The 1980 data is only partially available through the major third party Census Bureau data distributors. The UCLA Social Science Librarian provided me with extracts from the 1980 CD-ROM. Nathaniel Baum-Snow provided me with programs and a data dictionary to import the raw records into statistical software. 1990 data from Table NP11 (age not by sex), NP12 (race by sex by age) and NP13 (age by sex). 2000 data from Table NP012B (SF1). 2010 data from Table P12 (SF1).

tabulations of tract population in earlier years to reflect constant geographic boundaries are unavailable.

The tracts that I am able to classify are a subsample of all tracts consistently identified from 1970-2010. Most notably, I cannot classify tracts from Hawaii, Idaho (missing in 1980 raw data), Wyoming and Vermont (missing in 1970 raw data). Further, I drop tracts with fewer than 100 residents in each year. To make the tables estimable even if there is no population in a given year by age category cell, I round all 0s up to 1.[16]

Age Adjustment for 1980 and 1990

In the years 1980 and 1990, the granularity of the tract level age distribution measures does not support division into 10 year age categories, as my classification model requires. In these years, the population in older age categories is only reported as age 85 and above. I use a pseudo-cohort component project technique to redistribute the population in the 85 and older category to the 80-89 and 90 and above categories. My technique uses by sex life tables for each state from the US Mortality Database (Barbieri 2018) to project forward the population of older adults into these categories. I start with 10-year survival probabilities for each age from 75 to 114. Let, *t* denote the reference year where *t{1980,1990}*, *s* denote state and *g* denote sex. For each tract, I estimate two quantities, the population aged 80 to 89 and the population aged 90 and older by gender in state ($N80\_89_{tsg}$ and $N90up_{tsg}$), estimates are denoted with primes, observed values are not.

$$N80\_89'_{tsg} = N80\_84_{tsg} + (N85up_{tsg} - N90up'_{tsg}) \quad (1)$$

[16] I could also try rounding to a very small, positive non-zero value.

$$N90up'_{tsg} = \sum_{x \in S}(Nx_{t-10sg} * {}_{10}P_x), \quad (2)$$

where the set, *S*, is composed of five-year age categories from 80 to 99 and,

$${}_{10}P_5 = l_{x+n}/l_x, \text{ where, } l_{x+n} = l_x + (1-q_x) \quad (3)$$

Eq. 3 is the standard life table definition of the 10-year survival probability of 5-year age categories as the number surviving to the interval *x+n* divided by the number surviving to age interval *x*. Where q_x is the probability that someone in age interval *x* will survive to *x+n* (Preston, Heuveline and Guillot 2001).

I call this a *pseudo-cohort component* projection because I make an assumption of no migration. In some sense this is a reasonable assumption because mobility rates among the population 85 and older are indeed low. However, mobility does rise in old age and my migration assumption is the primary place where error enters the projections. Error may also enter to the extent that tract-level variation in state, year, sex age-specific mortality is obscured by my use of state-level year-sex life tables. I think this source of error is small.[17] Indeed old age migration does seem to drive most of the projection errors.

This projection technique produces estimates of the age distribution that are quite close to observed data,[18] but the projection does poorly at the very extremes of the distribution. Underestimates are much more common than overestimates. If deviance from observed values can be attributed to net migration, the fact that the means are close but individual observations

[17] Though age specific mortality rates likely vary between tracts, the state-level tables were the most geographically granular high-quality tables with sufficient period coverage that I was able to find.
[18] at the 1st, 2nd and 3rd moments (mean, variance and skewness)

are different makes sense. The mean of the entire sample should have near 0 net migration (international migration among those 90+ has to negligible). However, deviance in specific observations could be attributed to net internal migration. Though this method performs quite well for most tracts, it underperforms in cases when the population of older adults undergoes exceptionally large changes between decennial years (no migration assumption fails). For example, a newly constructed (or demolished) retirement community or assisted living facility can result in year to year changes of hundreds of older adults in a tract. Large underestimates appear to be areas that had retirement home construction in the intercensal period, for example, tracts in Sun City, AZ. Overestimates seem to be places of general population decline or redevelopment of older central city apartment housing, for example, downtown Berkeley, CA, or the low-density redevelopment of a retirement community in Providence Point, Pittsburgh.

To smooth the projection, I compare the total population from all observed age categories to the total population found by summing over the observed categories up to age 79 and my imputed values of ages 80 and above. I redistribute any deviance using the following ratio of survival probabilities.[19] This adjustment shrinks projection errors considerably and eliminates large overestimates.

I use measures of tract level characteristics[20] to describe my sample and to model the classification as a function of social, economic, housing and spatial characteristics. I also measure the distance of each tract from the center of its metropolitan area. Choosing a "center" of a metropolitan area is not as straightforward as it may seem. The NHGIS has developed a measure of a place's center and distributes these measures as the Place Points dataset (Manson et. al. 2018). Place points are designed to identify the historical, functional center of a place, like

[19] (lx85_89/lx75_79)/(lx90up/lx80up)

[20] From US Census Bureau summary tables, the Geolytics Neighborhood Change Database and the LTDB.

a central business district, (not necessarily the geographic center or the center of population). I measure the spherical distance from tract centers of population (US Census Bureau 2010) to the place point and adjust these to a rank percentile measure of distance within metropolitan area.

Aging Pattern Classification Model

I estimate models designed to identify whether the population follows a cohort aging or functional specialization pattern of population succession. The models predict the 10 by 5 frequency table of age-specific population counts. Neighborhoods in which the age structure changes over time (cohort aging) will exhibit cohort effects, but no age effects. Conversely, neighborhoods that have a consistent age structure over time will exhibit no cohort effects (age-specific population size will be independent of time). To assign a pattern of population succession to each neighborhood, I estimate three log linear models separately for each neighborhood, 1. a model of functional specialization 2. model of aging-in-place and 3. a saturated model (Goodman 1978; Powers and Xie 2000; Treiman 2009). The models take the forms,

$$\log(m_{ij}) = \lambda + \lambda_i^A + \lambda_j^P \quad (4)$$

$$\log(m_i) = \lambda + \lambda_i^C \quad (5)$$

$$\log(m_{ij}) = \lambda + \lambda_i^A + \lambda_j^P + \lambda_{ij}^{AP} \quad (6)$$

Where m_{ij} is the expected value of the population count in row *i* and column *j*. λ_i^A and λ_j^P are row and column marginals, parameterized as a set of dummy variables for the 10 age categories and a set of dummies for period (the 5 decennial census from 1970 to 2010), respectively. λ_{ij}^C is a series of dummies for the 14 birth cohorts that appear in the 50 cell table. Equation 4 estimates parameters for a neighborhood characterized by functional specialization, in which the age distribution of a neighborhood is independent of time or census period (constant over time). Equation 5 estimates parameters only for birth cohorts. Age-specific population is restrained to be solely a function of cohort progression. Equation 6 allows all parameters to be unrestricted and completely defines all cells in the table. The table cells are modeled with Poisson regression and parameters estimated with maximum likelihood.

Age, period, cohort models are unidentified because cohort is a direct product of age and period. It is impossible to directly assess age controlling for cohort and period. There are a few ways to avoid this problem in order to identify the aging-in-place model. I tested eq. 5 with collapsed age and period categories in the design matrix, so that the parameterization of age or period differs from the observed distribution. However, I present results from the basic cohort design matrix (Mason, et. al. 1973).

After estimating the separate models, I must choose among them in order to classify each neighborhood as cohort aging or functionally specialized. Techniques to classify neighborhood types based on aggregate characteristics vary in rigor and planning. For example, in their assignments of economic specialized functions to entire metropolitan areas, Farley and Frey (1994) and Logan, Stults and Farley (2000), deemed an area “specialized” on a dimension if it fell at least one standard deviation above the mean on the characteristic used to define the specialization. However, I follow Mason, et. al. (1973) and Bader and Warkentien (2016) in using measures of model fit to characterize the predominant pattern of population succession in each neighborhood. I employ a decision criteria that compares the fit of each model, using a ranked score that minimizes G^2, BIC, dissimilarity index, degrees of freedom and maximizes p-value.[21] In the case of ties, I prioritize the more parsimonious functionally specialized model. This scoring procedure is unweighted and probably favors assignment as functionally specialized, as BIC, degrees of freedom and the tie breaker penalize complexity. My procedure is conservative in its classification of cohort aging tracts.

After assigning a type to each neighborhood, I estimate a logistic regression model to describe the factors that are associated with neighborhood assignment as cohort aging. The model takes the general form,

$$Pr(y_i = 1|x_i) = \frac{exp^{(x_i\beta)}}{1 + \exp^{(x_i\beta)}} \quad (7)$$

Where $P_{ij} = Pr(y_i=j \mid X_i)$, J = 0, 1. The subscript *i* indexes tracts and *j* indexes neighborhood type and X is a vector of independent variables averaged over the 5 decade period including home ownership, vacancy rate, proportion married, population size, home value, rental cost, median income, age of housing units, distance from city core and a metropolitan area fixed effect.

Results

Results and Performance of the Classification Model

In this section, I present results from the classification model. I am able to classify 47,659 tracts in 264 metropolitan areas. Table 3.1 presents descriptive statistics for the results of the classification procedure. I classify most tracts as functionally specialized (about 94%) and only 6% of tracts as cohort aging. I attribute this in part to the decision criteria that favors a

[21] Type 1 and type 2 errors in the assessment of hypothesis tests may be a concern with this analysis, especially, as I will estimate these models separately on thousands of neighborhoods. I use the Bayesian Information Criteria (BIC) in assessing model fit. BIC can reduce these types of errors.

functionally specialized classification, but also an actual rarity of tracts whose age distributions more closely resemble a cohort procession design matrix than a design matrix of only period and age effects. In general the cohort aging model fits its selected tracts better than the functionally specialized model fits its selected tracts, as evidenced by differences in the G^2, p-value, BIC and Dissimilarity values.

Table 3.1. Descriptive statistics of classification model results

	Functional Specialization				Cohort Aging			
Fit Statistic	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
G^2	901.0	615.1	14.1	19507.1	1294.5	623.3	157.8	4828.0
P value	0	0.01	0	1.000	0	0	0	0
BIC	550.2	608.4	-301.7	19115.8	941.1	616.0	-147.4	4460.7
Dissimilarity	8.5	2.5	1.0	36.0	9.3	2.5	4.0	30.2
DF	40				36			
Obs.	45821				2946			

Figures 3.2 and 3.3 show maps of the distribution of neighborhood types for two select metropolitan areas, Chicago, IL and Minneapolis, MN. These two areas have more aging in place neighborhoods than most metropolitan areas and, even still, cohort aging tracts rarely appear (and do so only outside of the central city). These figures also show map cut outs of select neighborhoods for each neighborhood type. For example, a tract in the Kenwood Park area on Chicago’s Southside was classified, with strong fit statistics, as a functionally specialized area. This tract, not far from the University of Chicago, is home to a stable mix of children, young adults and middle aged adults. Year after year, this tract of older housing units, whiter than the city average and with more valuable housing, but lower incomes than average, maintains a stable mix of children, young adults and adults, with considerably fewer older adults than the city’s average. It is likely home to students, professors and their families (and at one time, a US president).

For select cohort aging tracts, I show plots of the age distribution by period to demonstrate the lock-step movement of age and period that the cohort aging classification model identifies. For example, by inspecting the plot of the age distribution in a suburban Twin Cities tract in Spring Lake Park, I can trace cohorts as they age. In 1970, this tract had a large cohort of children age 10-19, we see this cohort again at 10-year intervals in their early 20s, 30s, and 40s, though the cohort is diminished in size in each successive period. This tract also had a large cohort of adults 40-49 in 1970, likely the parents of the younger cohort. Similarly, we can trace this cohort over time as well. In Lincolnwood, IL, just north of Chicago, we can trace a similar cohort aging pattern by focusing on the cohort ages 50 to 59 in 1970 or on the relative stability of the size of the 1970 cohort of children 0 to 9.

Figure 3.2. Classification results and select tracts in Minneapolis-St. Paul, MN

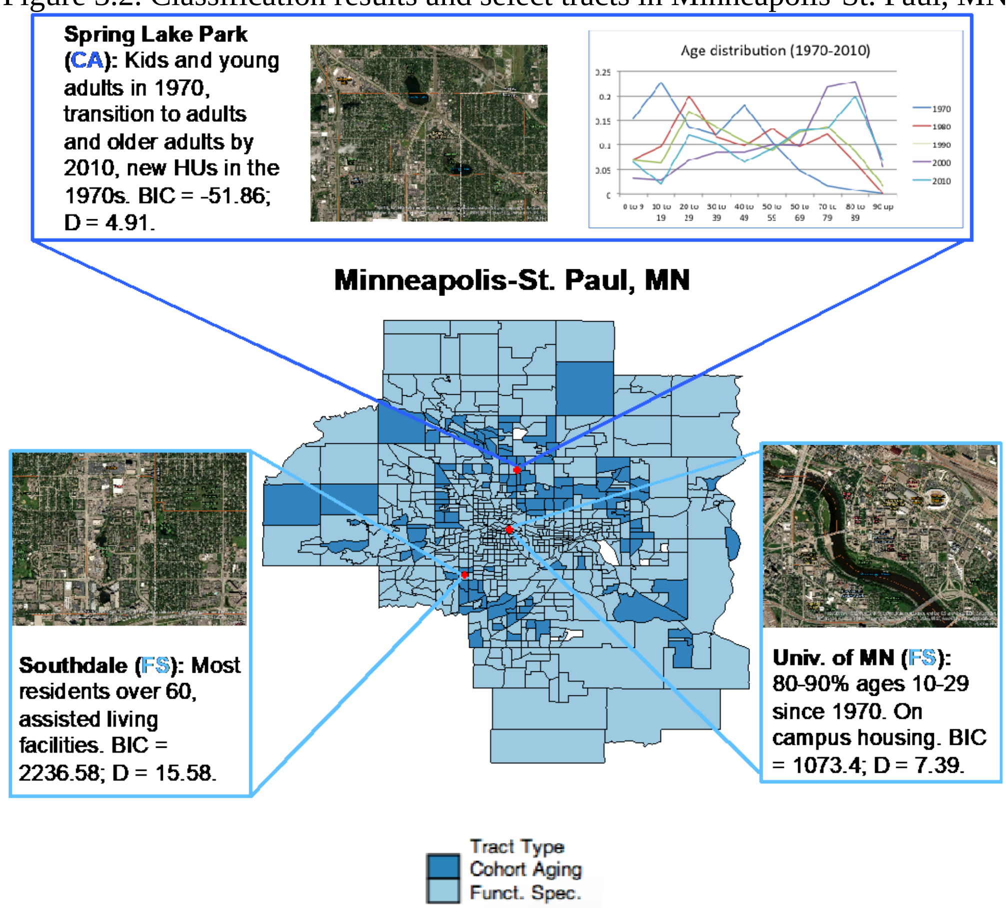
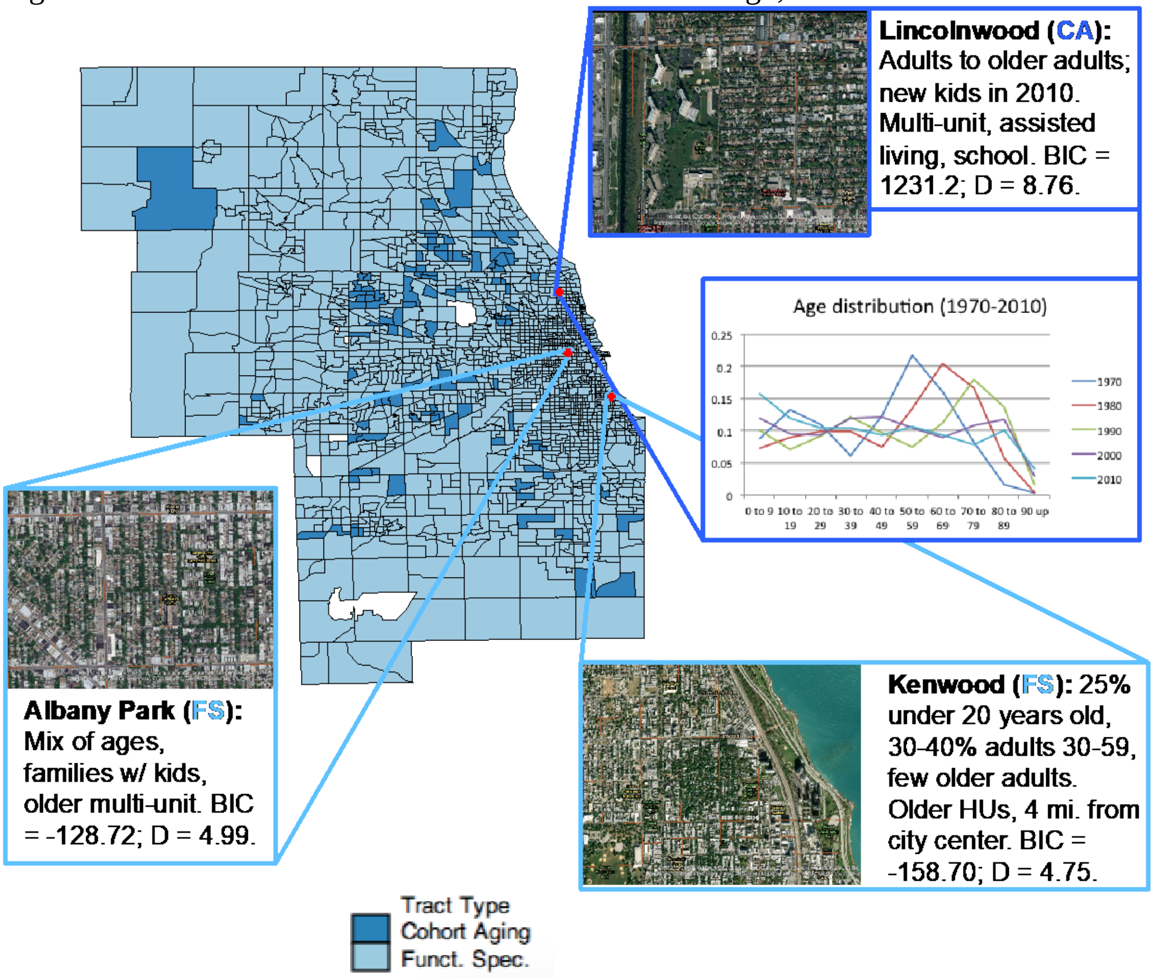


Figure 3.3. Classification results and select tracts in Chicago, IL



These examples demonstrate two elements of the cohort aging pattern as it plays out in actual neighborhoods. First, sudden shocks or demographic infusions, can shape patterns in the age distribution for many years after. However, these shocks and their impact over the long-term are likely both dependent on characteristics of the neighborhood, like amenities, which themselves likely develop endogenously.[22] Second, a pure cohort aging process is unlikely to occur in real neighborhoods, both as mortality will decrement a cohort as it ages and residential

[22] "The institutional structure rests on a population base, in the sense that particular functions are dependent for their performance on the presence of particular categories of persons" (Ryder 1964; p. 462).

mobility may bolster and even surpass these losses. To further illustrate these points, I look again to the tract in Spring Lake Park, MN. In 1970, Spring Lake Park was a new suburb of the Twin Cities, imbued with a large cohort of children 0-19 and a large cohort of adults 30-49, but very few residents over 60. More than half the housing stock was built before 1960. The new municipality had just bought its first snowplow and installed a sanitary sewer. It built its first hockey rink in the late 1960s and two more would follow by 1976. New housing construction in the 1970s brought the proportion of housing built before 1960 down to only a quarter by 1980. The population of older adults (70-79) grew dramatically between 1990 and 2000. Though this growth would include the original cohort 40-49 entering older adulthood, their persistence in the tract alone cannot account for the increase in the older adult population. Indeed, two senior housing facilities, the Cottages and Oakcrest Senior Housing, would be built between the 1990 and 2000 decennial censuses.[23] Though it was a relatively young tract in 1970, by 2010 almost 40% of the city was over the age of 70. The original 1970 cohort of adults was joined by the new residents, and perhaps, provided for themselves at the new senior living facilities.

In 1970, I find Lincolnwood also cohort aging, but at a different stage than Spring Lake Park. Lincolnwood, IL was founded 40 years before Spring Lake Park. In Lincolnwood, we can clearly trace the aging of the large cohort of adults 50-59 throughout the decades. In 1970 and 1980 Lincolnwood, was basically fully developed and even built a series of high rise condominium buildings. In a demographic sense, it looked similar to 2000 and 2010 Spring Lake Park, large cohorts of older adults, relatively few children. However, each year since 1980, the proportion of the population ages 0-9 in Lincolnwood, has ticked up.

[23] Spring Lake Park 50th Anniversary History and Memory report (2003)

Results of the Explanatory Model of Neighborhood Type

Table 3.2 presents descriptive statistics for the tracts by assigned neighborhood type and Table 3.3 shows the tract assignment distribution aggregated to the metropolitan area level. In general, the neighborhood types have similar total populations, household composition, housing costs and income levels. Cohort aging tracts are different from functionally specialized tracts on a number of dimensions and in largely expected ways. Specifically, they have more white residents, fewer shorter term residents, more college educated residents and newer housing stock. On average about 6.5% of tracts in a metropolitan area level are classified as cohort aging. I find no place where more than 30% are and some places have none.

Table 3.2. Descriptive statistics of neighborhood characteristics by type

	Func. Spec.		Cohort Aging	
Variable	Mean	SD	Mean	SD
Owner occupied	0.564	0.150	0.632	0.095
Vacant	0.068	0.049	0.044	0.033
HU pre-1960	0.480	0.277	0.307	0.191
Single unit	0.652	0.254	0.772	0.142
College	0.212	0.145	0.257	0.123
Group quartes	0.024	0.073	0.019	0.046
Married	0.541	0.121	0.605	0.058
Non-hisp. white	0.669	0.292	0.821	0.194
Families w/ child	0.398	0.115	0.417	0.083
Resident <10 yrs.	0.660	0.120	0.627	0.092
Manufacturing	0.173	0.082	0.186	0.079
Home value	11.948	0.573	12.122	0.435
Rental cost	6.478	0.361	6.656	0.310
HH income	10.842	0.408	11.091	0.243
Miles to core	17.882	57.992	16.715	47.770
Mi. to core (adj.)	0.204	0.395	0.114	0.233
Total pop.	3598.08	1405.87	3925.53	1358.01
Total pop. (ln)	8.108	0.417	8.208	0.385
Number of obs.	44,714		2,945	
Proportion	0.938		0.062	

Table 3.3. Classification results aggregated to metropolitan area level

Variable	Mean	SD	Min	Max
Func. Spec.	0.935	0.051	0.71	1
Cohort Aging	0.065	0.051	0	0.29
Tracts	181.31	390.62	1	4273
Observations	264			

In Table 3.4, I present the log odds results of the logistic regression model predicting classification as a cohort aging neighborhood as a function of various characteristics of the tract population and housing stock. Many of the differences between tract types evident in the sample means are also evident in the explanatory model, though some are reversed or amplified once other measures are controlled for. Perhaps most notable is the association between the proportion of residents who have lived in a tract for fewer than 10 years and classification as cohort aging. Residential stability, the fact that neighborhood residents are stationary and age in place, underlies the intuition behind the cohort aging model. As such, a large negative association with the proportion of residents in the neighborhood for fewer than 10 years is expected and among the largest associations I find in this model. A one standard deviation change in this measure (about 12 percentage points), is associated with a decrease in the odds of a cohort aging classification by a factor of 0.235 (exp(-12.25*0.118)), holding other measures constant. Inversely, for the same change, the odds of a functional specialization classification are 4.25 times greater than the odds of a cohort aging classification. Characteristics of housing seem to have a large influence on tract assignment. The proportion of housing units built before 1960 exhibits a large negative association with a cohort aging assignment, as does vacancy rate and proportion owner-occupied (the latter being in an unexpected direction). I also find a significant and positive association between single unit housing and cohort aging. Racial composition also appears to matter, a one standard deviation change in the proportion of non-Hispanic white residents is associated with odds of a cohort aging classification 1.8 times greater (exp(2.062)*0.289) than the odds of an functional specialization classification.

Most of these associations are robust to the inclusion of metropolitan area fixed effects, however, the associations with proportion married, proportion employed in manufacturing and home value lose significance, change sign or both. The measure of distance from the city center turns positive and significant in the model with fixed effects, with a one standard deviation change in distance increasing the odds of classification as cohort aging by 50%.

Table 3.4. Logistic regression results predicting classification as “cohort aging”

Variables	(1)	(2)
Owner occupied	-6.218***	-6.137***
	(0.387)	(0.415)
Vacant	-8.667***	-6.539***
	(1.337)	(0.949)
HU built pre-1960	-7.001***	-7.222***
	(0.170)	(0.179)
Single unit	2.117***	2.402***
	(0.273)	(0.299)
College	-0.730**	-2.668***
	(0.263)	(0.369)
Group quartes	1.049**	1.390**
	(0.395)	(0.456)
Married	-1.473*	-0.878
	(0.572)	(0.717)
Non-hisp. white	2.062***	1.502***
	(0.181)	(0.198)
Families w/ child	-2.684***	-3.767***
	(0.364)	(0.453)
Resident <10 yrs.	-12.25***	-12.52***
	(0.374)	(0.455)
Manufacturing	1.636***	0.129
	(0.310)	(0.539)
Home value	-0.443***	0.172
	(0.0878)	(0.152)
Rental cost	1.749***	2.180***
	(0.119)	(0.143)
Household income	-0.113	-0.229
	(0.186)	(0.254)
Miles to core (adj.)	-0.221	0.294**
	(0.205)	(0.107)
Total pop. (ln)	0.373***	0.463***
	(0.0611)	(0.0616)
Constant	2.794	
	(1.521)	

Table 3.4. continued

Metro Fixed Effects	No	Yes
Observations	47,659	46,811
p	0	0
ll	-8722	-7799
r2_p	0.211	0.221
Groups	.	238
Avg. obs. per group	.	196.7

Robust std. errors
*** p<0.001, ** p<0.01, * p<0.05

In summary, tracts characterized by cohort progression or *cohort aging* have newer housing stock, more single-unit housing structures, fewer vacant units, are further from the city center and have fewer new residents than tracts with stable age distributions or *functionally specialized*. However, *cohort aging* tracts also have fewer owner-occupied units, higher rental costs and fewer families with children than functionally specialized neighborhoods. Though this explanatory model is informative, it only explains about on fifth of the variance in the classification model. This doesn't come as much of a surprise, given that the classification model is explicitly designed to identify aging patterns.

Census tracts do not perfectly capture a "neighborhood," nor do their boundaries perfectly separate one unit from another. An underlying spatial phenomenon or characteristic is unlikely to obey tract borders. Adjacent or proximate tracts are likely not independent observations. For this reason, prediction errors, in the explanatory model may have spatially correlated (not independent) errors. I make some preliminary tests for spatial autocorrelation using Moran's I and in general reject the null hypothesis that observations are not randomly distributed spatially.

Discussion

I use a panel of census tracts from 1970 to 2010 and a series of log linear models to classify tracts according to longitudinal patterns in their age distribution. I design the models to specifically identify two ideal types of neighborhood aging. Functionally specialized neighborhoods have a consistent age distribution over time whereas the age distribution of cohort aging neighborhoods ages as would a stationary cohort. I present an explanatory model of tract type that demonstrates the social, economic and housing characteristics that are associated with classification as functionally specialized or cohort aging. Lastly, I suggest that the aging regime in a neighborhood, whether residents age as a cohort or a stable migration flow keeps the age distribution relatively constant over time, may present pathways to racial integration or durable barriers that uphold segregation for decades.

The explanatory model reveals that tracts characterized by cohort aging have newer housing stock, more single-unit housing structures, fewer vacant units, are further from the city center and have fewer new residents than tracts with stable age distributions (*functionally specialized*). However, cohort aging tracts also have fewer owner-occupied units, higher rental costs and fewer families with children than functionally specialized neighborhoods on average over the period 1970-2010. Tracts that age as a cohort are further from the city core than tracts I classify as functionally specialized. I see this both in the coefficient on distance from core in explanatory model results, but also in visual inspection of the tract type maps (those I present here and others). Notably, cohort aging tracts are almost exclusively located outside of the central city and are generally located in inner ring suburbs.

My expectations about the characteristics of each neighborhood type are largely consistent with the results of the explanatory model. Functionally specialized neighborhoods have certain amenities, some of which are age-specific and others that may appeal to a range of age groups, like proximity to the central city and multi-unit housing. These amenities and others that I find in general observation are also associated with this classification, educational institutions, are fairly durable at least over the span of multiple decades. Most neighborhoods appear to serve some specialized function, not necessarily for a single age group, but rather for a specific age distribution year after year. Cohort aging neighborhoods on the other hand change as a largely stationary population ages. The bundle of amenities in these areas, like single unit housing, some degree of distance from the central city, and undoubtedly for some, racial homogeneity, may be “seeded” by large scale home construction, founding or incorporation as a municipality. While it is possible cohort aging neighborhoods may reproduce the cohort aging pattern (perhaps allowing for racial integration through housing turnover), amenities and the characteristics of residents are probably endogenously determined. A cohort aging neighborhood could turn into a functionally specialized neighborhood. For example, as the population of Spring Lake Park, MN grew older, senior housing was built that both hosted existing older residents, but also drew others from outside the neighborhood. Those housing units are durable and will likely continue to draw older people to the neighborhood. These neighborhood types are certainly idealized and reality is more nuanced than the models alone can describe.

There is heterogeneity within the neighborhood types I identify. A functionally specialized neighborhood could include a constant large proportion of a certain age group, bars, apartments and art galleries for young unmarried adults, or a stable mix of the same age groups over time many single-family homes and schools for families with children. Likewise cohort aging neighbors may follow a pure cohort aging pattern or they may experience sudden influxes of certain age groups that bolster a cohort aging pattern, for example, through new construction.

In subsequent versions of this study I may test alternative design matrices to attempt to classify variations on the two ideal types I focus on in this paper, for example, retirement neighborhoods or places where young families move and remain. Heterogeneity within these classifications is both substantively interesting and may shape how long-term aging patterns influence racial segregation. In the third paper, I bring these classifications into a framework that assesses their associations with racial diversity at the tract level and racial segregation between neighborhoods at the metropolitan area level.

My classification technique finds far more functionally specialized neighborhoods than cohort aging neighborhoods. I think the relative rarity of cohort aging neighborhoods is due to models and a decision criteria that favors a classification as functionally specialized and reluctant to classify a tract as cohort aging. However, I also think that pure cohort aging tracts are actually relatively rare. The cohort model specifies a very specific cohort aging pattern and few neighborhoods likely follow this pattern precisely. Even a tract with a stationary cohort will not exhibit pure cohort dependence as the mortality schedule will shape the age distribution, imposing an age effect (that will be picked up in the independence model), again favoring the functional specialization classification.[24]

The classification model I use is fairly strict, in that it uses theoretically-informed a priori assumptions to identify a very specific type of aging pattern. An alternative approach could use unsupervised machine learning clustering algorithms to let the data describe how aging patterns emerge in neighborhoods over time. This approach is appealing in that clustering algorithms,

[24] In testing, I estimated eq. 2 (the pure cohort dependence model) on a simulated neighborhood population designed to exhibit pure cohort dependence in the absence of migration and mortality. Eq. 2 fit this table quite well, with BIC = -327.71 and p-value = 1. In the observed data, I never observe this strong of a model fit for eq. 2 among tracts classified as cohort aging. The same is true, though to a lesser extent for a test of the eq. 1 on a simulated age dependent tract.

will let the data speak for themselves, but is less appealing in that interpretation of clusters is challenging and I am looking to identify a certain type of neighborhood.

Both models are built on a base of “amenities,” in functionally specialized neighborhoods the stock of amenities is stable and age-specific. In cohort aging neighborhoods, amenities either are pre-existing and sufficient to support a cohort as it ages or more likely, develop out of the current needs of the cohort. In this study I don’t directly measure amenities, but subsequent work could likely benefit from doing so.

Chapter IV

Stacking the Deck: Age Structure and Racial Residential Segregation

Abstract:

Racial segregation is generally much higher than segregation by age, is closely linked to various forms of inequality, implicated in a number of adverse outcomes and, as such, draws much scholarly attention. However, the role that age structures play in maintain or modifying segregation patterns is understudied. In this chapter, I assess how the age distribution and neighborhood patterns of population succession are associated with neighborhood level racial diversity and metropolitan level racial segregation. Changes in segregation or neighborhood composition that are due to demographic pressures may be misattributed to changes in attitudes or housing market discrimination. I find that a youthful age distribution is positively associated with tract level racial diversity and negatively associated with metropolitan area level segregation. I find the opposite relationships for an older age distribution. Furthermore, a cohort aging pattern of neighborhood population succession appears to present durable barriers to racial integration, though it also holds inherent pathways to integration. Segregation may be unmoved by integrative or anti-discriminatory policies that fail to recognize conditions implied by differences in the age structure of racial groups.

Introduction

In this chapter, I connect age structure and the neighborhood level patterns of population succession I identified in chapter two to racial residential segregation. Specifically, I assess how the *age distribution* and *neighborhood patterns of population succession* are associated with neighborhood level racial integration and metropolitan level racial residential segregation.

Racial segregation in American metropolitan areas is typically high. On account of its severity, persistence and connection with racial prejudice, inequality and poverty, it receives more attention than other forms of segregation. Racial segregation generally rose from 1940 to 1970, but declined somewhat from 1970 or 1980 to 2010 (Cutler, Glaeser and Vigdor 1999; Iceland, Weinberg and Steinmetz 2002; Logan and Stults 2011). Segregation by race and by income are linked to numerous inequities, including access to services, school quality and exposure to crime and to detrimental health, educational and labor market outcomes and impediments to social mobility (Sharkey and Elwert 2011; Chetty et. al 2014; Sharkey 2016).

Residential segregation, particularly between blacks and whites and between Latinos and whites, is attributed to a number of factors, including past and ongoing racial discrimination that limits the ability of minorities to access certain neighborhoods, differences in income distributions and the ability to translate income into neighborhood attainment, fair housing legislation, post-war patterns of suburbanization, preferences to live near family members or same race neighbors and dynamic interaction between individual preferences and neighborhood composition (Massey and Denton 1993; Ellen 2000; Charles 2006; Clark 1992; Spilembergo and Ubeda 2004; Schelling 1971; Card et. al. 2007). Geographic familiarity, social networks and housing search strategies that are rooted in past experiences and historical racial segregation also work to preserve segregation (Krysan and Crowder 2017). These explanations for segregation have been fruitful for studies of residential segregation. However, they neglect direct consideration of the age distribution and aging patterns in neighborhoods, gaps that I address in this paper.

Starting in the mid-1960s and continuing through the early 1980s, children born during the Baby Boom (1946-1964) entered young adulthood. As the members of a large birth cohort, they faced a challenging labor market in which they competed for jobs with their large peer group and with those born earlier who remained in the labor force (Easterlin 1987). In 1970, the population of young adults ages 25-34 was 6 times as large as it was in 1960. Housing prices increased as large baby boom cohorts began to form families and surged into competitive housing markets (Myers and Pitkin 2009). Interregional residential mobility rates declined and many Boomers delayed long distance moves (Plane and Rogerson 1991). However, during the 1970s and 1980s, many neighborhoods near the centers of larger cities underwent gentrification, as largely white, college-educated young people elected to move into central city neighborhoods that had experienced decades of decline in the white population (Frey 1984; Myers and Pitkin 2009; Baum-Snow and Hartley 2016).

One explanation for the gentrification and decline in racial segregation in the 1970s and 1980s is that racial attitudes changed, especially, among young whites, who were willing to live in racially integrated neighborhoods that their parents had left or avoided. While there is some evidence to support this in later years (Ellen 2000; Charles 2006; Krysan 1998), demographic forces prevailing during this period suggest alternative explanations. As the baby boomers entered their years of peak residential mobility, there were many more individuals concentrated in the years of their lives when they were most likely to move to integrated neighborhoods than in previous decades. Further, recognizing competition in the housing market, young adults may have adjusted their preferences for same-race neighbors and/or expand the areas in which they would consider renting or purchasing housing.

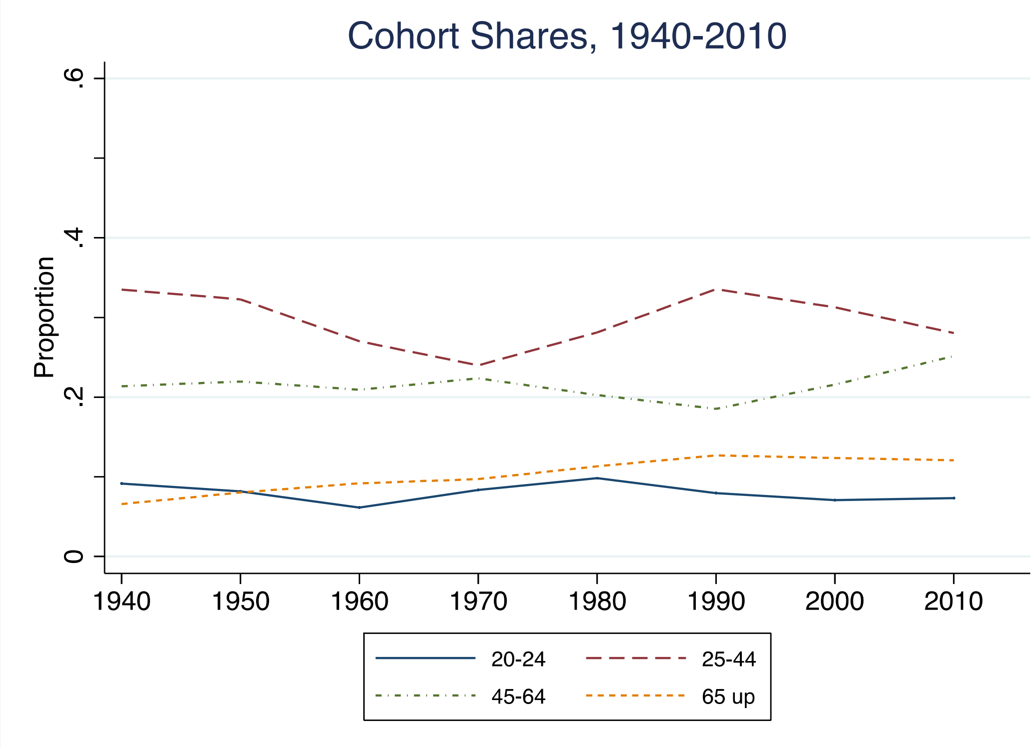
In this paper, I ask what happens to racial segregation in periods or places where demography has “stacked the deck”? That is, when the age distribution is organized in such a way that it could encourage changes in the spatial distribution of population. This could occur through residential mobility, as frequently mobile young people move between neighborhoods, through natural increase, as the age distribution of racial groups implies or amplifies differential growth rates or through housing market competition. Further, long-term aging regimes operating within neighborhoods may present pathways to integration or reinforce durable segregation patterns. For example, when young adults are relatively numerous does segregation between whites and non-whites decline? Does segregation change when whites are concentrated in years of low mobility (older adulthood) and non-whites are concentrated in years of high mobility (young adulthood)? Are neighborhoods in which residents age as a cohort more or less diverse than other neighborhoods?

Changes in segregation or neighborhood composition that are due to demographic pressures may be misattributed to changes in attitudes or housing market discrimination. This may inspire undue optimism that the social distance between groups is shrinking or that housing markets and their participants have become race neutral. Likewise, segregation may be unmoved by integrative or anti-discriminatory policies that fail to recognize conditions implied by differences in the age structure of racial groups. I examine the relationship between the age distribution and neighborhood level racial diversity and metropolitan area racial segregation. I also consider how the aging regime of a neighborhood is associated with racial diversity in the neighborhood and racial segregation in the broader metropolitan area.

Trends in Tract Diversity, Metropolitan Segregation and Age Distribution

The association between racial segregation and the age distribution likely varies at different points in the age distribution. I focus on four positions in the age distribution, ages 20 to 24, 25 to 44, 45 to 64 and 65 and older. Figure 4.1 presents trends in these portions of the age distribution from 1940 to 2010. The proportion of the population ages 20 to 24 has remained largely stable over time, though it has fluctuated, reaching high points in 1940 and 1980 and low points in 1960 and 2010. The population ages 25 to 44 follows a similar pattern though with a 10-year lead, but rising from 1970 to 1990. The older adult population (65+) has slowly, but steadily, gained in share of the total adult population.

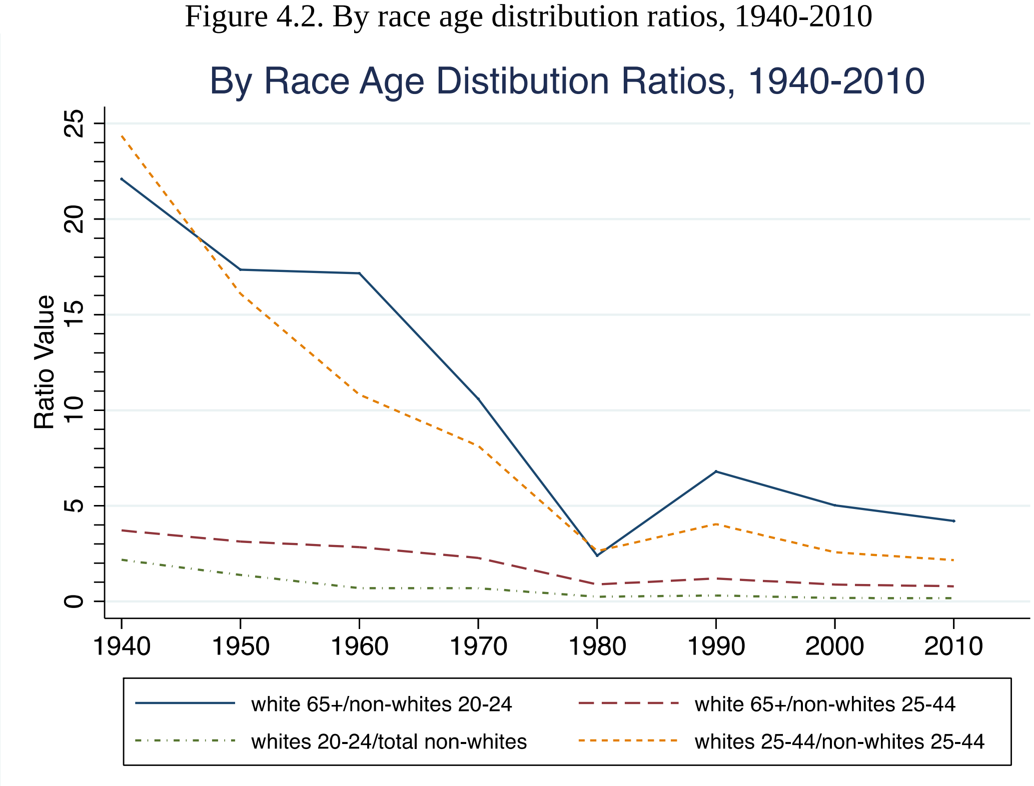
Figure 4.1. Cohort shares in select age categories, 1940-2010



The relative age distribution by race varies over time as well. All racial groups exhibit the general trend of the population, declining concentration in the ages 0 to 19 and growing concentration in the ages 65 and above. However, the intensity of the trend varies by race, as do absolute levels of concentration in each age category. The proportion of the white and black population 65 or older has tripled since 1940, though this increase has been slower for Hispanics. The gap between groups has generally widened since 1940, peaking in 2000 when 15% of the White population, 8% of the Black population and 4% of the Hispanic population were 65 years old or older.

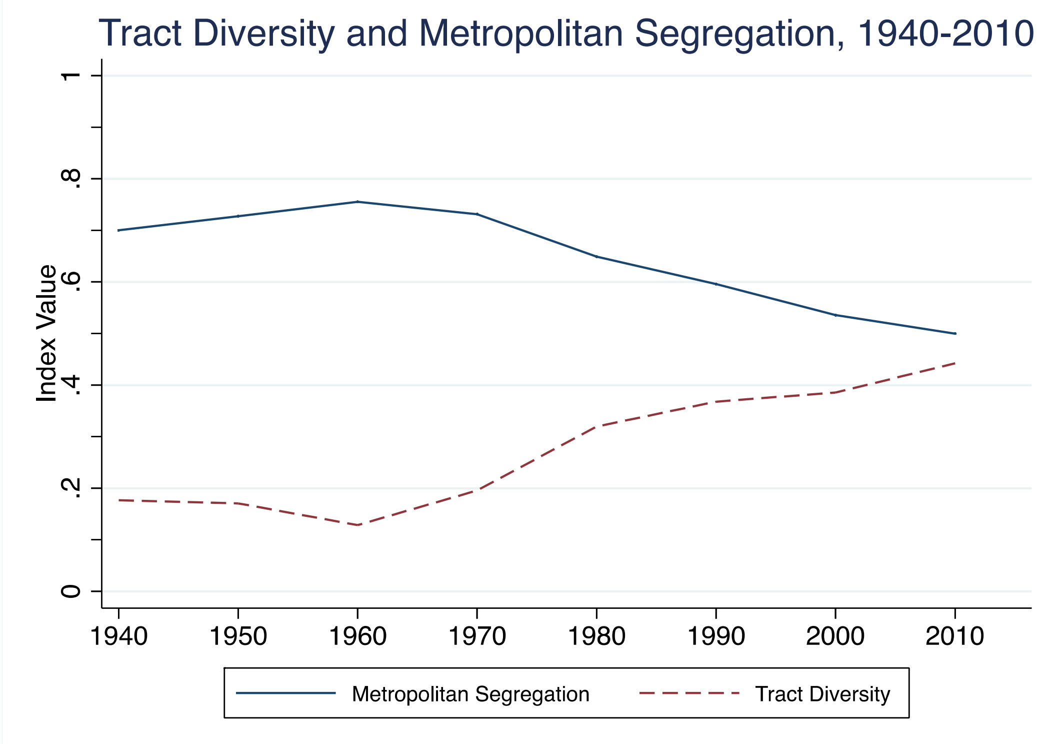
Despite differences in the age distribution of racial groups, the absolute population of these groups has trended toward convergence in metropolitan areas. Figure 4.2 shows selected ratios of the white to non-white population. All ratios have trended down in metropolitan areas, particularly stark is the equalization of the size of the older white population (65+) and the young adult (20 to 24) non-white population and of the population of white and non-white adults 25 to 44.

Figure 4.2. By race age distribution ratios, 1940-2010



I focus on two measures of racial segregation, a tract-level racial diversity index and a metropolitan area level segregation index. Figure 4.3 shows trends in racial diversity in census tracts and racial segregation in metropolitan areas from 1940 to 2010. Tract level racial diversity between whites and non-whites was relatively flat from 1940 to 1970, but has since steadily increased. Likewise, segregation between whites and non-whites was largely stable at high levels from 1940 to 1970, but declined thereafter. Both trends are consistent with past studies of segregation and the decline in racially homogenous census tracts (Ellen 2000; Glaeser and Vigdor 2012).

Figure 4.3. Tract racial diversity and metropolitan area segregation, 1940-2010



Age Distribution and Racial Composition

Age distribution may influence racial segregation for a number of reasons. First, many demographic events are age-graded. To the extent that moves, family formation and deaths, are related to the spatial distribution of population, it follows that fluctuations in the age distribution may work through these events to change racial segregation. Second, variation in the relative size of cohorts may work to modify demand and preferences in housing markets in ways that can influence segregation. Third, the prevailing aging pattern in a neighborhood may make it more or less amenable to racial change in ways that may be durable for decades.

Residential Mobility

Residential mobility is an important mechanism driving neighborhood change and residential segregation. Wilson (1987) attributed increases in the concentration of poor blacks in American cities during the 1980s, in large part, to the movement of middle class blacks out of poor, inner city neighborhoods into non-poor, largely white neighborhoods. Mobility in avoidance of the poor and non-white populations produced severe racial segregation in American cities (Massey and Denton 1993). Net migration flows, demonstrate the importance of mobility patterns for persistent black-white segregation and resegregation in temporarily integrated neighborhoods (Quillian 1999).

During an individual's life, the likelihood of making a residential move varies with age, "residential mobility is relatively high for children under age 5; relatively low during the mid-teens; and extraordinarily high for people in their early 20s. Thereafter, mobility rates decline with age, rapidly at first, and then more gradually until about age 85, when there is a slight upturn" (McFalls 2007). Neighborhood preferences for certain amenities and certain types of neighbors also change with age. Many studies of residential segregation consider how an individual's neighborhood preferences and probability of moving change with age (Johnson 2005; Sampson and Sharkey 2008; Painter and Lee 2009; Boustan and Shertzer 2013). For example, white households avoid moving into integrated neighborhoods (Ellen 2000) and move away from diversifying neighborhoods (South, Pais and Crowder 2011), especially, when they have children (Boustan and Shertzer 2013). This type of mobility behavior contributed to the rise in racial segregation in the mid 20th century, though integrative interregional moves by black households contributed to declines in segregation that occurred in subsequent decades (Sander, Kucheva and Zasloff 2018).

Natural Increase

Population change in neighborhoods and cities can occur in the absence of residential mobility, working instead through natural increase - population change that occurs through the operation of mortality and fertility. Given that residential mobility rates are lower now than in the past, there is reason to expect that mobility will be of declining importance for segregation patterns (Bader and Thomas 2016; Molloy 2017). Past studies of racial segregation and even a Supreme Court decision,[25] recognize that population growth rates are among the factors that contribute to racial residential segregation. In their study of black – white segregation in American metropolitan areas, Taeuber and Taeuber (1965), find that neighborhood racial change, the prevalence of 'succession and invasion' and the pace of change were associated with the relative growth rate of the black and white population in a metropolitan area.

[25] Supreme Court Justice Potter Stewart attributed black-white segregation in Detroit to, "unknown and perhaps unknowable factors such as *in-migration, birth rates*, economic changes, or cumulative acts of private racial fears." (cited in Richard Rothstein, *The Color of Law*, 2017, p. xii).

Age structure is a major determinant of natural increase and population momentum. Given an identical fertility and mortality schedule, a population concentrated in young and child-bearing ages will, at least in the short term, grow at a faster rate than a population concentrated in older ages. Group differences in size or age distribution may amplify the effects of fertility and mortality on segregation and neighborhood change and may potentiate change that occurs through residential mobility. As in the US, immigrant groups in the UK typically have a younger age distribution than the native born. Simpson, Gavalas and Finney (2008) decompose population change in two diverse Manchester-area cities into natural increase and migration. They find little evidence for white flight from immigrant areas, but find that places with first and second-generation immigrant populations have non-native populations with young age distributions (and as a result relatively few immigrant deaths and many immigrant births) and native-born white populations with older age distributions. In these areas, high white mortality and non-white natural increase account for much of the increase in minority concentration. Bader and Thomas (2016) parse neighborhood population change and aggregate racial residential segregation in the United States into the components due to migration and natural increase. For currently integrated neighborhoods, natural increase often leads to increased homogeneity and segregation between racial and ethnic groups. Though, natural increase can integrate neighborhoods, particularly, those where Latinos live.

Housing Competition

Numerous previous demographic studies consider the effects of differences in generation or cohort size on society. Cohort size shapes labor, marriage, and housing markets (Johnson 1980; Raymo and Iwasawa 2005; Myers and Pitkin 2009). Easterlin’s foundational work considered how differences in the cohorts of young men and older men shaped labor market and family outcomes (Easterlin 1987). Recently, Neumark and Yen (2020) argue for a more detailed division of the age distribution to understand the effects of cohort size on the labor market participation and returns.

Relative cohort size may influence where people live through effects on housing demand. Specifically, I use a relative supply-side effect framework to think about how changes in the age distribution may influence not just changes in the overall housing market, but also changes in racial segregation. The age groups I consider are rough proxies for stages in the life course and cycle of housing consumption.[26] When the size of a cohort is large, many individuals that are likely to be in similar stages of housing consumption will compete for housing. In a housing market in which agents hold preferences for neighborhood amenities that are correlated with race and/or hold explicit preferences for same race neighbors, as has been found, particularly among whites, (Charles 2000; Krysan, Couper, Farley and Forman 2009), competition among a particularly large cohort may encourage some buyers to modify their preferences. For example, whites with preferences for same race neighbors may relax these preferences and purchase housing in more diverse areas when faced with a large group of peers also ready to purchase housing. Black homebuyers with a preference to live near family, may choose to live further from relatives when the market is tight. When a cohort is large relative to the total adult population, competition for housing within the cohort will increase and ability to meet preferences will decrease, meaning that some will accept housing in areas that do not meet their desired preferences. For whites with preferences for same race neighbors, this will mean moving

[26] A more data driven approach could calculate the prime buying and prime selling cohorts at different points in time to make lees arbitrary age categories.

into less white neighborhoods, increasing diversity at the neighborhood level and decreasing segregation at the metropolitan area level.

Measuring the Age Distribution

To assess how the age distribution may work through these pathways to influence racial segregation, I focus on a series measures of the age distribution and of the relative age distribution of whites and non-whites.

The ratio of whites 65 and older to non-whites 20 to 24 compares whites in years of low mobility and high mortality (older adulthood) and non-whites in years of high mobility and high fertility (young adulthood). When older whites are numerous relative to younger non-whites diversity may fall and segregation may rise. When the ratio takes values closer to one diversity may rise and segregation may decline as younger non-whites may increase in numbers by forming families and older whites create housing vacancies that could be filled by younger non-whites. I also consider a modified version of this measure that uses the ratio of whites 65 and older to non-white 25 to 44.

The ratio of whites 20 to 24 to total non-white population considers the balance between whites in years of peak mobility and peak preferences for residence in diverse, urban neighborhoods with the total non-white population. As this ratio takes larger values, tract diversity may increase and segregation may decrease as a large cohort of young whites may chose to live in more racially diverse neighborhoods. This ratio attempts to proxy for an arrangement of the age distribution that may lead to white gentrification into historically non-white neighborhoods.

Lastly, the ratio of whites 20 to 44 to non-whites 20 to 44 compares racial groups in a broad age category that includes years of high residential mobility and family formation. I would expect a positive association with tract diversity and a negative association with segregation. However, if whites and non-whites engage in largely separate housing markets, as could be argued in the early part of the study period, there may be no association. Within race supply-side effects might still operate primarily through increasing prices or decreasing mobility.

I look for supply-side effects across the age distribution by measuring the proportion of the entire adult population in various age categories (relative to the total adult population).[27] I expect increases in the proportion of the population ages 20 to 24 and 25 to 44 to increase tract level racial diversity and decrease metropolitan area segregation. These cohorts are in peak years of residential mobility and housing consumption. Given competition from a relatively large group of peers, individuals may modify their housing preferences. Supply-side effects would predict increases in tract diversity and decreases in segregation for each of these age groups. However, I expect relatively neutral effects from the ages 45 to 64 as mobility is generally low in these ages. Though supply-side effects in the oldest age category would predict integrative effects, older adults have the lowest levels of residential mobility and generally live in the most racially homogenous communities. If supply-side effects are present, I would expect them to be tempered or washed out by this fact. I also expect that the lagged measure of population 65 and older could go negative as a large cohort of older adults in the past could suggest greater housing turnover in the future, though this would depend on how vacancy chains operate. Though this is an imperfect assessment of the supply-side effects of cohort size on neighborhood racial

[27] An alternative assessment might include the ratio of the population 65 and older to the prime buyer cohort or ratio of older whites to young whites/young non-whites.

composition, it does offer additional reasons to expect an association between the age distribution and racial segregation.

Housing prices present a further complication for any attempt to identify supply-side effects. When faced with housing competition, or the pressure to live in less white neighborhoods, whites will pay a premium to live in largely white neighborhoods (Cutler, Glaeser and Vigdor 1999). Housing price might absorb any effects of cohort size on segregation if white housing consumers simply bid up for housing in order to preserve segregation. In a sub-sample of my main files described in the data section, I am able to control for differences in median income, median rent and median housing value between whites and non-whites.

The influence of the age distribution on tract diversity and metropolitan area segregation may come at various levels and with a temporal lag. Racial diversity in tracts may be related to the age distribution of the entire metropolitan area, not just that of the tract itself. For example, tracts in metropolitan areas with many young people may be more diverse, even if the tract itself does not have a particularly large number of young people. The contemporaneous age distribution of a tract or metropolitan area may be associated with the degree of diversity or segregation. However, the deck must be stacked before it is dealt and the lack of temporal order does not satisfy the pre-conditions for a causal effect. For this reason, I include a lagged measure of the age distribution, to assess the extent to which the age distribution in an area in the past is associated with its current level of diversity or segregation.[28]

[28] The lagged measure has some short-comings, specifically, its relationship to diversity and segregation may be biased by endogeneity from residential mobility.

Neighborhood Level Pattern of Population Succession

In addition to changes in the age distribution and the relative age distribution of racial groups, the aging regime of a neighborhood may also influence the extent to which it offers pathways or barriers to racial integration. In chapter two, I develop a model to classify census tracts into two categories based on longitudinal patterns in their age distributions. The first category classifies neighborhoods as “functionally specialized” if they exhibit a relatively stable age distribution over time. The second category classifies neighborhoods as “cohort aging” if the population follows a cohort aging pattern. Functionally specialized neighborhoods are far more common than cohort aging neighborhoods. In this paper, I consider how neighborhood types may be associated with racial diversity at the neighborhood level and racial segregation at the metropolitan area level.

Functionally specialized neighborhoods may be more stably integrated than cohort aging neighborhoods. Neighborhoods with a stable age distribution will experience a higher degree of population churn (in and out migration) than those that age as a cohort. More frequent vacancies and residential turnover may offer more frequent opportunities for racial integration. However, neighborhoods can be functionally specialized in different ways that may be more or less amenable to racial integration. For example, a neighborhood near a university or military base characterized by a consistently young population and a retirement community characterized by a consistently older population, may exhibit different levels of racial integration. Dormitories or barracks in university of military communities are often integrated. Residence in these communities is often not elective and only temporary. Under these conditions people may accept living in less homogenous communities than they might prefer. University communities typically have a highly educated populace, segregation may be lower because residents may also have progressive attitudes toward racial integration. Retirement communities may have high levels of segregation in part because of racial differences in income or prejudicial attitudes that persist into older adulthood and translate into racially stratified residential experiences. In recent decades, metropolitan areas characterized as retirement communities, places with many residents 65 and older, exhibited high levels of racial segregation, while military communities were less segregated and university communities had mixed associations with racial segregation (Farley and Frey 1994; Logan, Stults and Farley 2000).

Neighborhoods classified as cohort aging may be less likely to undergo racial change than those characterized by functional specialization. Specifically, they may offer less frequent housing vacancies and be less likely to experience rapid racial turnover, but perhaps more likely to experience gradual change due to cohort replacement. However, Ellen (2000) argues that neighborhoods with high proportions of owner-occupied housing units (a correlate of aging-in-place neighborhoods found in chapter 3) may be more likely to undergo rapid racial change, as homeowners, particularly white homeowners, have historically been more sensitive to the racial composition of neighborhoods than renters. Cohort aging neighborhoods are by definition durable in terms of age distribution, that is cohorts remain in place and the neighborhood ages in step with time. This durability may also extend to the racial composition and these neighborhoods may resist integrative for decades.

Metropolitan areas with more cohort aging neighborhoods than functionally specialized neighborhoods may see less change in segregation over time than metropolitan areas with a greater concentration of functionally specialized neighborhoods. However, if a majority group is entering years of high mortality, vacancies will become available in neighborhoods characterized by cohort aging. These vacancies are available to be filled by minority group members, a possibility that seems more likely if a greater proportion of the minority group is concentrated in years of family formation than the majority group, and segregation would decrease.

Summary

Though the spatial distribution of racial groups is linked to numerous factors, I expect that the age distribution also influences segregation. Cohort size may influence segregation by increasing competition for housing, encouraging some participants in the housing market to accept housing in more diverse neighborhoods than stated preferences suggest they may want. Residential mobility behavior, specifically, the frequency of moves and the likelihood of living in diverse neighborhoods varies at different points in the life course. Fertility and mortality also vary with age and present possible ways that the age distribution, working through natural increase, may influence segregation. Furthermore, long-run patterns of aging within neighborhoods may present avenues or roadblocks to integration at the neighborhood and metropolitan area level. This paper explores these possible pathways by considering the proportion of the population in various age groups, the relative size of white and non-white age groups and the predominant pattern of aging in neighborhoods. I ask two basic questions,

1. *How are differences in the age distribution associated with segregation by race?*
2. *Do patterns of neighborhood population succession predict patterns of racial change?*

Hypotheses

The following hypothesis summarize my expectations for the relationships between the age distribution, relative differences in the size of racial groups and neighborhood aging pattern and the dependent variables tract racial diversity and metropolitan area segregation.

H1: The proportion of the population ages 20-24 will be positively associated with tract level racial diversity and negatively associated with metropolitan area segregation.

H2: The proportion of the population ages 25-44 will be positively associated with tract level racial diversity and negatively associated with metropolitan area segregation.

H3: The proportion of the population ages 45-64 will show no association with tract level racial diversity or metropolitan area segregation.

H4: The proportion of the population ages 65 and older will be negatively associated with tract level racial diversity and positively associated with metropolitan area segregation.

H5a: The ratio of whites 65 and older to non-whites 20-24 and the ratio of whites 65 and older to non-whites 20-44 will be negatively associated with diversity and positively associated with segregation.

H5b: The ratio of whites 20-24 to total non-white population and the ratio of whites 20-44 to non-whites 20-44 will be positively associated with diversity and negatively associated with segregation.

H6: Tracts classified as cohort aging will be negatively associated with tract level racial diversity and positively associated with metropolitan level racial segregation.

Data and Measures

I use tract-level tabulation data from the US Census Bureau for the years 1940-2010 to produce four files from two samples. The first sample includes the set of metropolitan areas that had been divided into tracts in 1940 (referred to as the *1940 sample*). I identify these areas in consistent metropolitan area boundaries over the entire panel period. The second sample includes a larger number of metropolitan areas that can be consistently identified from 1970 to 2010 (referred to as the *1970 sample*). In each sample, I produce a tract-level file and a metropolitan area-level file. Only in the 1970 samples, can I measure neighborhood aging from chapter 3.[29]

I measure the age distribution as the proportion of the adult population[30] in the following categories, ages 20 to 24, 25 to 44, 45 to 64 and 65 and older. I do so for the total population, the white population and the non-white population. The white and non-white distinction is the only racial categorization that I can consistently measure over the full study period. This coarse division has shortcomings in that racial segregation varies between whites and non-white groups and the racial category "white" as measured does not distinguish Hispanic or Latino ethnicity. Hispanic or Latino origin did not appear on the decennial census questionnaire until 1970. Rates of Hispanic or Latino race reporting (i.e. as "white" or another racial category), likely vary over the study period with fewer Hispanic or Latino residents reporting as white as time goes on.

I measure economic, demographic and housing characteristics at the tract level and metropolitan area level. Specifically, I measure population size, housing tenure, proportion employed in manufacturing, proportion with a college degree, median rent, median home value,

[29] For the years 1970 – 2010, I adjust the population of census tracts to account for boundary changes over time using the Longitudinal Tract Database crosswalk.
[30] 18 and older

proportion living in group quarters and proportion of housing that are single unit. For a sub-sample of metropolitan areas in the years 1970-2010, I produce measures of median income, median rent and median home value separately for whites and non-whites from IPUMS microdata. These measures are used as controls to better assess the potential that housing competition amongst a large cohort can reduce racial segregation.

The analysis focuses on two dependent variables, at the tract level, a measure of racial diversity and, at the metropolitan area level, a measure of racial segregation. I measure tract-level racial diversity with the unit entropy measure from the entropy of information theory index (eq. 1). At the metropolitan area level I measure segregation between whites and non-whites with the dissimilarity index and the entropy index (eqs. 2 and 3).[31]

The Dissimilarity Index, D, calculates the evenness of the distribution of two groups, *O* and *C*, over tracts *i* in a metropolitan area. The Entropy Diversity index, E, calculates each tract's level of diversity in reference to a group, *M*. The Entropy Diversity index is calculated for all tracts and for the entire metropolitan area. The Thiel Information Theory Index is then calculated, where t_i is the population of tract *i*, *T* is the metropolitan area population and E_i and *E* are the tract and metropolitan area Entropy Diversity values.

(1) $$E_i = \sum_{m=1}^{M} \pi_m * ln(1/\pi_m)$$

(2) $$D = 1/2 * \sum_{i=1}^{n} |(o_i/O - c_i/C)|$$

[31] I present results of the metropolitan area segregation measure with just the dissimilarity index, though results from the entropy diversity index are largely similar.

$$H = \sum_{i=1}^{n} [t_i(E - E_i)/ET \quad (3)$$

These dependent variables are all bounded within the 0,1 interval. The segregation measures can theoretically take values of 0 and 1, denoting complete evenness or complete segregation, though in practice no areas take these values. The diversity measure is bounded to a subset of 0,1 interval.[32] The diversity measure is undefined when there is complete racial homogeneity in a tract (no members of one group are present in a tract). Complete racial homogeneity in census tracts was more common in the beginning of the period I consider, but became considerably less common overtime. As a robustness check, I also make a version of the diversity measure that is defined even when a tract is completely homogenous (eq. 4). These measures are highly correlated and of the tracts in the analytical sample (non-missing on independent variables), 97% in the 1940-2010 sample and 98% in the 1970-2010 sample are defined in both measures. I prefer the first measure for its relationship to the familiar entropy index and present results from that measure.[33]

(4) *Div2 = 1 - ((white pop/total pop)^2 + (non-white pop/total pop)^2)*

[32] Specifically, the interval [(((1/n(MAX))*log(1/(1/ n(MAX))) + ((1/n(MAX)-1)*log(1/(1/ n(MAX)-1))), log(k)], where *n(MAX)* is the largest unit population (e.g. tract total person count) and *k* is the number of groups over which the measure is calculated. In this study, the observed lower bound is 0.000835 and *k* = {whites, non-whites}, thus, the theoretical upper bound is log(2).
[33] Results are largely identical when I estimate models with the fully defined diversity measure.

Key Independent Variables

My analysis focuses on measuring the association between the age distribution and racial diversity and segregation. I focuses on a series of key independent variables that I measure in various ways. I measure the proportion of the adult population in the following four categories, 20 to 24, 25 to 44, 45 to 64 and 65 and older. In the tract files, I measure each of these proportions in four ways, 1. within each tract, 2. over the entire metropolitan area, 3. lagged 10 years over the entire metropolitan area and, 4. lagged 10 years within each tract. In the metropolitan area files, I measure these proportions in two ways, 1. over the metropolitan area and, 2. lagged 10 years over the entire metropolitan area.

To assess the association of specific differences in the age distribution of the white and non-white population, I measure a series of ratios. I calculate, 1. the ratio of whites 65 and older to non-whites 20-24, 2. the ratio of whites 65 and older to non-whites 20-44, 3. the ratio of whites 20-24 to total non-white population and 4. the ratio of whites 20-44 to non-whites 20-44. I measure these ratios at both the tract and metropolitan area levels.

To assess the association between neighborhood pattern of population succession, functionally specialized (stable age distribution over time) or cohort aging (changes in the age distribution consistent with a pattern of cohort aging) and racial diversity/segregation, I measure tract type according to the classification model from Paper 2. In the tract level models, tract type is a binary indicator (coded “0” for functionally specialized tracts and “1” for cohort aging tracts). In the metropolitan area level models, this measure is aggregated to proportion of tracts classified as cohort aging in each metropolitan area.

Regression Analysis of Racial Diversity and Segregation

It is common to model continuous variables bounded in the interval 0 to 1, like proportions or indexes, with Ordinary Least Squares (OLS) regression. However, the diversity measure is beta or logit distributed and residuals from OLS models are heteroskedastic. To address potential concerns about the performance of the OLS estimation, I also model the diversity and segregation outcomes with beta regression (even though the segregation indices are approximately normally distributed and the residuals are less heteroskedastic). Beta regression can accommodate continuous dependent variables in the interval 0 to 1, their asymmetric distributions and heteroskedasticity (Cribari-Neto and Zeileis 2009).

I include a relatively small set of independent variables in the models. The model specifications vary slightly across the two samples and two dependent variables. I built models with the intention to minimize the number of predictors in order to keep multicollinearity low, to include the largest number of observations (as some independent variables are missing in some areas) and to maximize model fit. I include polynomials for independent variables with a non-linear relationship with the dependent variable and winsorize some independent variables at the 5^{th} and 95^{th} percentiles to coerce a linear relationship. My variable selection and transformation efforts have little effect on the coefficients of my key independent variables and generally improve model fit. I estimate all models with standard errors clustered on the metropolitan area.

Tract Level Regression Analysis

I estimate a model at the tract level to predict the value of the tract level racial diversity score. The model takes the form,

$$(5) \qquad Y_{ij} = \beta_0 + \beta_1 Key_{ij} + \beta_2 X_{ij} + \beta_3 Year_{ij} + \beta_4 Metro_{ij} + \varepsilon_i$$

Where Y_{ij} is tract *i*'s racial diversity score in year *j*. The coefficient for Key_{ij} describes the association between the age distribution and tract racial diversity. I estimate this model for four versions of each of the key age distribution variables, Key_{ij}, Key_metro_{ij}, Key_metro_{ij-10}, and Key_{ij-10}. The *Xs* contain contemporaneous measures of total population, education, manufacturing employment, housing tenure, rental costs and home value. The forth and fifth terms are for year and metropolitan area fixed effects. When the key independent variable is a portion of the age distribution, I include ratios of the age distribution by race to account for racial differences in the age distribution. For example, when estimating the association of the proportion of the adult population ages 20 to 24 on tract-level diversity, I include the ratio of the white and non-white population age 20 to 24 at the metropolitan area level. This is intended to estimate the association between the adult population ages 20 to 24 and tract-level racial diversity, net of any differences in the racial composition of the population ages 20 to 24 at the metropolitan area level.

I also estimate this model using the by race age distribution ratios as key independent variables. In those models I omit controls for differences in the age distribution by race (as this is precisely what I intend to measure with the ratios) and do not estimate the lagged models. I estimate these models using untransformed and winsorized versions of the by race ratios, which often have long right tails.

In the 1970 sample, I also estimate a version of this model that replaces the key independent variables for the age distribution with an indicator for the pattern of neighborhood population succession. The indicator denotes whether I classified a tract as functionally specialized (stable age distribution over time) or cohort aging (changes in the age distribution consistent with a pattern of cohort aging). This model describes whether neighborhoods characterized by cohort aging are less racially diverse than other neighborhoods. In these models, I also include controls for the age distribution and racial composition at the metropolitan area level.

Metropolitan Area Level Regression Analysis

I estimate a similar series of models at the metropolitan area level predicting segregation between whites and non-whites. These models are designed to assess the extent to which differences in the age distribution, and the prevailing pattern of neighborhood succession explain variation in racial segregation. The models takes the same general form as above,

$$(6) \qquad Y_{ij} = \beta_0 + \beta_1 Key_{ij} + \beta_2 X_{ij} + \beta_3 Year_{ij} + \beta_4 Metro_{ij} + \varepsilon_i$$

Where Y_{ij} is metropolitan area *i*'s segregation index in year *j*. The coefficient for Key_{ij} describes the association between the age distribution and tract racial diversity. I estimate this model for two versions of each of the key age distribution variables, Key_{ij}, and Key_{ij-10}. The *Xs* contain measures of total population, education, manufacturing employment, housing tenure, rental costs and home value. The forth and fifth terms are for year and metropolitan area fixed effects. As in the tract models of the age distribution, I include ratios of the age distribution by race to account for racial differences in the age distribution. I also estimate this model with by race ratios as the key independent variable and again do so with untransformed and winsorized ratios. In those models I omit controls for differences in the age distribution by race (as this is precisely what I intend to measure with the ratios) and do not estimate the lagged models. For a sub-sample of metropolitan areas in the years 1970-2010, I include measures of median income, median rent and median home value separately for whites and non-whites.

Again, only in the 1970 sample, I estimate a version of this model with the pattern of neighborhood population succession. Here, neighborhood type is aggregated from tracts to the metropolitan area level and enters the model as the proportion of tracts in the metropolitan area that I classify as cohort aging. The coefficient on this term describes whether metropolitan areas with many cohort aging neighborhoods are more or less segregated than neighborhoods characterized by functional specialization. As above, I include controls for the age distribution and the racial composition of the metropolitan area. I omit metropolitan fixed effects, as neighborhood type is measured as a proportion and does not vary within a metropolitan area.

Results of OLS and Beta Regression Models at the Tract and Metropolitan Area Level

Table 1.1 and Table 1.2 present the descriptive statistics for the dependent and independent variables used in the regression models for each of the samples at the tract and metropolitan area level, respectively. The characteristics of 1940 sample and the 1970 sample are very similar, thought there are some important differences. The 1940 sample is composed of a set of metropolitan areas that have been subdivided into tracts by the Census Bureau by 1940. These were among the largest metropolitan areas in the United States at the time. Suburban sprawl was fairly limited in 1940 and these areas were mostly defined by population in central cities and a first ring of suburbs or secondary areas. The 1970 sample includes a larger set of metropolitan areas that, by 2010, composed the largest areas in the United States. This sample includes areas in the south and southwest that grew primarily since the 1980s.

Table 4.1.1 Summary statistics for tract level samples

	1940 Sample				1970 Sample		
	mean	sd	N		mean	sd	N
diversity	.314521	.2361125	113464	diversity	.3371472	.2158125	278802
diversity2	.1970064	.173097	113464	diversity2	.2088173	.1614577	278802
% white	.7287404	.3149214	113464	% white	.7818097	.2572448	278802
% non-white	.2712589	.314922	113464	% non-white	.2181903	.2572448	278802
total population	4041.009	2256.194	113464	total population	3594.707	1888.437	278802
% 20 to 24	.1126718	.057958	113464	% 20 to 24	.1123786	.0747677	278802
metro % 20 to 24	.112508	.0207438	113464	metro % 20 to 24	.1141614	.0306523	278802
metro lag % 20 to 24	.1141814	.021035	108346	metro lag % 20 to 24	.1192845	.0318457	228446
lag % 20 to 24	.1185813	.0596445	72425	lag % 20 to 24	.1152576	.0732769	228643
% 25 to 44	.4303319	.0955063	113464	% 25 to 44	.4242091	.1045637	278802
metro % 25 to 44	.4268317	.0437505	113464	metro % 25 to 44	.4172228	.0476748	278802
metro lag % 25 to 44	.4348449	.0421841	108346	metro lag % 25 to 44	.4258696	.0462493	228446
lag % 25 to 44	.433166	.0959378	72425	lag % 25 to 44	.433827	.1039633	228643
% 45 to 64	.3073766	.0736841	113464	% 45 to 64	.3054775	.078174	278802
metro % 45 to 64	.3089737	.0376334	113464	metro % 45 to 64	.3072331	.0402917	278802
metro lag % 45 to 64	.3043726	.035592	108346	metro lag % 45 to 64	.2953286	.0359192	228446
lag % 45 to 64	.292543	.0723329	72425	lag % 45 to 64	.2949	.0737828	228643
% 65 up	.1496197	.0723865	113464	% 65 up	.1579348	.0863546	278802
metro % 65 up	.1516867	.0298554	113464	metro % 65 up	.1613828	.0366991	278802
metro lag % 65 up	.1466011	.0315409	108346	metro lag % 65 up	.1595173	.0378742	228446
lag % 65 up	.1557097	.0758169	72425	lag % 65 up	.1560154	.0870185	228643
log total pop.	8.162365	.496102	113464	log total pop.	8.017849	.6237672	278802
% vacant	.0532123	.0424753	113464	% vacant	.0676848	.0534795	278802
% vacant^2	.0046357	.0070349	113464	% vacant^2	.0074413	.0120427	278802
% single unit	.5676932	.3063904	113464	% single unit	.666203	.2595487	278802
log med. rent	6.731806	.3368739	113464	log med. rent	6.719302	.3663604	234379
% manufacturing employment	.1973756	.1149757	113464	% manufacturing employment	.1702902	.0980883	236792
% coll. Degree	.1921578	.1769737	113464	% coll. Degree	.2173966	.166582	278802
% renter	.4806563	.2641395	113464	% renter	.4117087	.2604658	278802
log med. home value	12.1505	.5765948	113464	log med. home value	12.1564	.5468219	234926
log med. home value^2	147.9671	14.04246	113464	log med. home value^2	148.077	13.33601	234926
log med. home value^3	1805.967	257.1076	113464	log med. home value^3	1807.373	244.4592	234926
non-whites/whites (metro pop. 20-24)	.5873691	.4585763	113464	non-whites/whites (metro pop. 20-24)	.4596128	.3081247	278802
non-whites/whites (metro pop. 25-44)	.4715649	.3811521	113464	non-whites/whites (metro pop. 25-44)	.3357881	.2582594	278802
non-whites/whites (metro pop. 45-64)	.3661608	.3378358	113464	non-whites/whites (metro pop. 45-64)	.2481832	.2252941	278802
non-whites/whites (metro pop. 65up)	.2514456	.2426882	113464	non-whites/whites (metro pop. 65up)	.1867509	.2328734	278802
ratio whites 65up to non-whites 20-24	6.610305	10.24332	113464	ratio whites 65up to non-whites 20-24	8.184365	14.41802	278801
ratio whites 65up to non-whites 25-44	1.198354	1.838541	113464	ratio whites 65up to non-whites 25-44	1.720225	3.247112	278801
ratio whites 20-24 to total non-white pop.	.3956912	.7494801	113464	ratio whites 20-24 to total non-white pop.	.4851706	1.028835	278802
ratio whites 25-44 to non-whites 25-44	4.894292	8.912109	113464	ratio whites 25-44 to non-whites 25-44	5.758054	10.90341	278802
proportion "cohort aging" tracts	.0587268	.235114	90623	proportion "cohort aging" tracts	.060885	.2391198	236807

Table 4.1.2 Summary statistics for metropolitan area level samples

1940 Sample	mean	sd	N
diversity	0.471827	0.1814743	423
diversity2	0.3083627	0.1443192	423
dissimilarity index	0.647625	0.1365318	423
# of tracts	302.9173	415.2158	423
% white	0.7666608	0.1573746	423
% non-white	0.2333778	0.1573328	423
total population	1181176	1567383	423
% 20 to 24	0.1154958	0.0227927	423
metro lag % 20 to 24	0.1175392	0.0231224	369
% 25 to 44	0.427484	0.0464656	423
metro lag % 25 to 44	0.4330587	0.0449754	369
% 45 to 64	0.3100927	0.0363917	423
metro lag % 45 to 64	0.3047843	0.0349709	369
% 65up	0.1469275	0.0360743	423
metro lag % 65up	0.1446178	0.0371895	369
log total pop.	13.47741	0.9504784	423
% vacant	0.0551186	0.0287425	423
% single unit	0.5730423	0.1599798	423
% manufacturing employment	0.2132436	0.0951873	423
% renter	0.4818748	0.1199518	423
log median home value	12.04277	0.3751605	423
non-whites/whites (metro pop. 20-24)	0.4525061	0.4383198	423
non-whites/whites (metro pop. 25-44)	0.3751112	0.3771286	423
non-whites/whites (metro pop. 45-64)	0.3011102	0.3545328	423
non-whites/whites (metro pop. 65up)	0.2231034	0.2761567	423
ratio whites 65up to non-whites 20-24	10.58775	20.5526	423
ratio whites 65up to non-whites 25-44	1.942157	4.068085	423
ratio whites 20-24 to total non-white pop.	0.7179705	1.603939	423
ratio whites 25-44 to non-whites 25-44	8.729528	20.57074	423
proportion "cohort aging" tracts	0.0596766	0.0413196	270
white med. rent white/non-white med. rent	1.280184	0.2186636	215
white med. home value/non-white med. home value	1.495007	0.2958978	215
white med. income/non-white med. income	1.479467	0.2048279	215

1970 Sample	mean	sd	N
diversity	0.419964	0.1699784	1697
diversity2	0.2638544	0.1315775	1697
Dissimilarity Index	0.4583044	0.1630719	1697
# of tracts	169.9511	375.2191	1697
% white	0.8234665	0.1159749	1697
% non-white	0.1765335	0.1159749	1697
total population	599305.8	1414689	1697
% 20 to 24	0.123395	0.0456292	1697
metro lag % 20 to 24	0.1269312	0.0469794	1415
% 25 to 44	0.4021095	0.049238	1697
metro lag % 25 to 44	0.4108484	0.0468408	1415
% 45 to 64	0.3056517	0.0447529	1697
metro lag % 45 to 64	0.2957137	0.0411818	1415
% 65up	0.1688437	0.0423772	1697
metro lag % 65up	0.1665068	0.0429836	1415
log total pop.	12.50054	1.069482	1697
% vacant	0.0792446	0.0376676	1697
% single unit	0.6951771	0.0776028	1697
% manufacturing employment	0.1789272	0.0953692	1326
% renter	0.3839605	0.1243252	1697
log median home value	11.96448	0.3269479	1326
non-whites/whites (metro pop. 20-24)	0.3522564	0.2991351	1697
non-whites/whites (metro pop. 25-44)	0.2430521	0.2298733	1697
non-whites/whites (metro pop. 45-64)	0.1805803	0.2034366	1697
non-whites/whites (metro pop. 65up)	0.1465871	0.2178807	1697
ratio whites 65up to non-whites 20-24	13.94494	26.47077	1697
ratio whites 65up to non-whites 25-44	3.039067	5.72342	1697
ratio whites 20-24 to total non-white pop.	0.8935638	1.908959	1697
ratio whites 25-44 to non-whites 25-44	9.838172	18.66252	1697
proportion "cohort aging" tracts	0.0456312	0.047964	1697
white med. rent white/non-white med. rent	1.196968	0.2271231	945
white med. home value/non-white med. home value	1.369534	0.3124721	945
white med. income/non-white med. income	1.459712	0.2244273	945

Tract Level Regression Results

Age Distribution

In this section, I present the results from the tract level models of racial diversity as a function of different positions in the age distribution. Figures 4.4a and 4.5a show the coefficient estimates from eq. 5 for the four measurements of the four age distribution variables in the 1940 and 1970 samples, respectively. Figures 4.4b and 4.5b present these same coefficients estimated with beta regression. In these and subsequent figures, I present age categories, from left to right as follows, 20 to 24, 25 to 44, 45 to 64 and 65 and older. For each age category, I present the coefficients for the age category within each tract, measured over the entire metropolitan area, lagged 10 years over the entire metropolitan area and, lagged 10 years within each tract.

The two younger age categories (20 to 24 and 25 to 44) are positively associated with tract level diversity and the older two age categories (45 to 64 and 65 and older) are negatively associated with tract level diversity. In the 1940 sample, nearly all of the coefficient estimates are statistically significant at the 0.05 level. The largest associations are in the 20 to 24 and 65 and up model. A one standard deviation change in the population ages 20 to 24 is associated with between a 0.109 (tract measure) and 0.126 (MSA lag) standard deviation change in tract level diversity. The associations are similar in size for a one standard deviation change in the population 65 and older. In general, coefficients in the 1970 sample are smaller and fewer are statistically significant. The associations with the age distribution of the entire metropolitan area are generally larger than the those with the age distribution at of the tract, though the former are made with less precision than the latter. The estimates from the beta regression show a very similar pattern to those from the OLS models in both the 1940 and 1970 samples.

Figure 4.4a. Coefficient plots, age distribution and tract racial diversity, 1940-2010

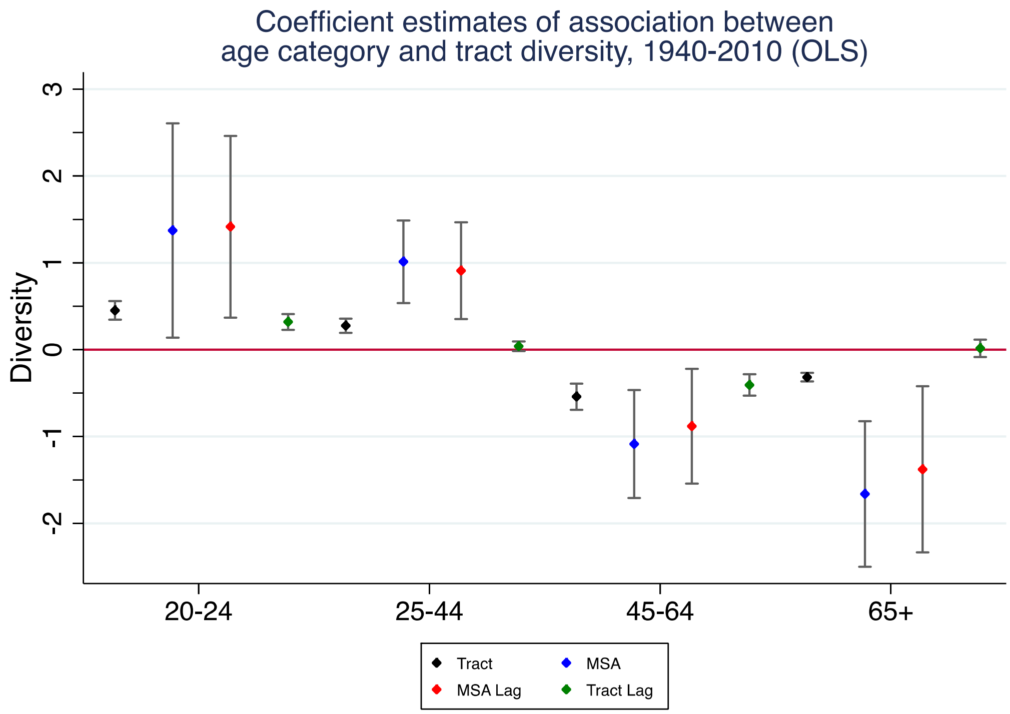


Figure 4.5a. Coefficient plots, age distribution and tract racial diversity, 1970-2010

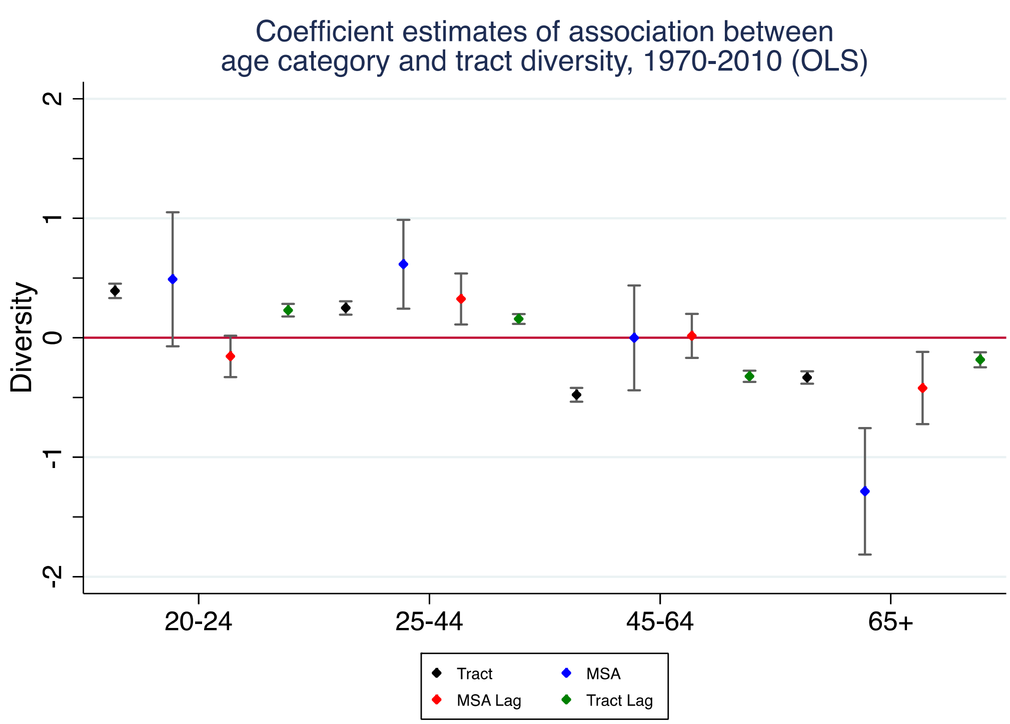


Figure 4.4b. Beta regression coefficient plots, age distribution and tract racial diversity, 1940-2010

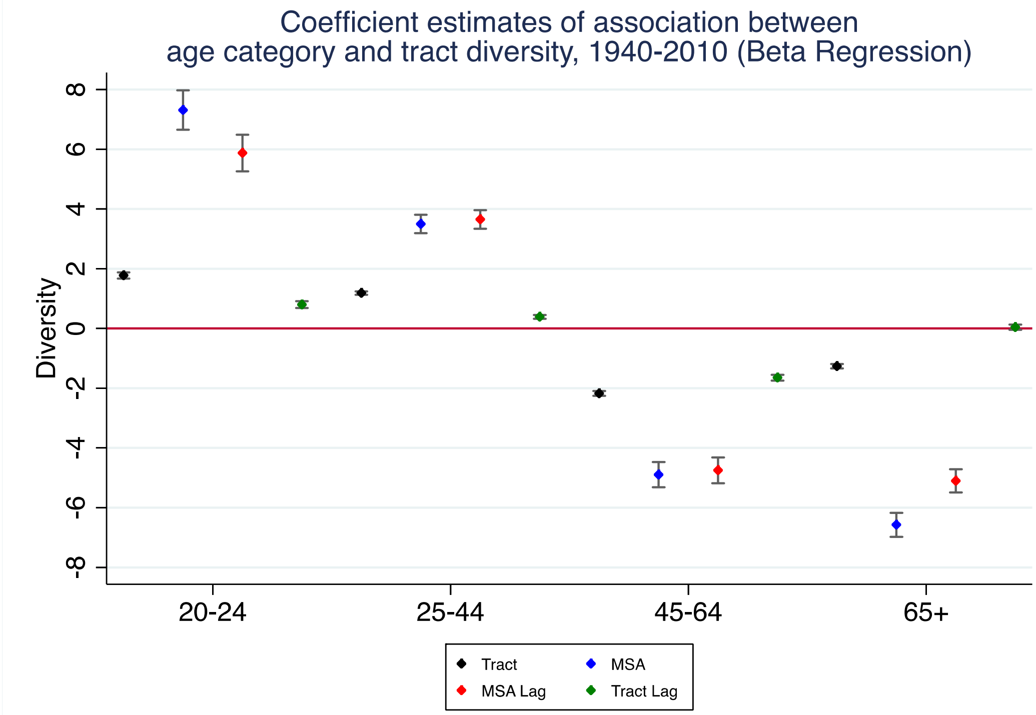
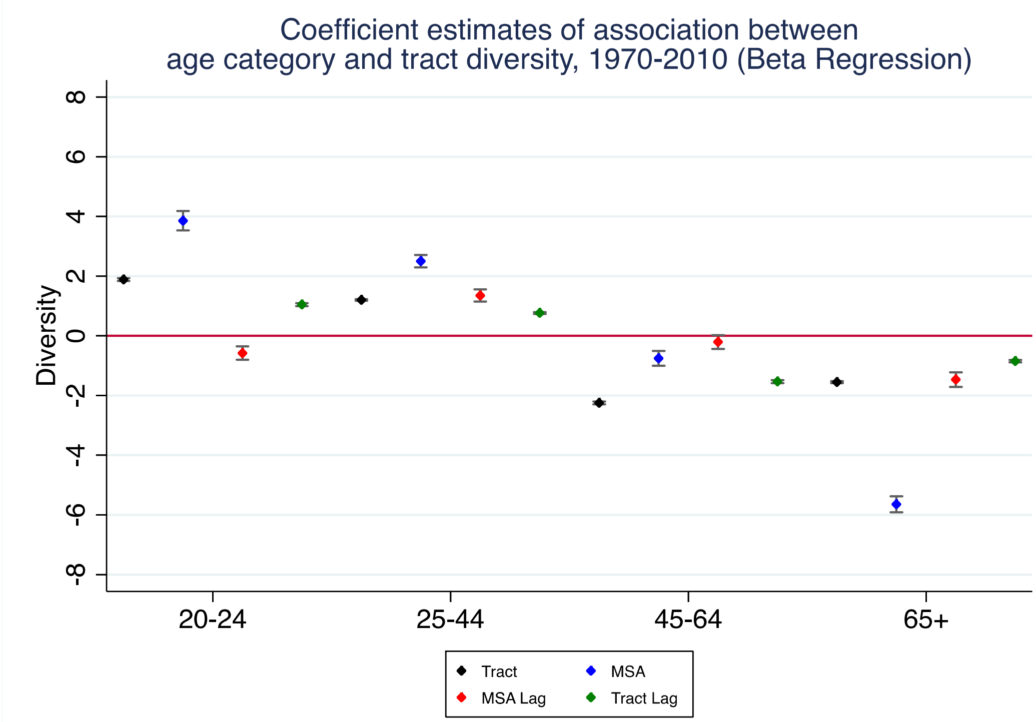


Figure 4.5b. Beta regression coefficient plots, age distribution and tract racial diversity, 1970-2010



By Race Age Distribution Ratio Regression Results

In Table 4.2.1, I present the results from the models that include ratios of the age distribution by race. Across all models and specifications, the associations between the age ratios and tract racial diversity are very small and the results are somewhat mixed. In both the 1940 and 1970 samples, the coefficients on each of the four ratios (whites 65 and older to non-whites 20-24; whites 65 and older to non-whites 20-44; whites 20-24 to total non-white population; whites 20-44 to non-whites 20-44) were small and negative. This is consistent with hypothesis H5a, but inconsistent with H5b and H5c. In the 1940 sample, no coefficient reached statistical significance at the 0.05 level, but in the 1970 sample, all did. Coefficients are smaller in magnitude in the 1970 sample then in the 1940 sample. The ratio of whites 20-24 to total non-white population exhibited the largest association. Higher values of each of the ratio at the metropolitan area level are associated with lower racial diversity in tracts. The differences between diversity predicted at the 10th and 90th percentile of each of the by race ratios are around 3.5-4.5%. The results from the beta regressions are consistent in sign and relative magnitude, but coefficients are estimated with considerably more precision and all estimates are significant at the 0.001 level. Coefficients for winsorized versions of the independent variables are identically signed, but considerably greater in magnitude and estimated with more precision.

Table 4.2.1 OLS and beta regression models predicting tract level racial diversity with by race age ratios

OLS Results

Key Ind. Variable	Coef. Est.	Std. Err.	p-value	N	BIC
1940-2010					
wh. 65up/non-wh. 20-24	-0.0013	0.00067	0.0572	113465	-69093.2
wh. 65up/non-wh. 25-44	-0.00726	0.00436	0.1022	113465	-69088.4
wh. 20-24/non-wh. pop.	-0.01613	0.00837	0.0593	113465	-69054.8
wh. 25-44/non-wh. 25-44	-0.0012	0.00075	0.1148	113465	-68999.7
1970-2010					
wh. 65up/non-wh. 20-24	-0.00055	0.0002	0.0059	278872	-214855
wh. 65up/non-wh. 25-44	-0.00187	0.00082	0.0223	278870	-214763
wh. 20-24/non-wh. pop.	-0.00589	0.0022	0.0077	278873	-214769
wh. 25-44/non-wh. 25-44	-0.00062	0.00023	0.0065	278873	-214821

Beta Regression

Key Ind. Variable	Coef. Est.	Std. Err.	p-value	N	BIC
1940-2010					
wh. 65up/non-wh. 20-24	-0.0096	0.0003	0	113465	-132173
wh. 65up/non-wh. 25-44	-0.056	0.0019	0	113465	-132151
wh. 20-24/non-wh. pop.	-0.1398	0.0044	0	113465	-132182
wh. 25-44/non-wh. 25-44	-0.0117	0.0004	0	113465	-132148
1970-2010					
wh. 65up/non-wh. 20-24	-0.0061	0.0001	0	278872	-289418
wh. 65up/non-wh. 25-44	-0.024	0.0006	0	278870	-289304
wh. 20-24/non-wh. pop.	-0.0635	0.0016	0	278873	-289216
wh. 25-44/non-wh. 25-44	-0.0073	0.0002	0	278873	-289401

Metropolitan Area Level Regression Results

Age Distribution

Figures 4.6a and 4.7a show the coefficient estimates from eq. 6 for the metropolitan area level models of the association between age distribution and racial segregation in the 1940 and 1970 samples, respectively. Figures 4.6b and 4.7b present these same coefficients estimated with beta regression. I present the same age categories as above measured in two ways, the metropolitan area at time t and lagged 10 years. In the 1940 sample, the pattern observed in the tract level models of racial diversity is again present, though, as expected, it is reversed. The two younger age categories (20 to 24 and 25 to 44) are negatively associated with segregation between whites and non-whites. The older two age categories (45 to 64 and 65 and older) are positively associated with segregation. As in the models of tract diversity, these associations are generally symmetric. Though the pattern holds for the sign of all coefficients, only half are statistically significant. The associations in the 1970 sample are much less clear, signs are not consistently in the expected direction and no coefficient is statistically different from zero. In both samples, the age category measures made at time *t* and those at *t-10* produce coefficients of similar magnitude. Results from the beta regressions are largely similar.

Figure 4.6a. Coefficient plots, age distribution and metro racial segregation, 1940-2010

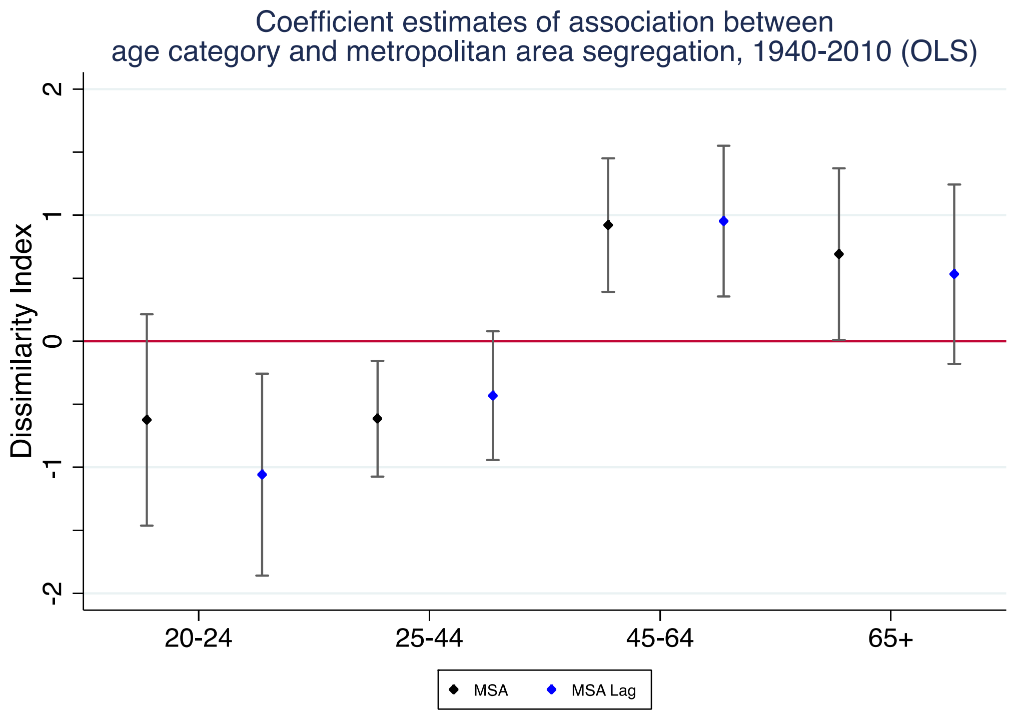


Figure 4.7a. Coefficient plots, age distribution and metro racial segregation, 1970-2010

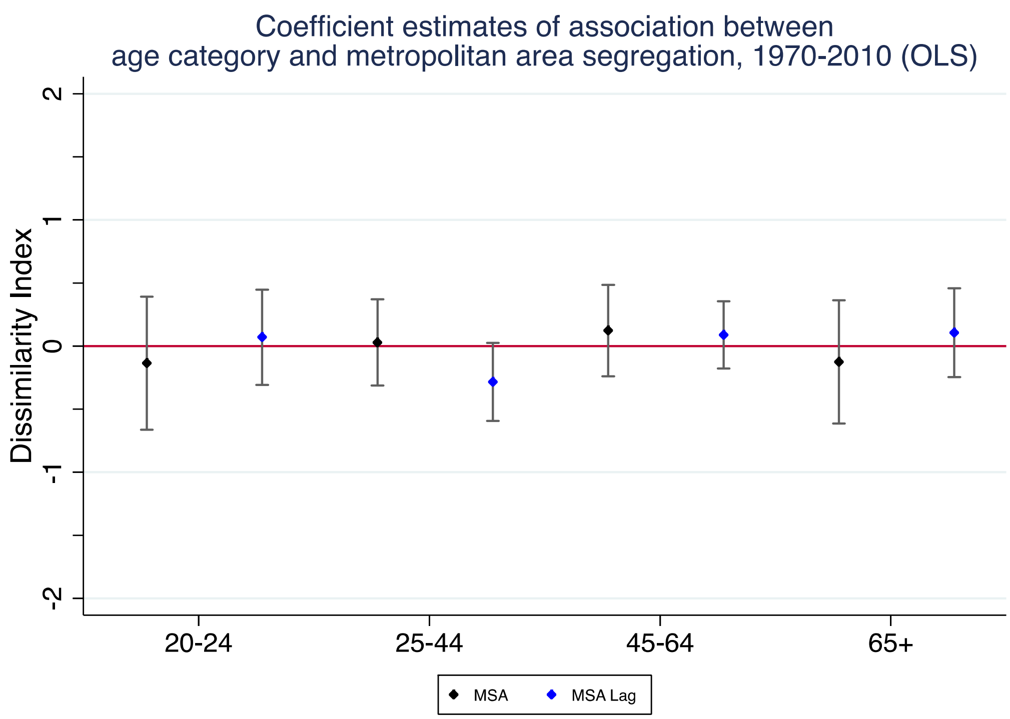


Figure 4.6b. Beta regression coefficient plots, age distribution and metro racial segregation, 1940-2010

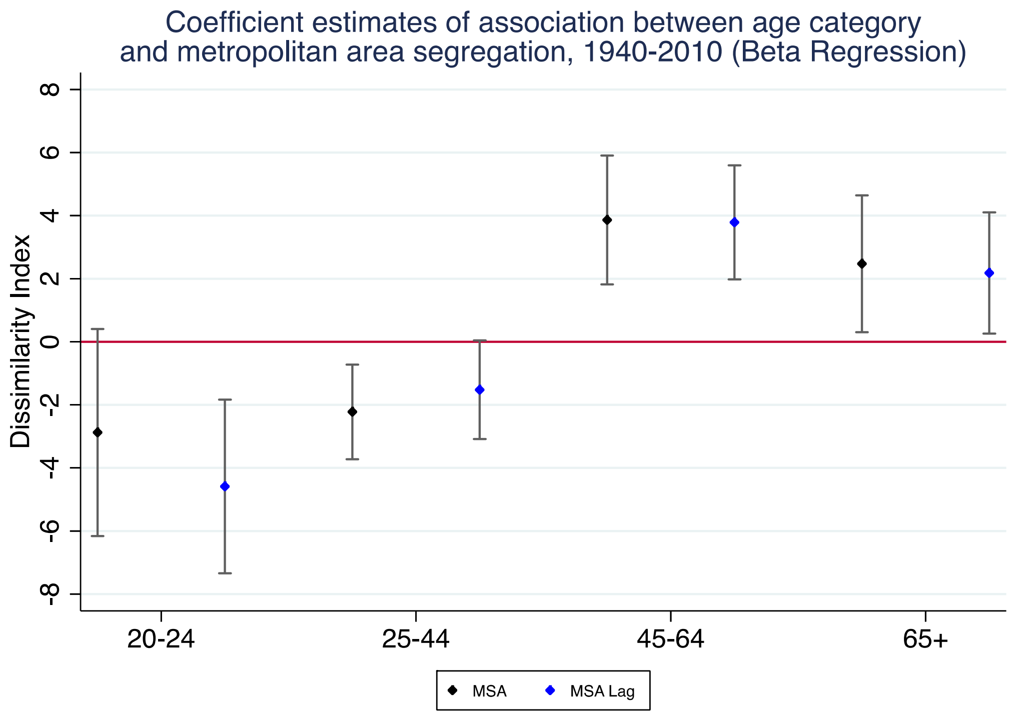
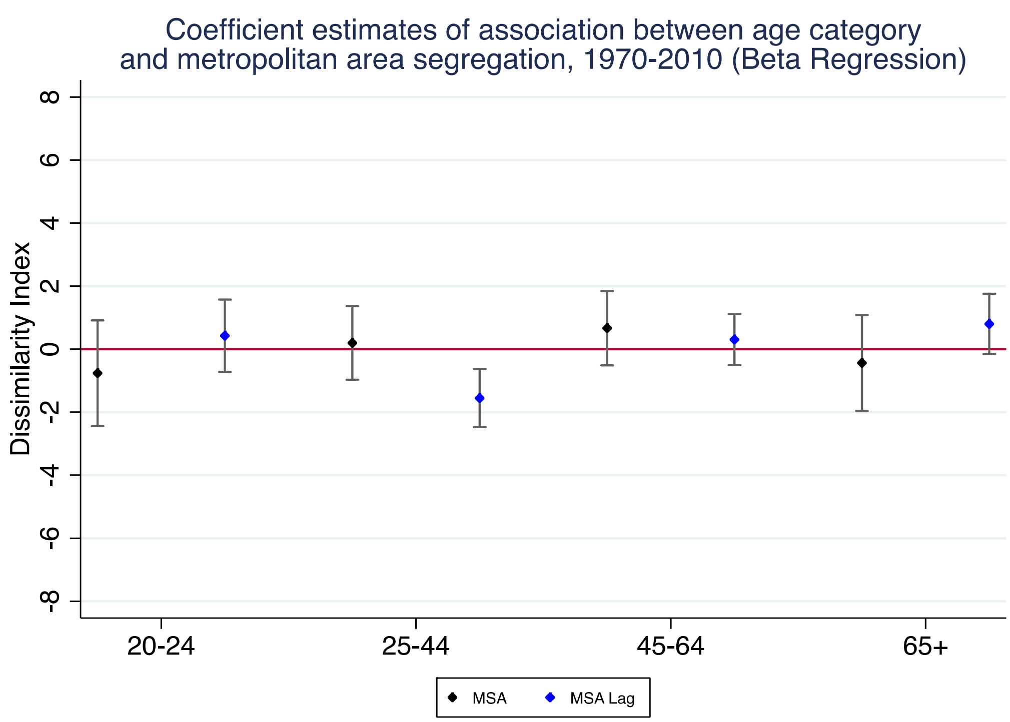


Figure 4.7b. Beta regression coefficient plots, age distribution and metro racial segregation, 1970-2010



The models of metropolitan area segregation include relatively few control variables and it is possible that omitted variables bias the estimates of the key coefficients. For a sub-sample of metropolitan areas, I include a series of additional control variables to account for racial differences in the income of whites and non-whites and differences in the prices whites and non-whites pay for housing (rents and home values). When faced with racial restrictions on residence, non-whites (particularly African Americans) may have to pay a premium for housing in predominantly white neighborhoods, or, historically, even for crowded and limited housing in segregated areas near the city center (Du Bois 1899, 1967). When faced with greater housing competition, whites may also pay more for housing in order to avoid non-white neighborhoods. Associations between the age distribution (e.g. cohorts competing in a housing market) and segregation may be washed out if whites bid up on housing to preserve a regime of residential segregation. Including these additional controls may explain the null results found at the metropolitan area level in the 1970 sample. I anticipate that expected relationships will strengthen once housing costs for whites and non-whites are held constant. A notable problem with this test is that the subsample for which I can measure racial differences in income and housing costs is quite small and significantly decreases the power of this analysis to detect statistically significant associations, even if those associations became stronger in the more complex models.

Figures 4.8a, 4.9a and 4.10a, present the same coefficient as above, but for the subsample of metropolitan areas in which I can measure the ratio of white to non-white rents, home values and incomes. Figures 4.8a and 4.9a are based on the 1940 and 1970 samples used previously, but Figure 4.10a introduces a new sample of metropolitan areas based on the IPUMS *metarea* variable (I refer to this as the *metarea* sample[34]). In the 1940 sample, the expected direction of all associations remains, but I find little evidence that including additional controls for racial differences in income and housing costs amplifies the coefficients. Most coefficients are similar in magnitude or attenuated and estimated with less precision. The results for the 1970 sample are more in line with my expectations from H6. After including the income and housing cost controls, all coefficients migrate to the expected sign, however, all remain indistinguishable from zero. In the metarea sample, the time *t* measures (with the exception of the 20 to 24 age category) increase in magnitude (relative to the eq. 6 models estimate from this sample without the additional controls) and the coefficients on the 25 to 44 and 65 and older categories now show statistically significant negative and positive relationships, respectively. The lagged *t-10* measures, however, are unchanged and indistinguishable from zero. In each of these samples with additional controls, the time *t* measures of the age distribution are generally of greater magnitude than the *t-10* measures. Figures 4.8b, 4.9b and 4.10b present the results of the “a” versions of these models estimated with beta regression. The results are largely consistent with those from the OLS models. In the models with additional controls, housing cost measures are consistently positive, though rarely statistically significant, income ratio much closer to 0, also rarely significant.

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[34] The *metarea* sample is, to some degree, a blend of the 1940 and 1970 sample. It includes both metros that were large in 1940 and those that did not grow until later, but holds those areas in their 2010 county boundaries.

Figure 4.8a. Coefficient plots, age distribution and metro racial segregation, with additional controls, 1940-2010

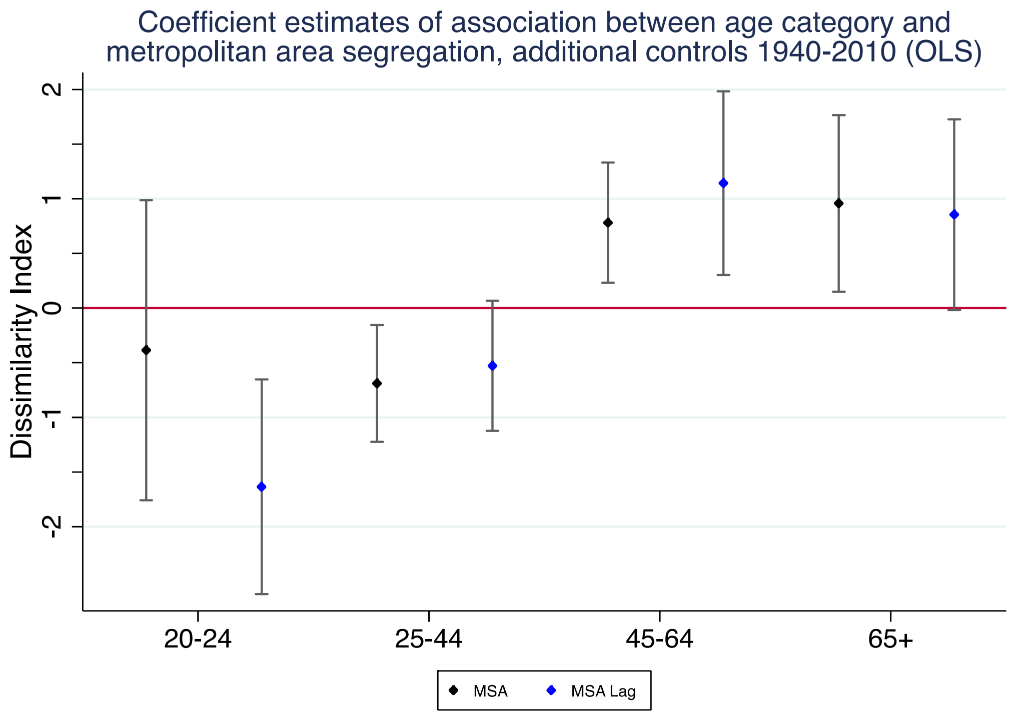


Figure 4.9a. Coefficient plots, age distribution and metro racial segregation, with additional controls, 1970-2010

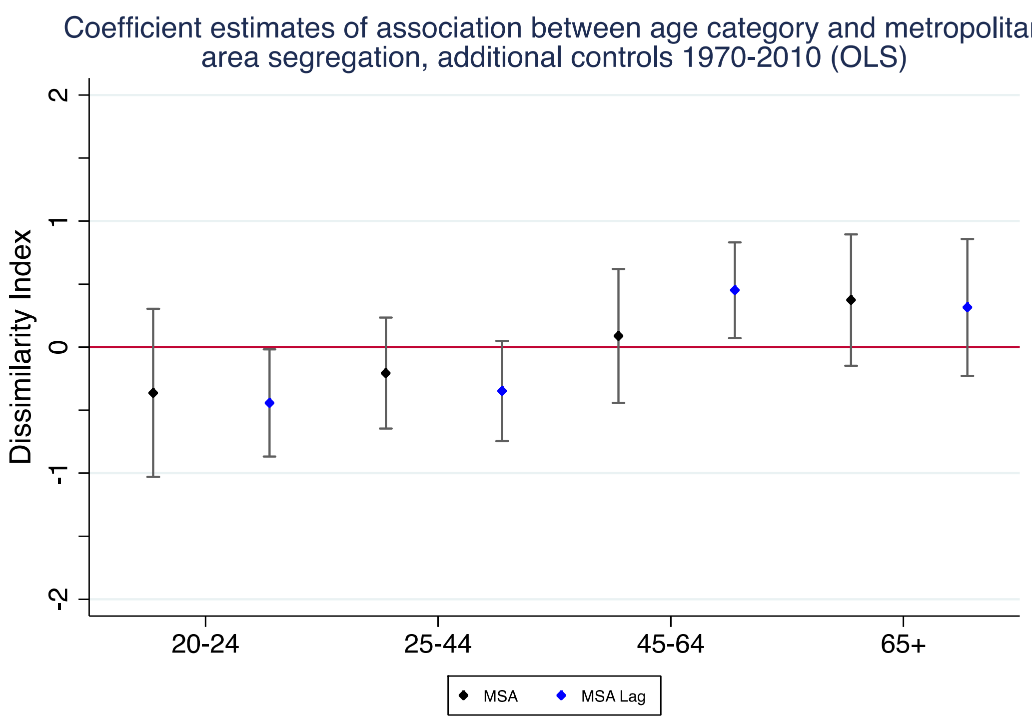


Figure 4.10a. Coefficient plots, age distribution and metro racial segregation, with additional controls, 1970-2010 (metarea sample)

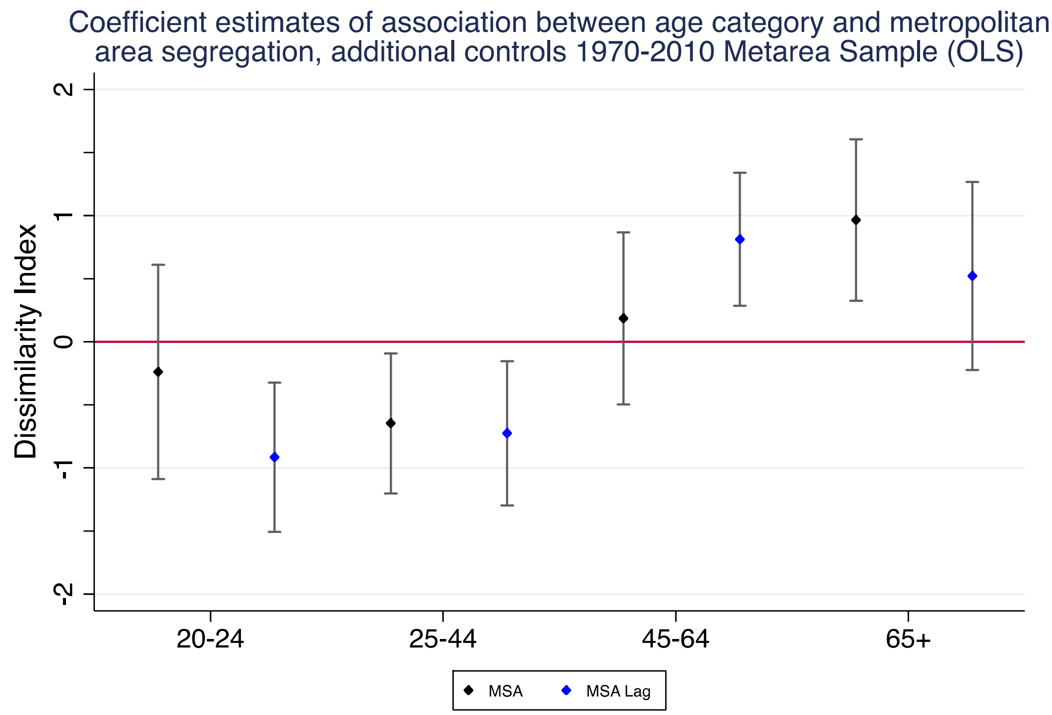


Figure 4.8b. Beta regression coefficient plots, age distribution and metro racial segregation, with additional controls, 1940-2010

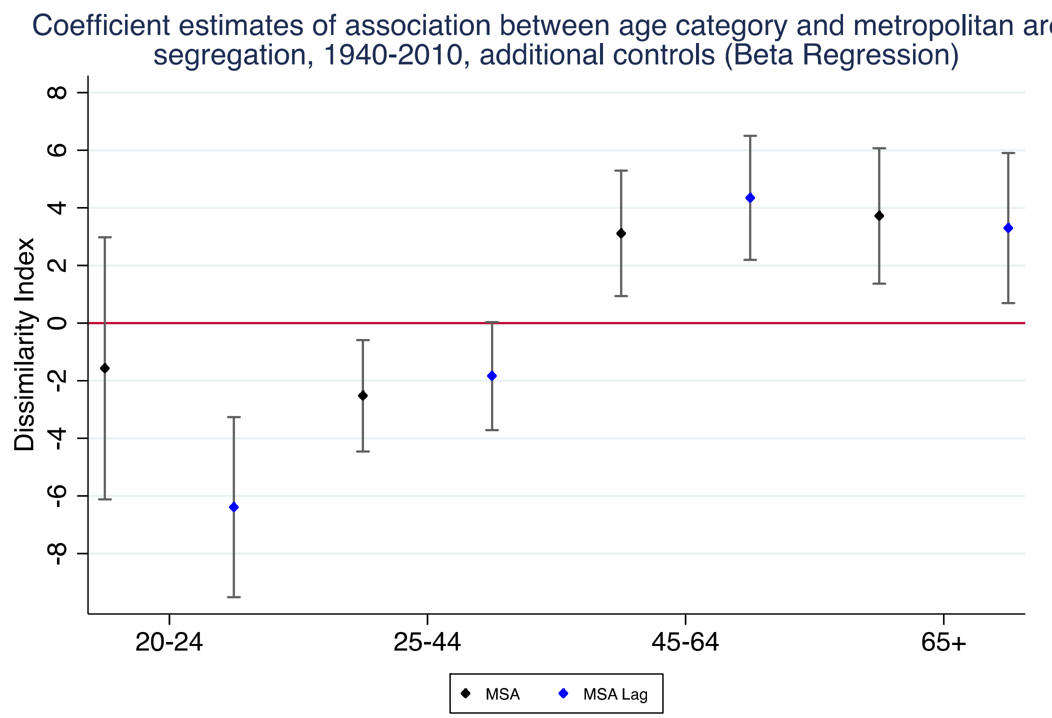


Figure 4.9b. Beta regression coefficient plots, age distribution and metro racial segregation, with additional controls, 1970-2010

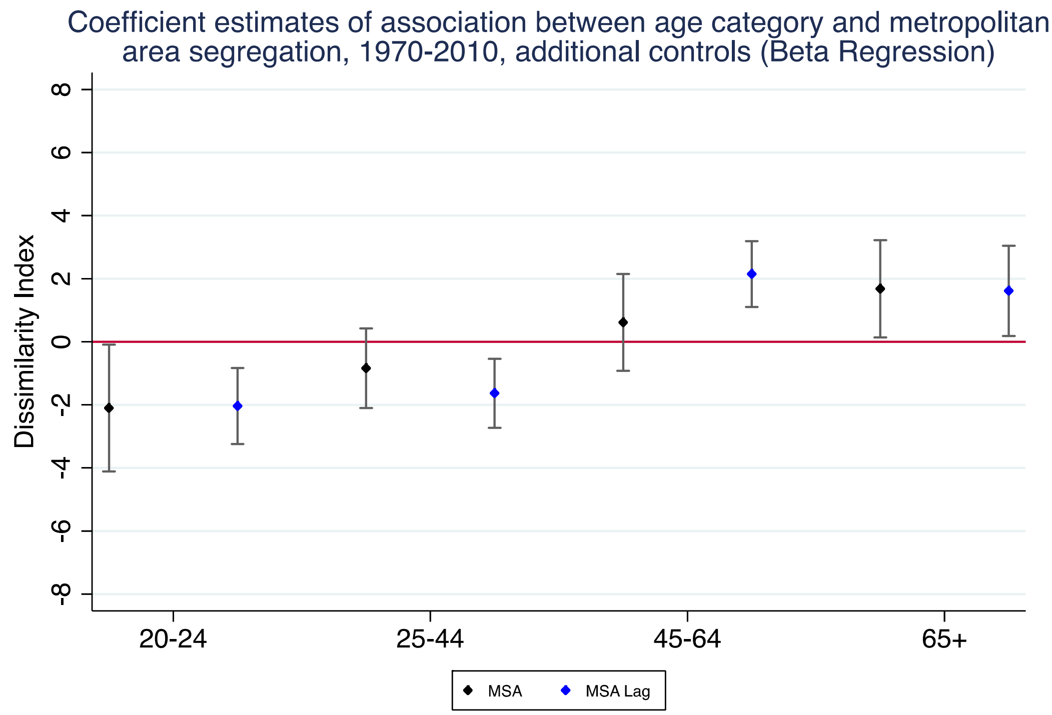
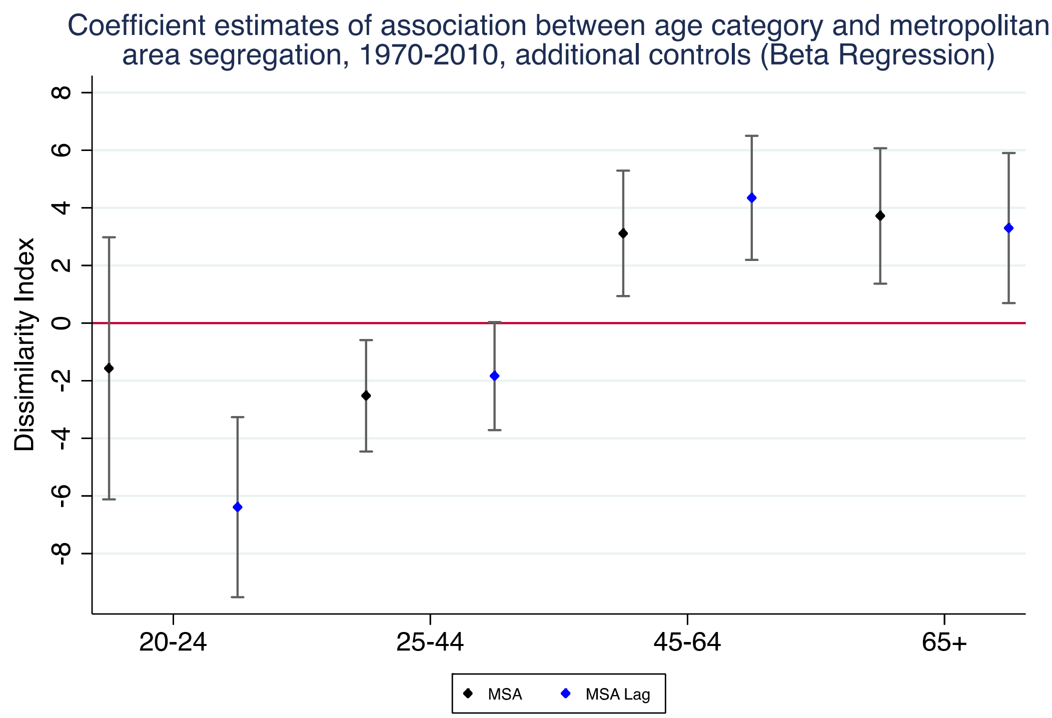


Figure 4.10b. Beta regression coefficient plots, age distribution and metro racial segregation, with additional controls, 1970-2010 (metarea sample)



By Race Age Distribution Ratio Regression Results

In Table 4.2.2, I present the results from the metropolitan area level models that include ratios of specific positions in the age distribution by race. The table shows results from the 1940 sample and the 1970 sample for both OLS and beta regression results. Across all models and specifications, the associations between the age ratios metropolitan area segregation are very small and largely negative. No estimate is statistically significant at even the 0.1 level in the 1940 sample, but all coefficients are significant at the 0.001 level in the larger 1970 sample. In contrast to the tract level models, coefficients are of smaller magnitude in the 1940 sample then in the 1970 sample. Consistent with the tract models, the ratio of whites 20-24 to total non-white population exhibited the largest association (negative). The differences between segregation predicted at the 10^{th} and 90^{th} percentile of the by race ratios are around 2%. The results from the beta regressions are consistent in sign and relative magnitude, but coefficients are estimated with considerably more precision and all estimates are significant at the 0.001 level. In general, all relationships strengthen for all of the metropolitan area level models. When additional controls for racial differences in median income and housing costs are included in the ratio models, the coefficients on the by race age ratios increase in magnitude. As in the tract level models, coefficients for winsorized versions of the independent variables are identically signed, but considerably greater in magnitude and estimated with considerably more precision.

Table 4.2.2. OLS and beta regression models predicting metro level racial segregation with by race age ratios

OLS Results

Key Ind. Variable	Coef. Est.	Std. Err.	p-value	N	BIC
1940-2010					
wh. 65up/non-wh. 20-24	0.0000598	0.00039	0.8796	423	-1201
wh. 65up/non-wh. 25-44	-0.000456	0.00166	0.7851	423	-1201.1
wh. 20-24/non-wh. pop.	0.002401	0.00393	0.5439	423	-1202
wh. 25-44/non-wh. 25-44	0.000156	0.00027	0.5727	423	-1201.7
MSA and additional controls 1940-2010					
wh. 65up/non-wh. 20-24	-0.00311	0.00213	0.1504	215	-816.06
wh. 65up/non-wh. 25-44	-0.01727	0.01246	0.1715	215	-816.65
wh. 20-24/non-wh. pop.	-0.02758	0.03992	0.4927	215	-801.93
wh. 25-44/non-wh. 25-44	-0.00336	0.00374	0.3735	215	-805.79
1970-2010					
wh. 65up/non-wh. 20-24	-0.001646	0.00028	0	1697	-4571.5
wh. 65up/non-wh. 25-44	-0.007589	0.00129	0	1697	-4582.2
wh. 20-24/non-wh. pop.	-0.020746	0.00268	0	1697	-4531.6
wh. 25-44/non-wh. 25-44	-0.002340	0.00029	0	1697	-4582.6
MSA and additional controls 1970-2010					
wh. 65up/non-wh. 20-24	-0.003118	0.00059	0	945	-3170.4
wh. 65up/non-wh. 25-44	-0.015090	0.00313	0	945	-3183.6
wh. 20-24/non-wh. pop.	-0.060890	0.00886	0	945	-3195.1
wh. 25-44/non-wh. 25-44	-0.005233	0.00078	0	945	-3196.5

Beta Regression Results

Key Ind. Variable	Coef. Est.	Std. Err.	p-value	N	BIC
1940-2010					
wh. 65up/non-wh. 20-24	-0.0004	0.00152	0.7676	423	-876
wh. 65up/non-wh. 25-44	-0.0054	0.00787	0.4892	423	-877.2
wh. 20-24/non-wh. pop.	0.0043	0.01512	0.7772	423	-876
wh. 25-44/non-wh. 25-44	0.0002	0.00113	0.8612	423	-875.9
MSA and additional controls 1940-2010					
wh. 65up/non-wh. 20-24	-0.0151	0.00467	0.0012	215	-536.2
wh. 65up/non-wh. 25-44	-0.0857	0.02626	0.0011	215	-538.2
wh. 20-24/non-wh. pop.	-0.1806	0.09622	0.0605	215	-521.6
wh. 25-44/non-wh. 25-44	-0.0193	0.0084	0.0213	215	-526.5
1970-2010					
wh. 65up/non-wh. 20-24	-0.0098	0.00102	0	1697	-1824
wh. 65up/non-wh. 25-44	-0.0423	0.00448	0	1697	-1827
wh. 20-24/non-wh. pop.	-0.1045	0.01096	0	1697	-1754
wh. 25-44/non-wh. 25-44	-0.0119	0.00118	0	1697	-1811
MSA and additional controls 1970-2010					
wh. 65up/non-wh. 20-24	-0.0168	0.00238	0	945	-1294
wh. 65up/non-wh. 25-44	-0.0757	0.01149	0	945	-1296
wh. 20-24/non-wh. pop.	-0.2932	0.03328	0	945	-1293
wh. 25-44/non-wh. 25-44	-0.0252	0.00321	0	945	-1303

Neighborhood Population Succession Regression Results

In this section, I present results from the models of the association between neighborhood population succession patterns and the two outcome measures, tract level diversity and metropolitan level segregation. As I can only classify tracts a cohort aging or functionally specialized in the 1970-2010 sample, I present results using only the 1970 sample. Table 4.3 shows the results for the tract level sample, the metropolitan level sample and the metropolitan level sample for which I measure the additional income and housing cost control variables. The results are entirely consistent with hypotheses H6.

Tracts classified as cohort aging (exhibit a cohort aging pattern) are negatively associated with tract level racial diversity. A tract that is cohort aging is expected to have a racial diversity score (0.028) lower than a tract classified as functionally specialized (stable age distribution over time), about a tenth of a standard deviation. Though the association is small on the tract level, it does aggregate up to shape segregation patterns in a metropolitan area. The association here is more pronounced than that at the tract level. Metropolitan areas with a higher proportion of tracts classified as cohort aging are more segregated by race. A one standard deviation change in the proportion of cohort aging tracts in a metro area is associated with a more than 1.5 standard deviation change in segregation between whites and non-whites. However, when by race median income and housing costs are included, this association moves toward 0 and is no longer statistically significant. The results are similar when the models are estimated with a beta regression.

Table 4.3. OLS and beta regression models predicting tract diversity and metro segregation models with neighborhood type (cohort aging)

Tract Diversity	**Coef. Est.**	**Std. Err.**	**p-value**	**N**	**BIC**
OLS	-0.02735	0.00456	0	236807	-193265
Beta Regression	-0.09619	0.0054	0	236835	-257028

Metro Segregation	**Coef. Est.**	**Std. Err.**	**p-value**	**N**	**BIC**
OLS	0.25302	0.11178	0.0242	1697	-2217.7
OLS w/ add. controls	0.044038	0.13429	0.7432	945	-1503
Beta Regression	1.090223	0.29542	0.00022	1697	-2258.12
Beta Reg. w/ add. controls	0.210477	0.36912	0.56853	945	-1503.33

I return to some of the census tracts I presented as examples in paper 2 to show how racial composition plays out in tracts with different patterns of population succession. Starting with the two cohort aging tracts, the tract in Spring Lake Park, MN was considerably less diverse than the metropolitan area average in 1970 and 1980, but began to close that gap in 1990, though it continued to lag behind the metro average. Lincolnwood too, lagged behind the city of Chicago in racial diversity, but approximated city averages by 2000. Turing to the two the functionally specialized tracts I presented near universities, one by the University of Minnesota and another just outside of the University of Chicago, both show considerably less variation in racial diversity over time compared to other tracts in the metropolitan areas. The tract near the University of Minnesota has consistently higher racial diversity than the city as a whole, while the tract near University of Chicago has lower racial diversity than the city as a whole.

Even as potential bulwarks to integration, cohort aging neighborhoods can present pathways to racial integration, particularly, to the extent that they can accommodate new demographic groups into their aging regimes. For example, when aging cohorts create housing vacancies through mobility to retirement or assisted living facilities or through mortality. This type of racial change seems increasingly likely given the racial gap between the oldest and youngest Americans. While functionally specialized tracts are, on average, considerably more diverse than cohort aging tracts, there is variation.

Discussion

This paper set out to explore connections between the age distribution and racial segregation. I anticipate associations between the two for a number of reasons. First, many age-graded demographic events also shape where people live. Second, following literature on the effects of cohort size in markets for labor and marital partners, I anticipate similar effects in housing markets that can influence to racial segregation. Lastly, the aging regime in a neighborhood, whether residents age as a cohort or a stable migration flows keep the age distribution relatively constant over time, may present pathways to integration or durable barriers that uphold segregation for decades. Easterlin worried that changes in women’s labor market participation and marriage and fertility patterns were, in part, incorrectly assigned to cultural changes in sex roles and work place opportunities for women. Similarly, this paper worries that declines in racial segregation may, in part, be incorrectly attributed to changes in racial attitudes or housing market discrimination, rather than changes in size of age cohorts or cyclical neighborhood aging patterns.

I model racial diversity in census tracts and racial segregation in metropolitan areas as a function of characteristics of the age distribution and a set of demographic, economic and housing controls. I find results generally in line with my hypotheses and support for the basic proposition that the age distribution is related to racial segregation net of differences in the age distribution of racial groups. I find evidence that in times and places with large cohorts of young people, racial segregation falls. Specifically, I find a positive association between the proportion of the population ages 20 to 24 and 25 to 44 and racial diversity at the tract level. This association is reversed at the metropolitan area level, as large cohorts of young people predict declining segregation between whites and non-whites. This result is largely attenuated in the 1970 sample, but to a lesser degree in the subsample in which I control for racial differences in the price of housing. These associations persist even after controlling for racial differences in the age distribution. I find opposite and generally symmetric associations in older portions of the age distribution. The size of cohorts aged 45 to 64 and 65 and older are negatively associated with tract level diversity and positively associated with segregation on the metropolitan area level. Tracts and cities with older populations are less racially integrated than those with younger populations.

Though this paper does not adjudicate between the various mechanisms that may drive this association (residential mobility, neighborhood preferences, natural increase, or housing market competition), looking to the results from the ratio models offers some additional information on the potential mechanism. The ratio of young whites to the total non-white population decreases metropolitan area segregation in the 1970 sample, as does the ratio of whites and non-whites ages 25 to 44. The former suggests an age-related residential mobility or gentrification mechanism (ages of high mobility and highest preferences for diverse neighborhoods), while the latter is more be consistent with a housing market competition explanation. In general, the associations I find between diversity, segregation and racial differences in age distribution (using untransformed measures) are small to null at both the tract and metropolitan area level.

I find some evidence that neighborhood aging patterns influence tract level racial diversity and metropolitan area level segregation from 1970-2010. Specifically, tracts that age as a cohort are less racially diverse than tracts that have a more stable age distribution over time. Tracts in which the population ages as a cohort may present barriers to integration, perhaps by producing fewer housing vacancies or lacking amenities valued by certain groups. These barriers are less present in other neighborhoods and population turnover creates opportunities for integration. While this relationship represents relatively small changes in racial diversity at the tract level, it appears to aggregate up to a larger association at the metropolitan area. Areas with more cohort aging tracts have higher levels of segregation, this relationship appears to be a linear aggregate or concave function of the tract level association. This evidence is mixed however, as estimating the model on a subsample in which I measure racial differences in income and housing costs eliminates the significant association.

The age and racial distribution of the United States continues to change. The fact that retirement communities are racially homogeneous (Farley and Frey 1994; Logan, Stults and Farley 2000), whites are less likely to live in integrated neighborhoods when they are old compared to when they are young adults and older whites are most segregated from young non-whites, suggest that the coming racial generation gap may mean rising racial segregation. However, demographic currents may also offer opportunities for integration. As the large baby boomer cohorts downsize their housing and sell their homes or die, racial segregation may decline if non-whites will fill the vacancies they create. Population aging continues, as older adults grow to a large share of the population than ever before. But generally, the age distribution as a whole is moving from pyramid to pole. The oldest Americans are largely white and the youngest Americans are largely non-white. The by race age ratios I measure will continue to decline. Will future population aging portend declining racial diversity and deepening segregation? Will this be outweighed by growing racial diversity in the population? Will segregation regimes change as the age distribution becomes more uniform?

Demographic currents offer both opportunities for expanding racial integration and pitfalls of deepening segregation. As fortuitous as integrative changes in the age distribution may be, they are neither sufficient nor the active intervention the issue requires. Social policies can seize on the opportunities changes in the age distribution present and double-down when demographic currents portend deepening segregation. Changes in the age distribution occur over decades, policy makers will have ample time to plan for demographic changes years out in the future. I also find some evidence that tracts that maintain a mixed age distribution present avenues to long-term integration while those that age as cohort may act as a bulwark against integration. Perhaps, incentivizing long-term age diversity in neighborhoods will increase racial diversity as well.

Underlying all policies for racial integration are questions about why racially homogenous neighborhoods are and remain unequal in the first place. Integration without investment may appear paternalistic at best and destructive at worst. Non-white neighborhoods have spent decades building and creating valued, vibrant and resilient communities, despite limited resources and explicit omission of investment by government and business. Racial change in these communities may have immediately detrimental effects, like housing displacement, or collective effects that may constitute a cultural trauma (Brown 2016), particularly, if prosperity associated with neighborhood change is available to few.

The metropolitan area fixed effects do a considerably amount of the heavy lifting in all models. In general, models that omit the metropolitan area fixed effects, all coefficients are in the expected direction, of greater magnitude and most are statistically significant. I do not know precisely what the fixed effects measure nor why they account for so much of the variation in the outcome.

This study has some short comings. First, the associations I find are not made in a causal analysis. It is challenging to find instrumental variables or other exogenous variation to the age distribution that occurs for a large portion of the population and can speak to the long timeframe of this study. Variation in the associations by sample and the small sample in which I measure racial difference in income and housing costs are also short comings. Likewise, I do not have measures for changes in the housing supply or racial attitudes. This analysis is on the aggregate level and various individual-level behaviors may produce the aggregate characteristics and relationships I observe. So of my hypothesis about the relationship between age and housing choice may be better tested in an individual level study of endogenous preferences and market conditions.

Chapter V

Conclusion

I situate this dissertation somewhere between the first two quotes that open it (and submit it with the caution noted in the third). As Norman Ryder writes, age is the principal variable in demography and the concept of a cohort links the lives of individuals to a historical context. As Louis Wirth notes, homogeneity is often observed in urban neighborhoods and comes about through complex processes, that may or may not be apparent to individuals. My goal in this dissertation is to show that age is due more consideration in the study of residential segregation. Both in the sense that young and old are segregated (though moderately), but also in the sense that, as an abstract aggregate, age structure *structures* where we live and does so at multiple levels, from the metropolitan area, to the neighborhood and the household.

The interaction of age and history provide the individual with a schedule of agency. As one ages, they step through various socially defined roles and engage in and experience events that are age-graded. These roles and events do not occur in isolation, but in a historical context characterized by many things, the age structure of cities, neighborhoods and households among them. Age is clearly an important property of the individual, but is also an element of social structure that constrains and enables the actions of the individual.

I bring this line of work to the study of residential segregation, first, by asking whether American cities are segregated by age (*they are, though not to the extent of race or income*) and further, does age structure in households and the population contour that segregation, (*it does and in countervailing ways*). Second, I ask how aging occurs in neighborhoods over many years (*most neighborhoods keep a stable age distribution, replacing residents as they leave and drawing newcomers from specific places in the age distribution*). Lastly, I ask if the age distribution and neighborhood aging patterns shape patterns of racial segregation (*it appears that they do*).

Review of Main Findings

In the first paper, I measure age segregation on the tract level in metropolitan areas from 1940 to 2015. I present model estimates of the associations between segregation and the socio-demographic characteristics of metropolitan areas. I revisit a number of considerations made in past studies and find results both consistent and inconsistent with those proposed by the "ecological model." I focus new attention on how the age structure of the population and living arrangements influence segregation.

Segregation between older adults and children and between older adults and young adults is low to moderate in American metropolitan areas. Older adults are slightly more segregated from children than from adults. At its peak in the 1970s and 1980s, average age segregation was about on the order of the 2010 levels of black-white or Hispanic-white segregation in Las Vegas, NV (among the least racially segregated large US cities). The proportion of the population 65 and older and the headship rate among adults 25-44 are strong and consistent predictors of age segregation, though in opposite directions. The population of adults 65 and older has grown since 1940, while household headship among young and middle-aged adults rose until 1980, but slightly fell since. As growth in the population of older adults decreased age segregation, largely concurrent increases in household headship among young adults raised segregation. In general, as older adults compose a larger portion of a population, segregation declines, particularly, between adults 25 to 44 and older adults.

Between the 1950s and the 1980s changes in living arrangements increased the variety of household types and decreased age diversity within households as the age diversity of the population increased. As age segregation peaked in the 1970s and 1980s, young adults formed households at rates higher than ever before. When many young adults form households of their own, age segregation increases, particularly, between children and older adults. Household formation among adults may both decrease age diversity within households, to the extent that these households exclude older adults, and within neighborhoods to the extent that they are formed in neighborhoods separate from older adults.

In the second paper, I use a panel of census tracts from 1970 to 2010 and a series of log linear models to classify tracts according to longitudinal patterns in their age distribution. I design the models to specifically identify two ideal types of neighborhood aging. Functionally specialized neighborhoods have a consistent age distribution over time whereas the age distribution of cohort aging neighborhoods ages as would a stationary cohort. I present an explanatory model of tract type that demonstrates the social, economic and housing characteristics that are associated with classification as functionally specialized or cohort aging. Lastly, I suggest that the aging regime in a neighborhood, whether residents age as a cohort or a stable migration flow keeps the age distribution relatively constant over time, may present pathways to racial integration or durable barriers that uphold segregation for decades.

I find considerably more functionally specialized neighborhoods than cohort aging neighborhoods. Though some of this disparity is probably due to my conservative cohort aging assignment method, I expect that neighborhoods that purely age as a cohort are rare. The explanatory model reveals that tracts characterized by cohort aging have newer housing stock, more single-unit housing structures, fewer vacant units, are further from the city center and have fewer new residents than tracts with stable age distributions (*functionally specialized*). However, cohort aging tracts also have fewer owner-occupied units, higher rental costs and fewer families with children than functionally specialized neighborhoods on average over the period 1970-2010. Tracts that age as a cohort are further from the city core than tracts I classify as functionally specialized and are almost exclusively located in suburbs.

In the third paper, I model racial diversity in census tracts and racial segregation in metropolitan areas as a function of the age distribution and a set of demographic, economic and housing controls. I find support for the basic proposition that the age distribution is related to racial segregation net of differences in the age distribution of racial groups. In times and places with large cohorts of young adults, racial diversity at the tract level rises. This association is reversed at the metropolitan area level, as large cohorts of adults ages 20 to 44 predict declining segregation (i.e. increasing diversity) between whites and non-whites. Though this result is mixed across samples. I find opposite and generally symmetric associations in older portions of the age distribution. The size of cohorts aged 45 to 64 and 65 and older are negatively associated with tract level diversity and positively associated with segregation on the metropolitan area level.

I find generally small and mixed associations between differences in the age distribution of whites and non-whites and segregation. The ratio of young whites to the total non-white population decreases metropolitan area segregation in the 1970 sample, as does the ratio of whites and non-whites ages 25 to 44. The former suggests an age-related residential mobility mechanism, while the later is more be consistent with a housing market competition explanation.

Lastly, I find evidence that neighborhood aging patterns influence tract level racial diversity and metropolitan area level segregation. Specifically, tracts that age as a cohort are less racially diverse than tracts that have a more stable age distribution over time. Tracts in which the population ages as a cohort may present barriers to integration, perhaps by producing fewer housing vacancies or lacking amenities valued by certain groups. These barriers are less present in other neighborhoods. Aggregated over a metropolitan area, segregation between whites and non-whites is positively associated with cohort aging tracts in some models.

Implications

The patterns I find in this dissertation could inform hypotheses about the future. Continued growth in the population of older adults could lead to declining age segregation, but rising racial segregation, though these trends could be attenuated or exacerbated by the growing racial differences between the youngest and oldest Americans. Neighborhoods that have aged as a cohort may repeat this cycle, perhaps with a more racially diverse radix (the initiating endowment of a life table) or they may transition into places that draw population from specific places in the age distribution.

However, my findings come from a specific time in the demographic history of cities in the United States. Population projections are clear, the future age and racial composition of the United States will be different than it is today. The age distribution will continue to move from pyramid to pole and will become more racial diverse. When I began this project the 2009 recession seemed like it may have shaken up the spatial distribution of population, to the extent that many young people moved back in with parents and residential mobility rates fell. As I submit this dissertation, the effects of COVID19 on old age mortality (particularly in group quarters), job loss and school closure seem likely to have an even deeper impact on many of the topics I discuss. Further, the balance of risks and benefits associated with age segregation are likely to change rather dramatically and in unfortunate ways for older adults. Older adults, already vulnerable to isolation and loneliness, are likely further at risk for these conditions given social distancing guidelines that both limit social contact with friends and family and make daily activities, such as shopping or medical appointments, considerably more challenging. Further, group quarters environments, which can offer centralized medical care and nearby peers, have proven to be locations of extreme infection risk. Additionally, racial disparities in infection risk and mortality have become stark. Black and Latinos in the United States have disproportionately suffered during the pandemic, due in part to pre-existing health disparities, differences in multigenerational co-residence, employment in essential industries and systemic racism.

Age and population age structure are important elements in the historic distribution of population within American metropolitan areas. I present evidence that age structure shapes segregation at multiple levels, from the household to neighborhood to the population. As the US population continues to grow both older and more racially diverse, age structure is likely to remain consequential and even increase in importance. My neighborhood aging classification scheme is both novel and consequential for racial segregation. The findings I present in this dissertation speak to long-running concerns in sociology about intergenerational interaction, neighborhood typology and the way that the age distribution can influence socio-demographic behavior. I hope the attention I give to age and age structure will inform future studies of residential segregation in the United States.

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