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Affordable Housing and Residential Segregation in San Francisco:
A Spatial Analysis between 2000 and 2015

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Abstract

Affordable housing developments provide an important mechanism to reduce income segregation and equalize access to city resources. This study examined the spatial distribution of affordable housing developments in San Francisco in 2000 and 2015 to determine its effectiveness in reducing the residential segregation of low-income households. Findings indicate that, though still moderately clustered, affordable housing developments after 2000 are more spatially dispersed than those before 2000, suggesting the probability of reversing the spatial clustering of low-income households. Further analyses confirmed that low-income households are indeed more spatially dispersed in 2015 than in 2000. However, the reversion was achieved by shifting clusters from amenity-rich downtown areas to resource-scarce city outskirts. As a result, the challenge to equalize access to city resource remains, and perhaps has worsened.

Affordable Housing and Residential Segregation in San Francisco: A Spatial Analysis between 2000 and 2015

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INTRODUCTION

The long-term health and vitality of a city depends on equitable distribution of its resources. To this end, residential segregation—the spatial separation of social groups by their housing locations in urban environments—cannot be overlooked because of its serious ramifications for socioeconomic equity and public health. To disadvantaged groups such as racial and ethnic minorities and the poor, residential segregation harms their educational attainment, labor market opportunities, and access to public services (Williams and Collins 2001; Quillian 2014). When segregated groups continue to live in the same segregated area, segregation compounds and may lead to structural disadvantages such as concentrated poverty and crime, decreased mobility and public health hazards (Anderson et al. 2003; Grady 2006).

Residential segregation in the U.S. can be attributed to several factors including exclusionary zoning laws in the 1930s, discriminatory homeownership practices in the 1940s, and the attitudes and preferences towards housing locations such as discrimination in the housing market and minority self-segregation (Rothstein 2017). In recent years, rising income inequality has emerged as a key driver of residential segregation, especially in cities undergoing soaring gentrification (Watson 2009; Bischoff, K. and Reardon, S. 2013; Shaw 2018). Such is the case of San Francisco, a city and county of 47 square miles bounded by water on three sides. Owing to the tech booms since the 1990s, the city is now No. 2 most expensive city in America with a living cost of 200% of the national average (The Council for Community and Economic Research 2019). In the course of each year between 2000 and 2015, population in the city increased an average of 2,915 households (US Census Bureau 2000, 2015) while housing units increased only 2,772 (San Francisco Planning Department 2015), leaving a deficiency of 243 units each year. As a result, there is an ongoing, worsening housing shortage in the city as reflected by the drastic increase of housing prices and fair market rent. By 2015, the fair market rent for a two-bedroom apartment in the city was \$2,062 (The U.S. Department of Housing and Urban Development's Office of Policy Development and Research 2015) and the median house value was nearly \$800,000³ (US census Bureau 2015). Such high housing cost is

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³ According to the latest updates, the fair market rent for a two-bedroom apartment in 2019 is \$3,170; the median house value in 2017 is \$ 927,400.

simply unaffordable to many people. Low-income households have no choice but to reside in certain neighborhoods or to move out of the city completely.

Affordable housing that provides subsidized housing for eligible low- and moderate- income households creates an opportunity to increase integration across different race, ethnicity, and income classes. Two types of affordable housing programs are available: fixed-location developments that construct, acquire, and rehabilitate affordable housing units, and tenant-based programs that subsidize tenants to rent in the private housing market. While fixed-location developments add to a city's housing stock, tenant-based programs rely on available housing in the fair rental market. In San Francisco, fixed-location affordable housing is supplied by several sources: (1) public housing that are funded through federal housing programs; (2) non-profit developments that are financed by the city and operated by private and non-profit corporations; (3) low-income housing tax credit (LIHTC) that offers substantial federal tax credits to developers for developing rental units for low- and moderate- income tenants; and (4) inclusionary housing that requires for-profit developers to allocate 12% units in their buildings and charge below-market rents for those units or pay an affordable housing fee otherwise. The Housing Choice Voucher Program, commonly referred to as Section 8, is a tenant-based program. Low-income households receive vouchers and apply them to rent houses at Fair Market Rent (FMR) in neighborhoods of their choice in the private rental housing market.

Affordable housing aims to provide safe and decent housing for low- and moderate-income families, and concurrently, reduce the segregation of racial, ethnic, and socioeconomic minorities to disadvantaged neighborhoods. Despite various affordable housing programs, there exists a nationwide crisis in affordable housing (Freeman 2002). The effectiveness of affordable housing to encourage social inclusion and integration also remains a critical concern. Traditional public housing, in particular, has been criticized for its tendency to concentrate in poor, minority neighborhoods (Massey and Kanaiaupuni 1993). Later approach of mixed-income housing developments increases neighborhood socioeconomic heterogeneity, but its effectiveness could not be always determined (Anderson et al. 2003). In fact, an analysis of inclusionary housing in San Francisco found that the program had not led to increased racial and ethnical diversity (Pamuk and Hill 2019). LIHTC has been more successful than other housing policies at locating in more diverse and advantaged neighborhoods (Freeman 2004), but there is still significant spatial clustering of LIHTC developments (Jewell 2005; Oakley 2008). Tenant-based programs such as Section 8 are generally more geographically dispersed than public housing and reduced low-income families' exposure to crime and neighborhood social disorder (Anderson et al. 2003), but, in some cities, voucher receivers still tend to be clustered in neighborhoods of high poverty rates and minority population (Oakley and Burchfield 2009) while in others experience substantial improvements in neighborhood conditions (Nguyen et al. 2017).

Research on affordable housing and residential segregation typically focuses on the impact of a particular program on the poor or racial and ethnic minorities (Oakley 2008, Wylie and DeFilippis 2010, Pamuk and Hill 2019). In this study, we focus on low-income households in San Francisco and take into account all affordable housing developments. Specifically, we

sought to determine whether the residential segregation of low-income households in the city has effectively been reduced and whether the reduction is due to the affordable housing developments between 2000 and 2015. The analysis has three parts. First, we study whether affordable housing placed in service between 2000 and 2015 is more geographically dispersed than those before 2000. More geographical dispersion indicates the possibility of decreased residential segregation. Second, we examine the change in the residential segregation of low-income households in 2000 and 2015. Last, we compare the spatial change in affordable housing and residential segregation to determine whether the change in residential segregation, if any, is due to the changes in affordable housing locations. In answering these questions, we take a spatial perspective.

DATA AND METHODS

To study residential segregation, the proportion of low-income households in each census tract in 2000 and 2015 was calculated first. The U.S. Department of Housing and Urban Development (HUD) considers a household low-income if its annual income is less than 80% of the Area's Median Income (AMI). HUD calculates AMI based on median family income which, in San Francisco, was \$63,545 in 2000 and \$96,835 in 2015. Accordingly, \$50,836 in 2000 and \$77,468 in 2015 should be the income limits for low-income households. These numbers were adjusted to \$50,000 and \$75,000, respectively, to coincide with the nearest income thresholds used by the Census Bureau when reporting income distribution. For each census tract, the decennial Census 2000 and 2015 American Community Survey (ACS) report the number of households in each income group, i.e. 0 – 9,999, 10,000-24,999, 25,000-34,999, 35,000-49,999, 50,000-74,999, 75,000-99,999, 100,000-149,999, 150,000-199,999, and 200,000+. Households in income groups below the income limit, \$50,000 in 2000 and \$75,000 in 2015, were summed to obtain the number of low-income households; the sum was then divided by the total number of households in the census tract to obtain the proportion of low-income households in that tract.

Data on fixed-location affordable housing were obtained from several sources: Public housing and LIHTC data from HUD database, non-profit developments data from San Francisco Mayor's Office of Housing and Community Development, and inclusionary housing data from SF Open Data. Geographically-referenced data on tenant-based programs such as Section 8 were not available, therefore not included in this research. For each building in an affordable housing development, the data obtained has its addresses, total units, and the date placed in service. Based on the addresses, the buildings were mapped using ESRI world geocoding service (ESRI 2012). The total number of units in each building and the number of affordable units in it were recorded. Since this research focuses on low-income households, only the affordable housing units reserved for households of 0-80% AMI were used. These affordable housing units are referred to as low-income housing hereafter. They are divided into two groups, pre 2000 and 2000-2015, based on the date they were placed in service.

To assess the effect of affordable housing on residential segregation, we conduct a three-part analysis using descriptive and spatial statistics. First, we compare the spatial distribution of low-income housing before and after (including) 2000 to detect any change in their geographic clustering. As mentioned previously, de-clustering suggests the potential of reduced residential segregation. To measure geographic clustering or dispersion, we use global Moran's I, a spatial statistic which takes into account proximity and similarity simultaneously (Anselin, Luc 1995). Moran's I has a value ranging from -1 to 1, with 0 meaning complete randomness, 1 meaning complete clustering, and -1 meaning complete dispersion. Its calculation requires two parameters: location and weight. Location can be obtained from building addresses; weights are attributes associated with each location. We examined three weights: (1) number of low-income units in a building, (2) median household income of the tract where a building is located; and (3) the proportion of low-income households of the tract. The corresponding Moran's I obtained tells whether low-income units are spatially clustered, whether affordable buildings tend to be located in neighborhoods with similar income, and whether in neighborhoods with similar proportion of low-income households. If no weight is used, the result tells whether affordable housing buildings are randomly distributed or clustered in the city.

Second, we compare the spatial distribution of low-income households in 2000 and 2015 to determine how residential segregation has changed. While there are five dimensions in residential segregation (Massey and Denton 1988), we focus on the clustering dimension which concerns the extent to which areal units inhabited by low-income households adjoin one another in space. A high degree of clustering implies the existence of enclaves where low-income households are contiguous and closely packed in space, creating structural difficulties to interact and integrate with other neighborhoods. To measure spatial clustering, we first calculated global Moran's I to determine whether low-income households are randomly distributed or spatially clustered in the city. If clustered, LISA—Local indicator of Spatial Association—is then employed to locate the clusters. LISA is a spatial statistic that identifies significant local clustering and reveals “hot spots” by taking into account not only the high or low values in a single place (e.g. a census tract) but also the values in nearby places (Anselin 1995).

When applied to low-income household dataset, it classifies the census tracts into five categories: high-high, low-low, high-low, low-high, and insignificant. High-high means a census tract has high proportion of low-income households and its neighbor tracts also have high proportion. Adjoining high-high tracts form a cluster of low-income households. Similarly, adjoining low-low tracts form a cluster where the proportion of low-income households is lower than what is expected under randomness. High-low and low-high are “outliers” in the sense that they differ significantly from their neighbors. A high-low census tract has high proportion of low-income households, but it is surrounded by tracts with low proportion. A low-high census tract is the opposite. Insignificant census tracts are not significantly similar or different than their adjacent tracts in terms of proportions of low-income households. Of interest to this study is the high-high clusters because they are where low-income households cluster and surround each other. Low-income households in such clusters have less opportunity to interact with other economic classes. This does not mean that tracts with high proportion of low-income households are in high-high category only. High-low and low-high categories also contain tracts with high

proportion of low-income households; these tracts, however, are adjacent to tracts of moderate or low proportion of low-income households thereby having more opportunity to integrate with other socioeconomic groups.

Last, we compare the results in first and second part to determine whether affordable housing placed in service between 2000 and 2015 is a possible reason behind the changes in the spatial clustering of low-income households. If the shift in low-income clusters does not coincide with the location of new developments, we can conclude that affordable housing is not the reason. Otherwise, further analysis is needed to ascertain the causal relationship. To facilitate interpretation, the 41 Analysis Neighborhoods created by San Francisco Department of Public Health and the Mayor’s Office of Housing and Community Development by grouping 2010 census tracts is used as the base map (Data SF 2019).

SPATIAL DISTRIBUTION OF LOW-INCOME HOUSING

Analysis of low-income housing reveals that, as of 2015, there are 33,675 low-income housing units scattered in 737 buildings. Among them, 33% were placed in service before 2000. Table 1 summarizes the supply by each program. Non-profit developments accounted for nearly 60% of the pre-2000 units. All programs except public housing increased its supply since 2000, especially inclusionary housing which the City made mandatory in 2002. LIHTC and non-profit developments each accounted for 46-47% of the units placed in service between 2000 and 2015; public housing and inclusionary housing accounted nearly equally for the rest. Overall, twice as many low-income units were supplied between 2000 and 2015 as those before 2000.

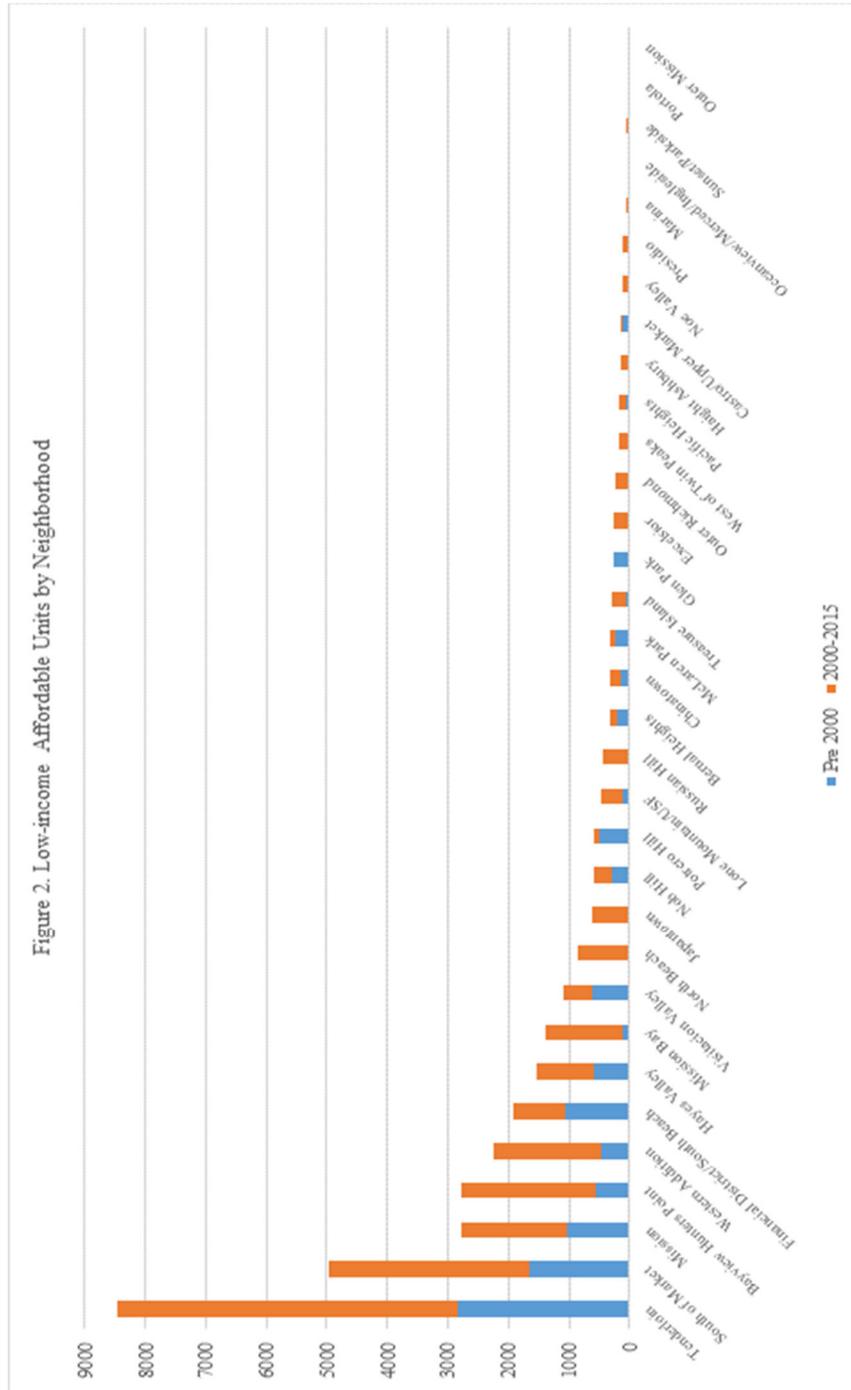
Table 1. Supply of low-income units by programs.

	Buildings	Pre-2000	2000-2015	total
Public housing	270	1,865	692	2,557
LIHTC	141	2,691	10,747	13,438
Non-profit development	272	6,511	10,464	16,975
Inclusionary housing	54	8	697	705
Total	737	11,075	22,600	33,675

The affordable buildings and units, however, are not evenly distributed across the city. As shown in Figure 1, most buildings are located in the east side. Before 2000, Tenderloin, South of Market, Financial District/South Beach, and Mission, in descending order, housed more low-income units than any other neighborhoods. While Tenderloin and South Market remain the top two neighborhoods for low-income units placed in service between 2000 and 2015, Bayview/Hunters Point located in the southeast of the city emerged as the third, surpassing Financial District/South Beach, and Mission. Neighborhoods such as Japantown and North Beach had no low-income units before 2000 but a meaningful number between 2000 and 2015. Results from global Moran’s I,

calculated using building locations and different weights, suggest that the pre-2000 units are more spatially clustered (Moran's $I = 0.31$) than the 2000-2015 units (Moran's $I = 0.23$). The pre-2000 buildings are highly clustered in neighborhoods with similar median household income (Moran's $I = 0.93$) and proportion of low-income households (Moran's $I = 0.85$). In contrast, buildings placed in service between 2000 and 2015 are located in neighborhoods with a greater variety of income (Moran's $I = 0.45$) and proportion of low-income households (Moran's $I = 0.36$). Overall, low-income housing in the city is still moderately clustered as of 2015, but compared to 2000, it is much more geographically dispersed and in neighborhoods with greater diversity. This indicates the possibility of reduced clustering of low-income households.

Figure 2. Low-income Affordable Units by Neighborhood

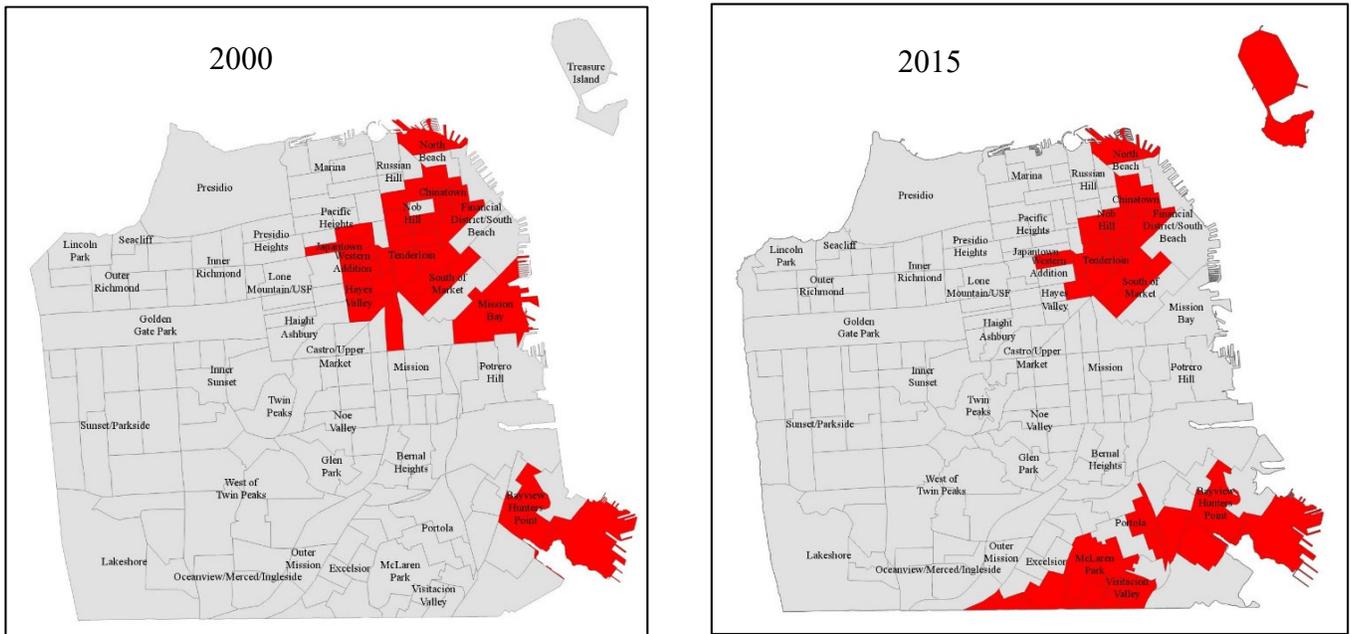


SPATIAL CLUSTERING OF LOW-INCOME HOUSEHOLDS

The proportion of low-income households in the city changed little from 2000 to 2015 – 45% in 2000 and 47% in 2015. Global Moran's I, which is 0.52 in 2000 and 0.46 in 2015, suggests that low-income households are not randomly distributed but moderately clustered in the city. Indeed, the proportion of low-income households in a census tract ranged from 14.3% in Seacliff to 94.7% in Chinatown in 2000; and from 15.8% in Petrero Hill to 95.3% in Bayview/Hunter's Point in 2015 if Golden Gate Park is excluded. Given that twice as many low-income units were placed in service between 2000 and 2015 when compared to those before 2000, and the newly supplied units are located in more diverse neighborhoods, we hypothesize that citywide residential segregation of low-income households decreased between 2000 and 2015. In other words, greater geographic dispersion of low-income households is expected.

Global Moran's I, 0.52 in 2000 and 0.46 in 2015, supports our hypothesis - while low-income households remain clustered in the city, the clustering, moderate in strength, has decreased. LISA results, however, raises some questions. Figure 3 shows the high-high clusters in 2000 and 2015. Though the two maps overlap, they are markedly different. In 2000, there were four low-income clusters. The largest was centered around Tenderloin and consisted of Chinatown, Financial district/South Beach, Japantown, and part of Western Addition, Hayes Valley, and Mission. The other three clusters, located in North Beach, Mission Bay, and Bayview/Hunter's Point, respectively, were much smaller in comparison. By 2015, the Tenderloin – Chinatown cluster remained a stronghold, but it had shrunk in size by losing tracts in Nob Hill, Mission, and Hayes Valley. The cluster in Mission Bay was gone. Meanwhile, the cluster in Bayview/Hunter's point had grown much bigger. Nearby, a new cluster emerged in the south edge of the city to consist of McLaren Park, Visitation Valley, and Excelsior. Treasure Island, separated from the main land of the city, had 33.5% low-income households in 2000 but 75.5% in 2015.

Figure 3. Low-income household clusters in San Francisco in 2000 and 2015.



DISCUSSION

The change in the spatial distribution of low-income housing and that of low-income households has several indications. First, affordable housing placed in service between 2000 and 2015 cannot be the reason behind the spatial change in low-income clustering. As shown in Section 3, nearly 40% of the low-income units placed in service between 2000 and 2015 were located in Tenderloin and South Market. In contrast, only 10% were added in Bayview/Hunter's Point; Visitacion Valley, McLaren Park, Treasure island, and Excelsior together accounted for less than 5%. Despite this, Tenderloin – South Market cluster shrank while Bayview/Hunter's Point cluster expanded. Meanwhile, McLaren Park/ Visitacion Valley/Excelsior emerged as a new cluster. Apparently, the location of newly added low-income units cannot explain this change. There must be other drivers.

Gentrification is one possibility. In the last 20 years, the transit hubs and new medical centers built in Mission Bay has transformed it into a neighborhood with more public services and amenities, thus attracting wealthier households to move in. Its proportion of low-income households dropped from 63.2% in 2000 to 40% in 2015. Similarly, development of luxury water-front properties and proximity to city center transformed North Beach to another gentrified neighborhood. In comparison, Bayview/Hunter's point, McLaren Park, and Visitacion Valley are post-industrial neighborhoods much further away from the city center and have much less resources in public transit, healthcare facilities, employment opportunities, availability and quality of neighborhood services. Housing in these neighborhoods are among the least expensive in the city, they thus attract low-income households who want to remain in San Francisco but with very limited budget. While this study did not include Section 8 data, it is likely that market forces and personal choices have led voucher holders toward the least expensive neighborhoods

even though, in theory at least, they may live in any neighborhood of their choice in fair rental market. Unsurprisingly, such neighborhoods are at the outskirts of the city and lack amenities. By moving to such neighborhoods, low-income households will have to spend much more time to commute to their jobs and access public services. According to Mazzella (2017), people living in the outer edge of the city need to spend 35% more time in the morning and 200% more time in the evening to travel by public transit to a healthcare facility providing care to the uninsured and individuals with subsidized health insurance.

We have thus reached the conclusion that, though low-income clusters are indeed more geographically dispersed in 2015 than in 2000, we cannot be certain that increased dispersion translates to better equality in resource sharing and social integration. It is possible that the predicament of low-income households has worsened in 2015 than in 2000 despite the efforts to site new affordable housing units in more diverse neighborhoods.

CONCLUSIONS

The social, physical, and economic characteristics of a neighborhood impact its residents in myriad ways (Chetty, Hendren, and Katz 2016). Soaring gentrification in San Francisco since 2000 has made housing affordability a serious concern, especially to low- and moderate-income households. Strategic placement of affordable housing developments and voucher holders in certain neighborhoods may reduce residential segregation and provide upward mobility opportunities to low-income households. In this study, we analyzed the spatial distribution of affordable housing in San Francisco in 2000 and 2015 to determine its impact on residential segregation of low-income households.

Using descriptive and spatial statistics, we have found that project-based low-income affordable housing continue to cluster moderately in the city, but the clustering strength decreased slightly. Twice as many low-income units were placed in service between 2000 and 2015 as those before 2000, and these newly added units are located in neighborhoods with a greater variety of median household income and proportion of low-income households. Meanwhile, low-income households are more geographically dispersed in 2015 than in 2000, indicating the probability of successful reversion in residential segregation. LISA analysis, however, reveals that the increased dispersion was achieved by low-income households shifting from gentrifying downtown to outskirts neighborhoods which have the least expensive housing in the city. The location of the low-income housing placed in service between 2000 and 2015 cannot explain the shift, because the majority of the newly added units are not located in the newly-emerged or expanded low-income clusters. Considering that these neighborhoods are mostly post-modern industrial neighborhoods with much less amenities, increased geographical dispersion of low-income households does not seem to indicate better equality in resources accessibility. In fact, overrepresentation of low-income households in these neighborhoods could possibly destabilize these neighborhoods particularly if they are weaker or declining already and create new areas of poverty and social isolation.

On the other hand, gentrification has brought changes to all neighborhoods in the city. While low-income households may remain disadvantaged when compared to other economic classes, it is also possible that, compared to themselves before 2000, low-income households now have better access to resources and opportunities. Along this line, a direction for future research is to examine neighborhood changes, especially those in low-income clusters, in terms of crime, the quality and availability of public services, residents' access to market goods and services, and neighborhood conditions to determine whether the gap between low-income clusters and the rest of the city has narrowed.

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