

Article

Predictable Surprise: The Spatial and Social Morphology of Aging Suburbs in the U.S. Metropolitan Areas

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Abstract: Elderburbs, defined as old suburban neighborhoods in terms of their ‘built environments’ and ‘demographic structures’, have emerged prominently in academic discussion due to the social vulnerability and outdated built environments of senior dominant neighborhoods that barely meet the needs of their aging populations. Even though previous literature has revealed concerns about suburban decline and the growing number of seniors, these two points of interest have largely been examined in isolation from one another. Thus, this paper attempts to unveil the spatial and social morphology of Elderburbs in 20 U.S. metropolitan areas from 1990 to 2010. Elderburbs were identified by two major criteria; built year (first-generation suburbs built between 1950 and 1970) and demographic aging (based on elderly, elderly-child, and elderly dependency ratios). The findings of this study indicate that Elderburbs have increased and expanded out to suburban areas, especially in the Northeast and Midwest. On the contrary, Elderburbs in the South have decreased and moved closer to core cities. Differing from our assumptions, both Elderburbs and Elderurbans were found to be less socially vulnerable than ordinary suburban and urban neighborhoods.

Keywords: aging neighborhood; vulnerability; suburbs

1. Introduction

‘Every modern city convenience plus country comfort at down-to-earth cost’ ([1], p. 203).

This quote comes from an advertisement for Levittown in New York, one of the first large suburban developments that appeared in the 1950s. Suburbs, consisting of large homes with private yards and pleasant natural surroundings located far from crowded urban centers, have long been part of the American dream and were once the picture of youth. However, while once seen as ideal communities for young families with children, suburbs are now aging. These built environments, referred to as ‘Elderburbs’ by Stafford [2], have experienced aging along with their residents. Today, more than 35 million people age 65 and older live in suburbs, and this will reach 56 million by 2020, an increase of 42% [3]. According to the research by the U.S. Department of Housing and Urban Development [4], the older population growth in central cities was 9.0%, while it grew by 17.1% in the suburbs between 1990 and 2000. As a result, typical suburban settings function no longer as perfect refuges for seniors who have aged and thus have different needs. In many suburbs, utilitarian destinations such as clinics, restaurants, and shops typically must be reached by private car, consequently isolating seniors and causing them to participate in fewer outdoor trips. Large single-family housing dominates suburban

developments and hardly meets the needs of elderly empty nesters seeking smaller houses in or near their current neighborhoods. Similar to other developed countries, concerns about the growth of aging suburbs and the ‘silver tsunami’ in the U.S. have grown tremendously.

Although previous research has attempted to examine this issue conceptually and empirically, few studies have addressed the specific geographic and social morphology of older adults in conjunction with aging suburbs. To fill this gap, this paper attempts to identify the transition of ‘Elderburbs’, old suburbs with a majority of older population, in terms of geographical and social morphology during the 20 year period from 1990 to 2010, specifically in 20 of the most populated metropolitan areas. It primarily examines arguments from previous literature by questioning whether (1) the number of Elderburbs has increased over time; (2) Elderburbs have been expanding further from the urban core; and (3) Elderburbs are more socio-economically vulnerable than are other suburban neighborhoods. The outcomes are expected to enhance knowledge about aging in the suburbs, as well as the aging of the suburbs themselves, in order to allocate available resources and services to these neighborhoods through processes of restructuring and retrofitting.

2. Literature Review

2.1. Suburbs in the U.S.

Suburbs were once regarded as utopian communities in which people enjoyed the luxuries of green lawns safely fenced away from overcrowded central cities. Since the first true appearance of the New York suburban development known as Levittown in 1957, suburbs have rapidly expanded across the U.S. This dramatic growth was made possible not only due to individual desires, but also thanks to numerous factors that encouraged the rapid suburban developments. The large number of World War II veterans and baby boomers led to increased housing needs [5], to which the Federal Housing Authority responded by providing long-term mortgages lasting ten to 30 years. The G.I. Bill also supported low-interest mortgage rates for returning veterans [6], and the National Interstate and Defense Highways Act (1956) funded the construction of highways connecting urban centers and suburbs so that people could commute to work easily. In addition, widespread consumerism, one of the strategies used to jumpstart the economy during the Great Depression, promoted the desire for larger homes and private cars [5]. Applying Henry Ford’s approach of mass production to houses also made vast suburban developments possible [7]. Suburbs accommodated baby boomers and their families in large houses with similar designs at low cost that were located within commuting distance from the city center by private car. As a result, while over 30 percent of the population lived in downtown in 1970, it was decreased to nearly 15 percent in 2010, while the suburban population increased about three times faster than that of cities [8]. Furthermore, a growing number of job opportunities were provided in the suburbs, especially large corporate headquarters operations and high-technology industries [9]. In contrast, a growing number of minorities who were financially unable to move or buy a house stayed in urban areas [10].

Regardless of this description of suburbs, it is difficult to find consensus for an academic definition of a suburban development. Researchers, however, have described several distinctive characteristics of suburbs: (1) they are not in the urban centers [11]; (2) they possess uniform environments characterized by features such as low-density single-family detached houses, large backyards, and cul-de-sac streets [12]; and (3) they are characterized by homogeneous socio-economic and racial demographics, the majority being middle-class and relatively older than those in an inner city [10,13]. When considering characteristics such as ‘not in the urban center’, ‘city center’, or ‘suburban’, scholarly explanations become less straightforward due to varying standards. For example, Douglas [14] emphasized accessibility from the suburbs to the ‘heart’ of the city, and Clapson and Hutchison [15] defined suburbs as areas between the town center and the countryside but within accessible distance by automobile. There is no global agreement on ‘acceptable commuting distance’, even though Kneebone and Holmes [16] found that the typical commuting distance in 96 large U.S. metro areas was 7.6 miles

between 2000 and 2010, while the commuting distance for larger metropolitan areas reached up to 12.8 miles (e.g., Atlanta-Sandy Springs-Roswell MSA, GA). The U.S. Census Bureau [17] observed that the average commute time was about 25.4 minutes or a distance of approximately thirteen miles when taking 30 mph to be the average travel speed. Even though many scholarly researches assumed that most of the job centers were located at city centers, not suburbs, recent job decentralization has been reshaping the economic landscapes, and job hubs in suburbs have been constantly growing [18]; total jobs have decreased in cities by 1.8%, while there has been a 4.2% increase in the suburbs between 2000 and 2012 in large metro areas [16]. Despite the total job growth in the suburbs, Kneebone and Holmes [16] found that the job proximity dropped by 7.3% in the suburbs, which was twice as much as in the cities (−3.5%). This indicates that the creation edge cities do not help to reduce the commuting distance, and people are sprawling out regardless of the job proximity.

Suburbs were also often divided into different sub-categories. Inner suburbs—also called inner-ring, first-ring, or older—are located close to the center of a city. Outer suburbs—outer-ring, second-ring, third ring, fringes, or exurban areas—are located farther from urban cores than are inner-ring suburbs [19–21]. As with the vague definitions of suburban and urban areas, the literature has not successfully described empirical evidence for the visible limits of different suburb rings. However, Seaver, Morris, and Rapson [22] suggested that inner-ring suburbs are mostly post-WWII communities built between 1945 and 1965. Lucy and Phillips [23] defined inner-suburbs as those constructed between 1945 and 1970, while neighborhoods built after this period are usually considered second or third-ring developments. Nelson and Sanchez [24] defined ‘suburban’ and ‘exurban’ based on the relationship between residential settlements and economic activities, not just by physical location. First, they distinguished urban and non-urban areas through population density, such that areas with more than 1000 persons per square mile were considered urban, while areas with fewer residents were considered non-urban. Afterwards, they distinguished between suburban and exurban areas based on demographics, such that exurban households tended to have larger families and higher household incomes.

Despite these efforts, several studies have used the concept of principal cities and Metropolitan Statistical Area (MSA) provided by the U.S. Census Bureau only if the major interest lies not in defining the characteristics of urban and suburban areas; in other words, for data mining and conducting analyses for empirical studies. The U.S. Census Bureau defines suburbs as located ‘within metropolitan areas but outside of core cities’ [11,25]. Even though these approaches are useful for identifying the multi-nuclear aspects of metropolitan areas, the census definition does not perfectly match the conceptual definition since it includes the periphery of metropolitan areas, often called ‘exurban’, that frequently exceed the acceptable commuting distance.

2.2. Emerging Elderburbs and Issues

Forty years ago, Golant [26] projected that older adult residents would become concentrated in metropolitan areas, especially in the suburbs. His projection proved true for the first time in 1980. A great number of older people lived in the suburbs, 10.1 million, and 8.1 million in the central cities [27], and a trend was mainly reinforced by the many 1950s parents and baby boomers that have stayed in the suburbs and are now reaching retirement age [28]. Aging populations are a global trend, though they are especially a concern in the U.S. due to the development of ‘Elderburbia/Elderburbs’. Stafford [2] crafted this term to identify old suburbs with predominantly senior populations and worried a mismatch between their aging populations and typical suburban settings. Elderburbs (EB) discourage seniors from living actively and independently [29], since they need more accessibility to daily services and destinations that can be reached in a short distance [30], but traditional suburbs were originally built to suit the needs of young families with more mobility [31].

Despite the needs-space mismatch issue, older adults hesitate to move their residency. Older people have frequently expressed their desire to remain and grow old in their own communities [32,33]. According to Harrell and Houser [34], 48% of householders 65 years of age or older have lived in

their current home for more than 20 years. The high residential stability of older people, often called ‘aging-in-place’ stems from reasons such as attachment to their homes and neighborhoods [33] and higher rates of home ownership [35]. In 2015, the homeownership rate of those 65-years-old and over accounted for about 78.7% nationwide, the highest proportion of all age groups; the average homeownership rate is 63.7%, while the lowest rate is 35.1% for those under 35 years old [36]. Homeownership and a sense of community are mutually complementary. Homeowners are usually more active in property management, community organizations, demands for city services benefitting their economic interests, and other activities [37]. These activities lead to greater social interaction, a sense of community, and a psychological identification of neighborhood among the older adults who age in place [38]. In turn, increased social capital due to the longer tenure of older adults leads to higher residential stability [39–41]. Enhanced social capital is more critical for seniors than for younger families because of the declining capacity for independent living among older people [42]. Social support and emotional connections from old neighbors make independent living possible for seniors [43]. Rosow [44] also concluded that areas with large concentrations of aged residents tend to be places where many opportunities for friendship and helping patterns can be found.

By contrast, the high residential stability of the older population could not solely be the result of voluntary choice. Because of the low mobility of the elderly, they are less likely to move once they are settled in a place, due to the great expenditure of time and energy associated with moving [27]. Seniors in old suburbs also have difficulty selling their homes since the generations following the baby boomers have smaller populations, resulting in fewer housing demands [28]. The recent housing bubble has significantly reduced the chance for older adults to sell their houses in order to move to other places.

We find and will find more seniors in suburbs, whether voluntarily or non-voluntarily, which results in various issues. Some researchers argue that neighborhoods with dominant older populations tend to be more socially vulnerable to economic decline, lower home values, poverty, age segregation, or crime due to diversity in age composition [38,45,46]. By contrast, the recent large migration of retirees tend to find less vulnerable places such as age-segregated and comprehensively-planned gated communities for their migration destinations [47]. The retirement destination region known as the Sunbelt has experienced above-average employment and income growth due to the professional skills and capital assets brought by in-migrating retirees [48,49]. These benefits from migrating retirees help to mediate the socio-economic vulnerabilities of such regions.

2.3. Literature Gap

Previous literature has discussed the trends of aging populations and related issues such as the impact of the built environment on outdoor activities and senior mobility [50–52], the migration patterns of the older people [31,53,54], the benefits of aging in place [55,56], and the social vulnerability of the elderly [57,58]. Researchers have also analyzed socio-demographic changes in suburbs [59,60], the decline of suburbs [22,23,61], and the socio-economic, demographic, or cultural differences between urban and suburban areas [62–64]. However, they have examined the aging population and the suburban transition separately. It would be more meaningful to ponder these issues together through a study on EBs, while questioning (1) the geographical distribution of the elderly in old suburban areas; (2) how they have changed; and (3) whether these neighborhoods are relatively vulnerable compared to other suburban or urban neighborhoods.

3. Materials and Methods

3.1. Study Areas and Data

The socio-economic, demographic, and geographic characteristics of EBs between 1990 and 2010 were analyzed in 20 MSAs ranked in the top 20 based on population size in 2010 (Figure 1 and Table A1). Since census tracts covered the entire U.S. from 1990, the time span of the research is twenty years from

1990 to 2010. The total population of 20 MSAs accounts for nearly 37% of the entire U.S. population (300.7 million in 2010). We measured older adults-dominant neighborhoods by using population variables in three different approaches (Elderly Ratio, Elder-Child Ratio, and Elderly Dependency Ratio), and we measured social vulnerability by using variables developed by the U.S. Centers for Disease Control (CDC) using data from the 2010 U.S. Census at the census tract levels. All relevant data and maps were gathered from the decennial census and the American Community Survey.

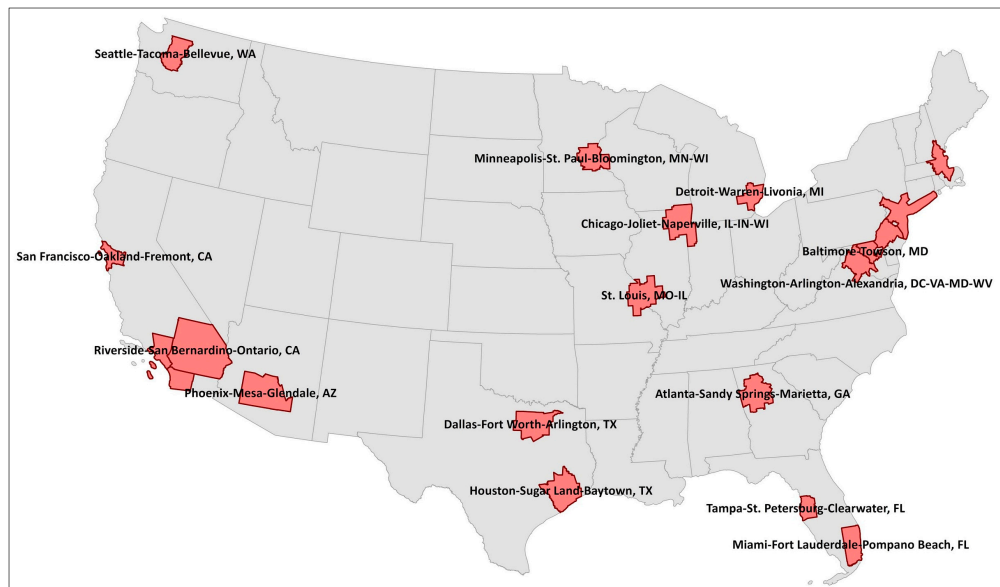


Figure 1. Top 20 MSAs by population size in 2010.

3.2. Research Process

The main purpose of this study is to identify the geographical and social morphology of the EBs. Thus, the research was conducted in three major steps. More details about the operationalization will follow in the sections below.

1. This study defines EBs as old suburbs with a predominantly senior population, for each of which 'old', 'suburbs', and 'senior dominant' were first identified based on previous literature and its operationalization.
2. Then, the geographical morphology of EBs was identified and compared by regions in terms of the numbers and ratio of EBs and the distance from the city center.
3. After this, the study explored and compared whether identified EBs are socially more vulnerable than other regular suburban neighborhoods, urban neighborhoods, and Elderurbans (EU) built at the same time as EBs with high aging population indices but located in urban areas. The comparison was done by regions using analysis of variance (ANOVA).

3.2.1. Urban vs. Suburban and Built Old

Suburbs refer to areas not located in the core cities or cities of each MSA. Several studies have identified, defined, and measured urban, suburban, and rural areas. While population and/or housing density is the most common tool [65–68], there is some research which reflects the influence of socioeconomic aspects on defining spatial patterns [69,70]. This study utilized only the core city concept, not that of principal cities suggested by the U.S. Census Bureau, since our major interest lay in 'old suburbs', the first generation of suburban developments. A core city would be the historically dominant and largest municipality in the metro area, while principal cities in 2010 might have been exurbs or fringes of core cities in the 1950s when the first suburban developments appeared. To identify

core cities, the names of MSAs and principal cities in 2010, as well as standard metropolitan areas (SMAs) and core cities in 1950, were matched (see Table A2). Core or principal cities that overlapped in 1950s SMAs and 2010 MSAs were selected as core cities in this study. One census tract corresponded to one neighborhood as often found in the previous empirical studies [71]. If the boundaries of the census tracts and municipalities did not exactly match—for instance, if a census tract extended between urban and suburban areas—any census tract that overlapped with a suburban area by 50% or more was classified as a suburb [72]. Neighborhoods built between 1950 and 1970, when the suburban developments started and had rapidly expanded, now require significant remodeling and revitalization efforts.

3.2.2. Aging Neighborhood Population

The demographic structure of the older people in a neighborhood was defined by three indicators accounting for the ratio of seniors to the total population, seniors to children, and seniors to the working population. Any census tract with a high elderly ratio (ER, ECR, and EDR) was identified as an ‘elderly dominant neighborhood’. The study does not only adopt one aging index, but rather used three indices because each of them is not able to perfectly represent the aging neighborhoods.

The elderly ratio (ER) refers to the simple proportion of people of at least 65 years of age. There is no global agreement about the high value of the ER, but Shryock, Siegel, and Larmon [73] argued that an ER value of 0.1 or more indicates an aging population. The national ER average in the U.S. in 2010 had already reached 0.13, so this study considered an ER of 0.13 or greater to be indicative of aging.

$$\text{Elderly Ratio(ER)} = \frac{\text{Ages}_{65+}}{\text{Total Pop}}$$

The value of the elder-child ratio (ECR) measures the proportion of people at least 65 years of age per 100 children aged 14 years or younger. This measure proves to be more sensitive than does the ER since it shows the differences or changes in age composition at both ends of the age spectrum. Similar to the ER, there is no common criterion used to define the high value of the ECR, but according to Shryock, Siegel, and Larmon [73], a value of 15 may be used to indicate ‘young’, while a value of over 30 may be used to indicate ‘old’. As of 2010, the national ECR average for the U.S. was 65.77, indicating that the U.S. had already entered the ‘old’ stage. This study used the average ECR value of 65.77 as a threshold to define an area as aging.

$$\text{Elder – Child Ratio(ECR)} = \frac{\text{Ages}_{65+}}{\text{Ages}_{0-14}} \times 100$$

Lastly, the elderly dependency ratio (EDR) shows the proportion of older residents per 100 working-age people between the ages of 15 and 64. The national EDR average in the U.S. in 2010 was 19.43. Similar to the ER and the ECR, there are no universal criteria to determine a high value for the EDR. Likewise, a neighborhood with an EDR of 19.43 or higher was considered to be aging. Therefore, this research identified an Elderburb as a suburb meeting all three thresholds based on the ER, ECR, and EDR.

$$\text{Elder Dependency Ratio(EDR)} = \frac{\text{Ages}_{65+}}{\text{Ages}_{15-64}} \times 100$$

3.2.3. Social Vulnerability Index

This paper utilized eleven components (in Table 1) to determine the social vulnerability of EBs, following the approach of Berke et al. [74] and Flanagan et al. [75]. However, in contrast to previous studies, the percentage of people at least 65 years of age was excluded since the share of older adults was already taken into account when the EBs were identified with aging indices. American Community Survey (ACS) 5-year estimates from 2006 to 2010 data were used to calculate the Social Vulnerable Index (SVI). Since SVI flag counts provide specific information about areas that have vulnerable populations,

it is a useful tool to identify specific districts that need to target plan policies. A census tract would have a score of 1 (a ‘flag score’) if it falls within the top 25th percentile of each individual indicator. The bottom 25th percentile was used to measure per capita income. The scores from each item were then composited at a census tract level to identify areas with socially vulnerable populations. The most vulnerable census tract would theoretically have a score of 11. Since census data have had boundary changes between Census 1990 and 2010, 1990 and 2000 census tract boundaries were regenerated based on 2010 boundaries using a tool, Geospatial Modeling Environment.

Table 1. Social Vulnerability Measures.

Domain	Measures	Description
Socioeconomic Status	Percent of individuals below the poverty level	Individuals below the poverty level = ‘under 0.50’ + ‘0.50 to 0.74’ + ‘0.75 to 0.99’. Percent of persons below the federally defined poverty line, a threshold that varies by the size and age composition of the household. Denominator is total population where the poverty status is checked.
	Per capita income in 2010	Mean income computed for every person in a census block group. (In 2010 inflation adjusted dollars)
	Percent of people persons with less than a high school diploma	Percent of persons 25 years of age and older, with less than a 12th grade education (including individuals with 12 grades but no diploma)
Household Composition	Percent persons 17 years of age or younger	
	Percent of male or female householders, no spouse present, with children under 18	‘Other family: male householder, no wife present, with own children under 18 years’ + ‘Other family: female householder, no husband present, with own children under 18 years’.
Minority Status	Percent Minority	Total of the following: ‘Black or African American alone’ + ‘American Indian and Alaska Native alone’ + ‘Asian alone’ + ‘Native Hawaiian and other Pacific Islander alone’ + ‘some other race alone’ + ‘two or more races’ + ‘Hispanic or Latino -white alone’.
	Percent of persons 5 years of age or older who speak English less than ‘well’.	For all age groups and all languages—the total of persons who speak English ‘not well’ or ‘not at all’.
Housing & Transportation	Percent multi-unit structures	Percent of housing units with 10 or more units in the structure
	Percent of mobile homes	Percent of housing units that are mobile homes
	Crowding	At a household level, more people than rooms. Percent of total occupied housing units (i.e., households) with more than one person per room.
	No vehicle available	Percent households with no vehicle available

Note: The Berke et al. [59] model uses 12 variables. We exclude one of these variables (percentage of persons at least 65 years old) because the share of older adults was already taken into account in the aging indices.

4. Results

4.1. Geographical Morphology of Elderburbs Identifying Elderburbs

The results showed that the total number of EBs increased, while the number of EUs decreased. The EUs decreased between 1990 and 2000 and slightly increased in 2010, though this trend differed slightly by region. All regions experienced an increase in the number of EBs with the exception of the South. EUs in the South and Midwest decreased, while the number increased in the Northeast and West. The number of EUs decreased slightly during the first decade and later increased in the Northeast, though they remained constant in the West. Southern and western regions had fewer EBs, while the Northeast had the most EBs and EUs. The share of EBs yielded different results from the

absolute numbers. The overall share of EBs and EUs to the total neighborhoods in suburban and urban areas has constantly decreased; in 1990, the share was similar until the number of EUs fell more sharply compared the number of EBs, though this trend differed by region. EBs have decreased in the West and South while increasing in the Northeast and Midwest. The most substantial decrease was found in the South, where EBs dropped from 15.6% to 8.1% and EUs decreased from 23.6% to 14.5%. In 2010, about 26% of suburban neighborhoods were EBs in the Northeast, while only 12% were in the West.

The locations of EBs were measured by their distance from the centers of the nearest core cities in each MSA. There were no dramatic changes in the location of EBs for 20 years, as shown in Table 2, until the EBs moved one mile further from 16.5 to 17.5 miles. Based on the maximum distance from the center of a core city to the center of the farthest neighborhood of each MSA—on average, the farthest neighborhood was located 70 miles from the center—EBs were found to be relatively closer to urban centers. Assuming a 30-mph driving speed, residents in EBs are likely to reach these urban centers in about 30 minutes. EBs in the South were located the farthest in 1990, but those in the Northeast outpaced them in 2010. EBs expanded by about 3.4 miles a year for 20 years, while being constricted toward the center by 1.3 miles. EUs have also moved slightly farther from urban centers in all regions. Only the EBs in the South moved closer to city centers, with the distance between them decreasing from 19.8 to 18.5 miles. The typical commute distance in 96 large metro areas in the U.S. between 2000 and 2010 was 7.6 miles, while the commute distance in larger metropolitan areas reached up to 12.8 miles [16]. This implies that EBs were located beyond the typical commute distance to job centers, possibly meaning that EBs have become aging suburbs of people not actively engaged in economic activities. Table 2 and Figure 2 explain the changes in number, share, and location in miles from the core city (cities).

Table 2. Number, Share, and Distance of EB and EU.

		Year	West	South	Northeast	Midwest	All
Number	EB	1990	428	525	827	587	2367
		2000	506	478	1024	685	2693
		2010	587	444	1163	654	2848
	EU	1990	234	259	351	165	1009
		2000	239	236	333	139	947
		2010	265	212	370	125	972
Share (%)	EB	1990	12.1	15.6	19.7	20.3	16.4
		2000	10.5	11.1	24.2	23.4	15.2
		2010	10.3	8.1	26.2	23.5	13.8
	EU	1990	15.4	23.6	10.7	10.1	16.5
		2000	11.0	20.8	11.1	9.6	13.8
		2010	9.9	14.5	11.2	9.0	11.0
Distance (Mile)	EB	1990	15.0	19.8	18.7	12.3	16.5
		2000	15.3	18.0	18.7	12.4	16.0
		2010	18.4	18.5	19.5	13.3	17.5
	EU	1990	5.5	3.9	5.6	4.3	4.7
		2000	5.5	4.0	6.2	4.5	4.9
		2010	6.1	4.3	6.2	4.5	5.2

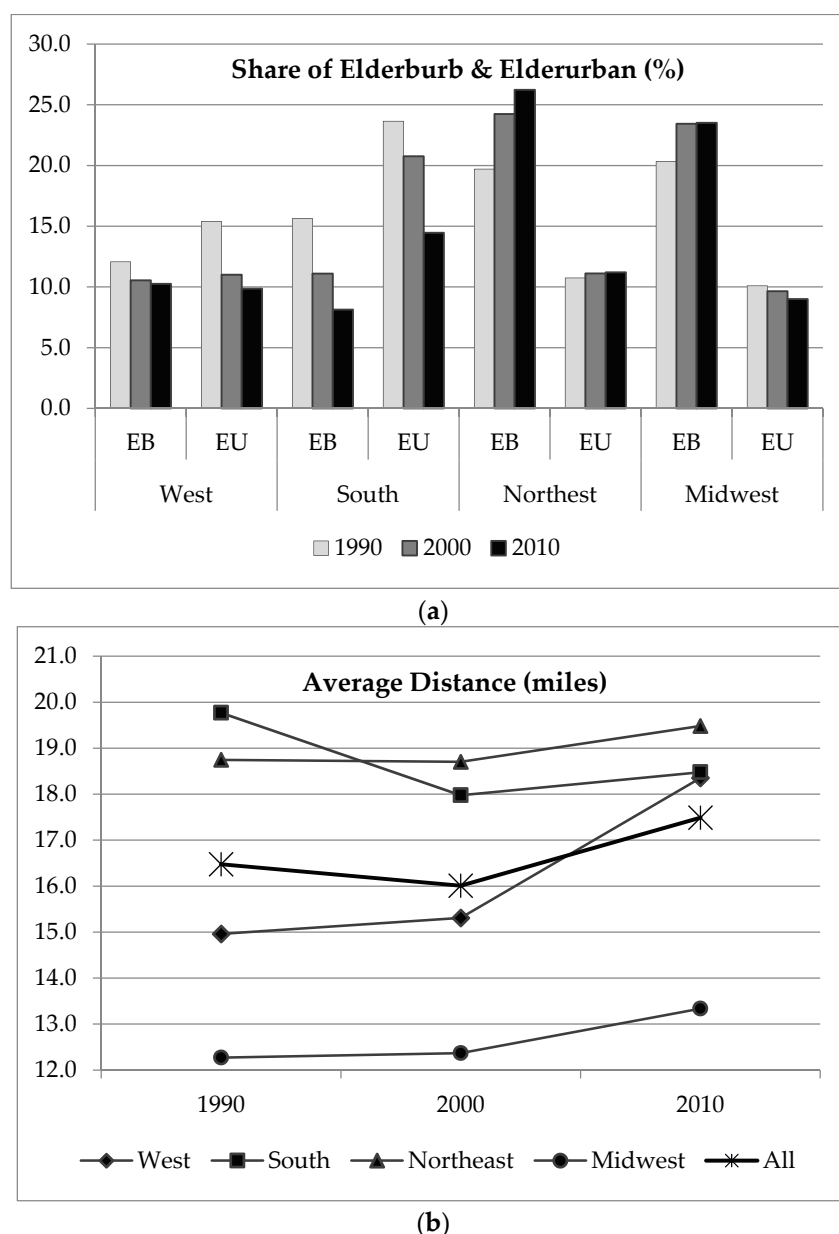


Figure 2. The Change of Share and Distance from Core City to Elderburbs. (a) Share of EBs and EUs by Regions; (b) Average Distance from Core City to EBs.

4.2. Socio-Economic Morphology of Elderburbs

Descriptive statistics indicate that both EBs and EUs have become more socially vulnerable since 1990, regardless of region. EBs in the South have become most vulnerable, as illustrated in Table 3. The average SV score of the South in 2010 was 3.1, almost triple the national average of 1.1. Since 1990, the most socially vulnerable EBs are located in the Miami-Fort Lauderdale-Pompano Beach, FL Metro Area, where the SV score has increased steadily over the past two decades (see Table 3). In examining the differences in social vulnerability scores between EUs and EBs, the gap was the largest in 1990 and in 2010 in Detroit-Warren-Livonia, MI, across all MSAs; the second-largest gap occurred in 2000. Figure 3 displays the transition of social vulnerability composite scores between 1990 and 2010 in the Miami-Fort Lauderdale-Pompano Beach, FL Metropolitan Area (the highest average social vulnerability score MSA) and the Detroit-Warren-Livonia, MI, Metropolitan Area (the largest gap in average social vulnerability score between EUs and EBs).

Table 3. The average social vulnerability (SV) score by Region and MSAs from 1990 in 10 year intervals.

Region	MSA Names	Year					
		1990		2000		2010	
		EB	EU	EB	EU	EB	EU
Western	Los Angeles-Long Beach-Santa Ana, CA	1.2	1.2	1.5	1.1	1.8	1.5
	Phoenix-Mesa-Glendale, AZ	1.9	1.4	0.9	1.1	1.9	1.3
	Riverside-San Bernardino-Ontario, CA	1.2	4.0	1.5		2.4	4.0
	San Diego-Carlsbad-San Marcos, CA	1.5	0.7	1.0	0.6	1.9	1.0
	San Francisco-Oakland-Fremont, CA	0.7	3.3	0.5	2.4	0.6	2.7
	Seattle-Tacoma-Bellevue, WA	0.7	1.2	0.5	1.2	0.8	1.1
	<i>Regional Average</i>	1.1	1.4	1.1	1.2	1.5	1.5
Southern	Atlanta-Sandy Springs-Marietta, GA	2.1	3.6	1.3	3.7	2.3	4.8
	Dallas-Fort Worth-Arlington, TX	1.5	1.4	1.1	1.9	1.7	2.0
	Houston-Sugar Land-Baytown, TX	2.0	2.9	1.6	3.0	1.7	3.1
	Miami-Fort Lauderdale-Pompano Beach, FL	2.4	5.6	2.6	5.8	2.7	5.4
	Tampa-St. Petersburg-Clearwater, FL	1.5	2.2	1.3	1.9	2.4	2.4
	<i>Regional Average</i>	1.9	1.6	2.1	1.6	3.1	2.1
Midwestern	Chicago-Joliet-Naperville, IL-IN-WI	0.6	2.5	0.6	2.0	0.9	3.0
	Detroit-Warren-Livonia, MI	0.4	4.2	0.4	2.9	0.8	5.3
	Minneapolis-St. Paul-Bloomington, MN-WI	0.7	1.4	0.6	2.0	1.0	2.0
	St. Louis, MO-IL	0.8	3.3	0.6	2.3	1.1	3.0
	<i>Regional Average</i>	0.6	2.2	0.5	2.0	0.7	2.2
Northeastern	Baltimore-Towson, MD	0.7	2.4	0.5	2.6	0.9	4.0
	Boston-Cambridge-Quincy, MA-NH	0.8	3.9	0.6	3.4	0.6	2.8
	New York-Northern New Jersey-Long Island, NY-NJ-PA	0.9	2.7	0.6	2.7	0.7	3.3
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	0.7	1.3	0.5	1.9	0.5	2.1
	Washington-Arlington-Alexandria, DC-VA-MD-WV	0.7	2.7	0.5	3.3	0.8	3.4
	<i>Regional Average</i>	0.8	2.9	0.5	2.7	0.7	3.2
Total		0.9	2.1	0.8	2.0	1.1	2.4

To compare the statistical vulnerability differences among various groups in terms of (1) urban versus suburban areas; (2) EBs versus EUs; (3) EBs versus regular suburbs; and (4) EUs versus regular urban areas by census region, we applied *t*-tests and ANOVA. We have included the summary tables for four statistical outputs in Appendix A (Tables A3–A6). First, the results of the *t*-tests showed that, in all three test years (1990, 2000, and 2010), the mean vulnerability of urban areas was statistically higher than that of suburban areas, indicating that urban areas are more socially vulnerable than are the suburbs. Second, after applying a two-way ANOVA, the mean vulnerability of EUs was found to be higher than that of EBs in all test years. The South had the highest mean vulnerability in both EBs and EUs, indicating that the EBs there might be the most socially vulnerable. Third, the vulnerability level in regular suburbs was found to be higher than that of EBs in all years according to the results of ANOVA. Specifically, the mean vulnerability of EBs in the South has been consistently the highest out of the four census regions. Fourth, the two-way ANOVA results revealed that, in all test years, the mean vulnerability of EUs was lower than that of regular urban neighborhoods, regardless of region. EUs in the West have consistently been the least vulnerable during all test years.

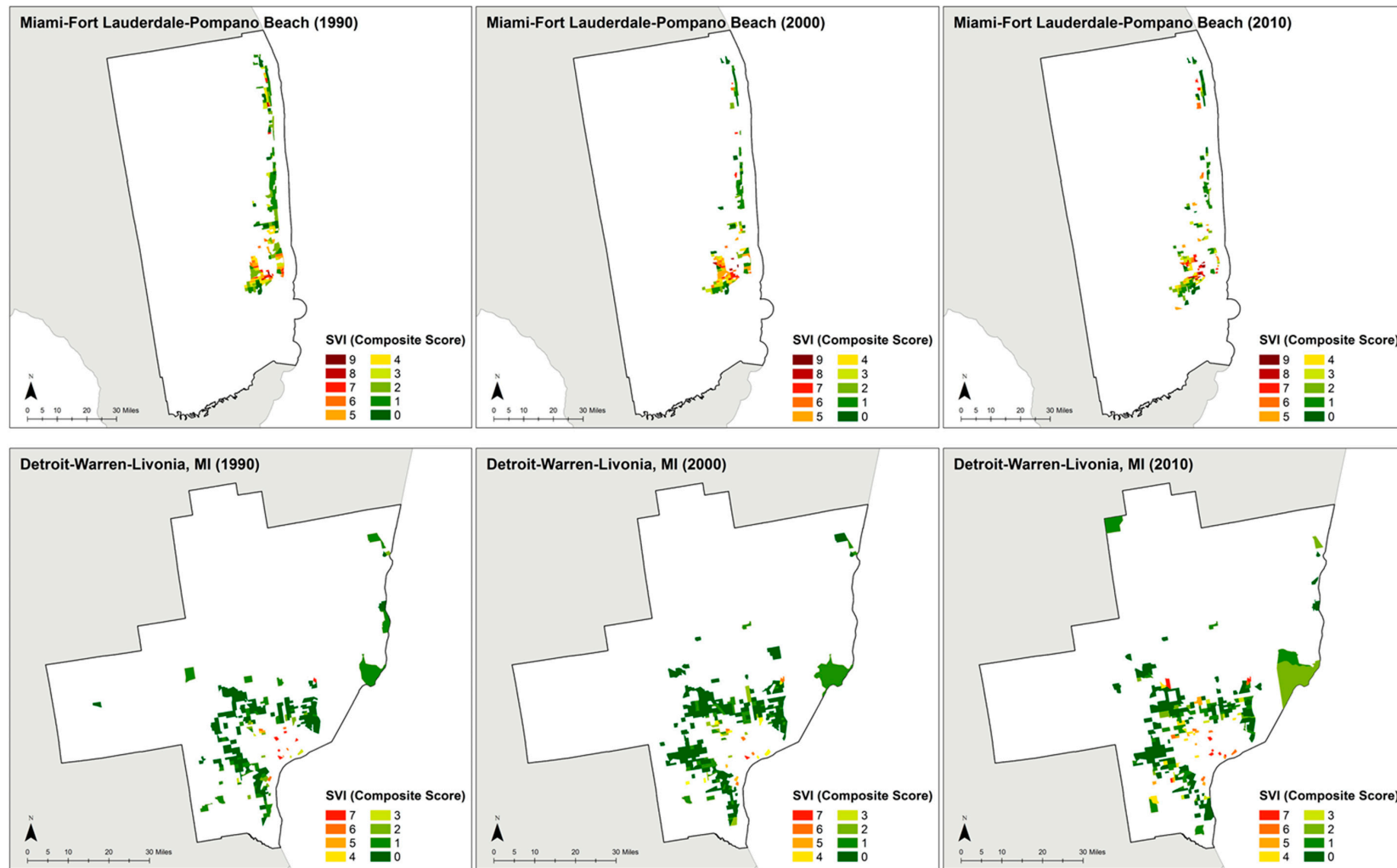


Figure 3. The transition of the social vulnerability index (SVI) between 1990 and 2010 in the Miami-Fort Lauderdale-Pompano Beach, FL Metropolitan Area (Top, the Highest Average SVI Score) and the Detroit-Warren-Livonia, MI Metropolitan Area (Bottom, the Largest Gap between EUs and EBs).

5. Discussion and Conclusions

This paper provides preliminary observations of the geographical and social morphology of EBs. To summarize findings from observations and analyses, we found several interesting trends. First, the number of EBs has increased over the years, while the share of EBs has decreased in all regions. On the contrary, the number and share of EUs has constantly decreased, implying that the population of individuals at least 65 years of age has grown in MSAs, though a great influx of young people moving into MSAs was simultaneously found. Moreover, inner-city gentrification efforts across the nation appeared to attract young and professional groups into urban centers or, possibly, it is just the classic ‘rural to urban migration’ for occupational and educational opportunities in urban areas. Simultaneously, recent urban gentrification efforts may contribute to the decreasing age of built environments of urban areas. In addition, EBs have been steadily expanding further from core cities, though this spread is not immense. By regions, the South only shows different trends. There, the number and share of EBs, in addition to the distance to core cities, has decreased, possibly due to rapid urbanization and not due to a decrease in the older population, since the older population increased from 448,227 in 1990 to 681,442 in 2010, while the median year built increased by 10 years from 1972 to 1982, which is the most significant increase compared to that of other regions; namely, seven years in the West (1966 to 1973), four years in the Northeast (1955 to 1960), and nine years in the Midwest (1964 to 1972).

Second, the growth of EBs was substantial in the Northeast and Midwest. As expected, suburbs in the Frostbelt are aging while the Sunbelt is becoming younger thanks to remodeling and renovation efforts in the built environment. According to Frey [60,76], the low values of aging indicators for Sunbelt areas were rooted in the rapid growth of a younger population. A combination of immigration, domestic migration, and the natural increase of the younger population correlates with the relatively low-share of older residents in these areas. On the other hand, both the out-migration of young adults and the aging-in-place of older residents may significantly affect the growth of EBs in the Northeast and Midwest. Thus, although increases in the absolute number of older people in metro areas have become quite common throughout the nation, the differences in shares of the younger population, specifically the under-45 population, may reveal different patterns of EBs and EUs based on census regions.

Third, as expected, urban neighborhoods were more vulnerable than suburban neighborhoods. Similarly, EUs were more socially vulnerable than EBs. In contrast to our first assumption, both EBs and EUs tended to be less vulnerable than regular suburbs and urban neighborhoods, indicating that the areas identified as EBs or EUs tended to have various merits such as ‘retirement magnets’. Nevertheless, the older people who have lived in suburban areas for a long time are still likely to experience problems such as poverty, low accessibility, and poor housing conditions. Furthermore, regardless of the level of vulnerability, the concentration of older people in suburbs is accompanied by an increase in diverse needs to maintain their quality of life. Homeownership among Millennials and Generations X and Y has shown a steady decline since the mid-2000s [77]. The older adults, whether they are migrant retirees or aged-in-place seniors, tend to be relatively wealthy and have an ability to overcome the vulnerable nature of an old population. However, this trend will change in the near future when these younger generations, who are in their 30s or 40s, reach 65 years or more.

Creating policies and government interventions for all age groups is an inviolable goal. However, current policies have unduly focused on certain age groups, especially young and working age groups, even though society is aging. For example, as Massey et al. [78] noted, most studies on affordable housing focus on poor families rather than housing for the older people, and central cities rather than suburban areas. Although this study did not directly expose them, it was assumed that the concentration of the elderly population in the suburbs was due to two major causes. First, the people who migrated into suburbs in 1940–1950 are aging. In this case, the issue is that the current suburban setting may not meet the needs of the increased aging population. Seniors, especially those living in old suburban settings, often ask for other types of community-based solutions such as promoted walkability, independent living, or accessibility to essential services [79]. Second, aging in suburbs can

be exacerbated by the migration of retirees. In this case, to find the reason for the retirees' migration, more detailed analyses are needed to verify whether the aging policies in the suburbs enhance the migration of retirees. However, regardless of the causal factors of aging in the suburbs, before discussing what researchers, decision makers, and politicians must do to meet these needs, a careful observation of demographic and structural conditions is necessary for more efficient allocation of available resources and services, resulting in an improved quality of life for all age groups. In this sense, this paper provides information on how we might define Elderburbs, where they are located, and which social conditions they carry. Still, this study has limitations that should be addressed in future studies. We used several criteria to define 'aging' with respect to neighborhood and population, but there is no global standard definition. Furthermore, it would be more effective to maintain geographic boundaries (census block groups) during the study period to directly track demographic transitions. However, since census block group boundaries have changed in the last two decades, it was difficult to conduct a consistently comparative analysis on the spatial and social morphology of Elderburbs. Future studies need to address this issue. Even though this paper monitored the geography and social morphology of Elderburbs, it did not identify the reasons that these spatial patterns were created. Future empirical studies should investigate what kind of attributes in suburbs push or pull older people and the relative extent of the effects of those factors. In addition, future study may take micro-level spatial speculation to prepare specific policies that could fit the needs of local governments and authorities.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix

Table A1. Top 20 MSA in 2010 by Region.

Name of MSA	Pop.	Name of MSA	Pop.
West Region: 32,117,088		South Region: 28,645,800	
Los Angeles-Long Beach-Santa Ana, CA ⁽²⁾	12,828,837	Dallas-Fort Worth-Arlington, TX ⁽⁴⁾	6,371,773
San Francisco-Oakland-Fremont, CA ⁽¹¹⁾	4,335,391	Houston-Sugar Land-Baytown, TX ⁽⁶⁾	5,946,800
Riverside-San Bernardino-Ontario, CA ⁽¹³⁾	4,224,851	Miami-Fort Lauderdale-Pompano Beach, FL ⁽⁸⁾	5,564,635
Phoenix-Mesa-Glendale, AZ ⁽¹⁴⁾	4,192,887	Atlanta-Sandy Springs-Marietta, GA ⁽⁹⁾	5,268,860
Seattle-Tacoma-Bellevue, WA ⁽¹⁵⁾	3,439,809	Tampa-St. Petersburg-Clearwater, FL ⁽¹⁹⁾	2,783,243
San Diego-Carlsbad-San Marcos, CA ⁽¹⁷⁾	3,095,313	Baltimore-Towson, MD ⁽²⁰⁾	2,710,489
Midwest Region: 19,850,084		Northeast Region: 34,997,024	
Chicago-Joliet-Naperville, IL-IN-WI ⁽³⁾	9,461,105	New York-Northern New Jersey-Long Island, NY-NJ-PA ⁽¹⁾	18,897,109
Detroit-Warren-Livonia, MI ⁽¹²⁾	4,296,250	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD ⁽⁵⁾	5,965,343
Minneapolis-St. Paul-Bloomington, MN-WI ⁽¹⁶⁾	3,279,833	Washington-Arlington-Alexandria, DC-VA-MD-WV ⁽⁷⁾	5,582,170
St. Louis, MO-IL ⁽¹⁸⁾	2,812,896	Boston-Cambridge-Quincy, MA-NH ⁽¹⁰⁾	4,552,402
Total Population: 115,609,996			

Numbers in ^() refers to ranks based on the population size as of 2010.

Table A2. MSA in 2010 and SMA in 1950 with Principal and Core Cities.

1950		2010	
SMA	Core City	MSA	Principal City
Atlanta, GA	Atlanta	Atlanta-Sandy Springs-Marietta, GA	Atlanta, Marietta, Sandy Springs
Baltimore, MD	Baltimore	Baltimore-Towson, MD	Baltimore, Towson
Boston, MA	Boston	Boston-Cambridge-Quincy, MA-NH	Boston, Cambridge, Framingham, Peabody, Quincy, Waltham
Chicago, IL-IN	Chicago	Chicago-Joliet-Naperville, IL-IN-WI	Arlington Heights, Chicago, Des Plaines, Elgin, Evanston, Gary, Hoffman Estates, Joliet, Naperville, Schaumburg, Skokie
Dallas, TX	Dallas	Dallas-Fort Worth-Arlington, TX	Arlington, Carrollton, Dallas, Denton, Fort Worth, Irving, McKinney, Mineral Wells, Plano, Richardson

Table A2. Cont.

1950		2010	
SMA	Core City	MSA	Principal City
Detroit, MI	Detroit	Detroit-Warren-Livonia, MI	Dearborn, Detroit, Farmington Hills, Livonia, Novi, Pontiac Southfield, Taylor, Troy, Warren
Houston, TX	Houston	Houston-Sugar Land-Baytown, TX	Baytown, Conroe, Galveston, Houston, Sugar Land
Los Angeles, CA	Los Angeles	Los Angeles-Long Beach-Santa Ana, CA	Anaheim, Arcadia, Burbank, Carson, Cerritos, Compton, Costa Mesa, Fountain Valley, Fullerton, Gardena, Glendale, Irvine, Long Beach, Los Angeles, Montebello, Monterey Park, Newport Beach, Orange, Paramount, Pasadena, Pomona, Santa Ana, Santa Monica, Torrance, Tustin
Miami, FL	Miami	Miami-Fort Lauderdale-Pompano Beach, FL	Boca Raton, Boynton Beach, Deerfield Beach, Delray Beach Fort Lauderdale, Homestead, Kendall, Miami Beach, Miami, Pompano Beach, West Palm Beach
Minneapolis-St. Paul, MN	Minneapolis, St. Paul	Minneapolis-St. Paul-Bloomington, MN-WI	Bloomington, Eagan, Eden Prairie, Minneapolis, Minnetonka, Northfield, Plymouth, St. Paul
New York-Northeastern NJ, NY-NJ	New York	New York-Northern New Jersey-Long Island, NY-NJ-PA	New Brunswick, New York, Newark, White Plains
Philadelphia, PA-NJ	Philadelphia	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Camden, Philadelphia, Wilmington
Phoenix, AZ	Phoenix	Phoenix-Mesa-Glendale, AZ	Glendale, Mesa, Phoenix, Scottsdale, Tempe
San Bernardino, CA	San Bernardino	Riverside-San Bernardino-Ontario, CA	Chino, Colton, Hemet, Ontario, Palm Desert, Redlands, Riverside, San Bernardino, Temecula, Victorville
San Diego, CA	San Diego	San Diego-Carlsbad-San Marcos, CA	Carlsbad, National City, San Diego, San Marcos
San Francisco, CA Oakland, CA	San Francisco Oakland	San Francisco-Oakland-Fremont, CA	Berkeley, Fremont, Hayward, Oakland, Pleasanton, Redwood City, San Francisco, San Leandro, San Mateo, San Rafael, South San Francisco, Walnut Creek
Seattle, WA Tacoma, WA	Seattle Tacoma	Seattle-Tacoma-Bellevue, WA	Auburn, Bellevue, Everett, Kent, Renton, Seattle, Tacoma
St. Louis, MO-IL	St. Louis	St. Louis, MO-IL	Centralia, Charles, St. Louis
St. Petersburg, FL Tampa, FL	St. Petersburg Tampa	Tampa-St. Petersburg-Clearwater, FL	Clearwater, Largo, St. Petersburg, Tampa
Washington, DC-MD-VA	Washington, DC	Washington-Arlington-Alexandria, DC-VA-MD-WV	Reston, Arlington, Alexandria, Washington

Table A3. Statistical Vulnerability Differences between Urban vs. Suburban areas.

Year	Urban		Suburban		95% CI for Mean Difference	t-Statistics
	Mean	Std. Dev.	Mean	Std. Dev.		
1990	4.416	3.209	1.822	2.311	−2.671, −2.518	−66.545 *
2000	4.482	3.219	1.904	2.447	−2.653, −2.503	−66.720 *
2010	4.287	2.941	2.007	2.274	−2.345, −2.215	−66.618

* denotes p -value < 0.05.**Table A4.** Statistical Vulnerability Differences between Elderburbs (EBs) vs. Elderurban (EUs) by Census region.

Year	Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Statistics	p -Value
1990	EB vs. EU	1	1,126.44	1126.44	351.24	0.00
	By Census region	3	279.67	93.22	29.07	0.00
	Interaction	3	244.80	81.60	25.44	0.00
	Residual	3368	10,801.42	3.21		
	Total	3375	12,655.47	3.75		
2000	EB vs. EU	1	1175.29	1175.29	435.82	0.00
	By Census region	3	320.46	106.82	39.61	0.00
	Interaction	3	418.32	139.44	51.71	0.00
	Residual	3632	9794.45	2.70		
	Total	3639	12,033.92	3.31		
2010	EB vs. EU	1	1675.92	1675.92	497.36	0.00
	By Census region	3	392.77	130.92	38.85	0.00
	Interaction	3	730.75	243.58	72.29	0.00
	Residual	3812	12,845.15	3.37		
	Total	3319	16,040.88	4.20		

Table A5. Statistical Vulnerability Differences between EBs vs. Regular suburbs by Census region.

Year	Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Statistics	p -Value
1990	EBs vs. Regular suburbs	1	1910.53	1910.53	384.59	0.00
	By Census region	3	998.99	333.00	67.03	0.00
	Interaction	3	273.79	91.26	18.37	0.00
	Residual	13,313	66,134.64	4.97		
	Total	13,320	71,141.63	5.34		
2000	EBs vs. Regular suburbs	1	2966.35	2966.35	550.52	0.00
	By Census region	3	1643.06	547.69	101.64	0.00
	Interaction	3	339.45	113.15	21.00	0.00
	Residual	15,868	85,500.85	5.39		
	Total	15,875	95,043.71	5.99		
2010	EBs vs. Regular suburbs	1	1871.47	1871.47	388.58	0.00
	By Census region	3	1404.95	468.32	97.24	0.00
	Interaction	3	265.46	88.49	18.37	0.00
	Residual	18,059	86,975.88	4.82		
	Total	18,066	93,448.02	5.17		

Table A6. Statistical Vulnerability Differences between EUs vs. Regular Urban Areas by Census region.

Year	Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Statistics	p-Value
1990	EUs vs. Regular suburbs	1	4885.32	4885.32	516.10	0.00
	By Census region	3	557.15	185.72	19.62	0.00
	Interaction	3	60.91	20.30	2.14	0.00
	Residual	7141	67,595.43	9.47		
	Total	7148	73,605.31	10.30		
2000	EUs vs. Regular suburbs	1	4957.68	4957.68	517.47	0.00
	By Census region	3	428.61	142.87	14.91	0.00
	Interaction	3	352.35	117.45	12.26	0.00
	Residual	7506	71,911.71	9.58		
	Total	7513	77,826.07	10.36		
2010	EUs vs. Regular suburbs	1	2085.86	2085.86	254.06	0.00
	By Census region	3	815.24	271.75	33.10	0.00
	Interaction	3	373.21	124.40	15.15	0.00
	Residual	8264	67,848.98	8.21		
	Total	8271	71,560.38	8.65		

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