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Concentration or diffusion? Exploring the emerging spatial dynamics of poverty distribution in Southern California

Abstract: While urban poverty has been known to be spatially concentrated in inner city areas for a long time, the degree of poverty concentration has declined substantially since the 1990s, whereas poverty has increasingly expanded to suburban areas to which relatively little attention has been paid. This study examines how poverty distribution has changed in the Los Angeles-Long Beach Combined Statistical Area and why. More specifically, an investigation is made to capture the detailed changes of poverty rates in over three thousand census tracts over the last two decades and to identify the major forces behind these spatiotemporal changes by employing spatial regression models. Results show that high poverty areas have stretched over space, not in a way that expands their overall size but in a way that increases the degree of spatial fragmentation throughout the last two decades. The results also reveal that neighborhood poverty change is largely shaped by wealth clustering and other spatially-explicit processes.

Key words: Neighborhood change; Poverty distribution; Wealth clustering; Southern California

Introduction

Recent decades have witnessed a dramatic change in the distribution of poverty within large metropolitan areas in the United States. During the 1990s, poverty in inner city areas became notably less concentrated (Berube & Frey, 2002; Jargowsky, 2003). Instead, poverty has expanded to suburban areas, particularly inner- and middle-ring suburbs with certain characteristics of housing and built environments (see e.g., Holliday & Dwyer, 2009; Lee, 2011), similar to what have been found in many metropolitan regions in Europe and elsewhere (see e.g. Randolph & Tice, 2014; Hochstenbach & Musterd, 2018). The number of people living under poverty line in the suburbs of the 95 largest US metropolitan areas had increased by 25% from 2000 to 2008, which was five times faster than the growth rate of inner city areas (Kneebone & Garr, 2010).

This trend has defied the conventional understanding of urban poverty distribution that poverty tends to be concentrated in the centers of large cities (Massey & Eggers, 1993; Frey & Fielding, 1995), but the newly emerging pattern has often failed to attract public attention or timely policy response. Although a handful of studies have explored these recent changes in poverty distribution and provided some useful insights into the phenomenon, still little is known about how the spatial distribution of poverty has evolved over time in contemporary metropolises, what factors are behind the change in distribution, and by what mechanisms these factors affect poverty distribution over space. Furthermore, prior research has often overlooked the importance of spatial interdependence that can shape poverty dynamics at a disaggregated geographical level substantially. The lack of understanding (or inaccurate understanding) of

poverty distribution can prevent us from implementing appropriate interventions and result in an inefficient allocation of resources, which in turn aggravates the problem (Gunn, 2017).

To better understand the evolving nature of urban/suburban poverty, this study examines how neighborhood-level poverty distribution has changed from 1990 to 2010 with a focus on the Los Angeles-Long Beach Combined Statistical Area (CSA). More specifically, the present study conducts two sets of spatially-explicit analyses – 1) exploratory spatial analyses and 2) spatial regression analyses – to capture the detailed change patterns over the last two decades and to identify the major forces behind the changes. In doing so, explicit attention is paid to two different theoretical standpoints adopted for explaining neighborhood change dynamics – one focusing on each neighborhood’s evolutionary trajectory; the other highlighting the importance of the relative location/position and spillovers from surrounding neighborhoods. In particular, consideration is given to the possible effects of housing vintage and neighborhood development cycles (Brueckner, 1980; Lucy & Phillips, 2006; Brueckner & Rosenthal, 2009), which can shape household location decisions in a region, and the so-called “endogenous gentrification” (Guerrieri, Hartley, & Hurst, 2013) that can make it difficult for poor residents to stay in the areas adjacent to wealthy neighborhoods, as richer households bid up housing prices to take advantage of living in these places.

The analyses show a complex pattern of changes with an increasing degree of spatial fragmentation, involving the emergence of small poverty concentrations in remote locations and significant poverty reductions in some inner-city neighborhoods. The detected changes appear to be attributable not only to each neighborhood’s development characteristics but also to spatial interdependence between neighborhoods. Specifically, the current dispersion of poverty seems to

be shaped by the forces of wealth clustering and other spatially-explicit dynamics in contemporary metropolitan areas.

The remainder of this article is organized as follows. The next section reviews recent studies on the spatial distribution of poverty and associated factors. The *Study Area, Data, and Methodology* section provides an explanation of the methodology along with a description of the study region, variables, and data used. The exploratory analysis and spatial regression results are then presented in the following two sections, respectively. The last section concludes the article with a discussion of the major findings and their implications.

Literature Review

A great deal of scholarly attention has been paid to the spatial distribution of poverty. While early research tended to focus on poverty concentration in urban cores, more recent studies have broadened the scope of analysis and investigated the changing patterns of poverty distribution. This section provides a review of studies exploring recent poverty change dynamics and forces behind the changing geography.

Recent Poverty Change Dynamics

As briefly mentioned above, poverty is no longer a problem unique to inner city areas. The last two decades have witnessed a dramatic transformation of poverty distribution. With the emergence of large-scale redevelopments, inner cities are not a synonym for poverty concentration anymore; instead, they have increasingly attracted middle and upper-middle classes in recent years. At the same time, a considerable number of poor residents have out-

migrated to places further from the city cores. However, not many studies have analyzed this recent transformation of poverty distribution in a systematic fashion, and in particular, only a handful of studies have looked at poverty patterns through a disaggregated-level (e.g., census tract-level) investigation, which can give us a more complete understanding of the detailed changes in poverty distribution that have taken place recently.

The changing geography of poverty is a central focus of these studies, which has often been investigated by juxtaposing central cities and suburbs. Over the last few decades, the trajectories of urban and suburban poverty have become different from what had been seen in the past. Scholars have detected evidence of poverty suburbanization in many metropolitan regions from the 1990s (Raphael & Stoll, 2010; Howell & Timberlake, 2014; Kneebone & Nadeau, 2015; Allard, 2017). This trend of poverty suburbanization may have reduced central cities' economic burden, and some poor residents who moved to mid- or high-income suburbs have been better off with greater access to jobs and opportunities (Covington, 2015). However, Covington (2015) also noted that about 40 percent of suburban poor population lived in low-income areas and that the trend has generated new poverty concentrations in suburban locations. In fact, poor residents in low-income suburbs would be even more struggling than their counterparts in urban neighborhoods due to limited available support or services for the poor in these areas compared to inner cities (Kneebone & Nadeau, 2015).

Some scholars have contended that a simple comparison of urban and suburban poverty is not enough and that the 'central cities vs. suburbs' dichotomy would prevent us from understanding detailed intra-metropolitan spatial patterns of poverty dynamics precisely (Lee, 2011). In particular, given that suburbs are not a homogeneous group of places, some studies have distinguished inner-ring suburbs from other parts and detected that inner-ring suburbs

presented unique patterns of poverty changes. Inner-ring suburbs are unique in many ways: “They must cope with aging housing, school systems, and infrastructures along with declining incomes and an over-reliance on property taxes. Furthermore, public policy was mainly developed to aid central cities and has ignored the problems faced by inner-ring suburbs” (Cooke, 2010, p.181). Challenges also arise from difficulties in attracting new investment in competition with other places (see e.g. Lee & Leigh, 2007; Hanlon, 2009). Consequently, increases in inner-ring suburb poverty have been reported in places such as Atlanta, Cleveland, and Philadelphia metropolitan regions (Lee & Leigh, 2007) and Montreal, Canada (Séguin et al., 2012). Results of Cooke’s (2010) study, using the Panel Study of Income Dynamics, also indicated a poverty increase in inner-ring suburbs from 1989 to 1997, whereas outer-ring suburbs did not experience such an increase in the 1990s.

However, it should be stressed that inner-ring suburbs were not the only area experiencing poverty rate increases. Lee (2011) indicated that in the Atlanta Metropolitan Statistical Area from 1970 to 2000, poverty in inner cities and outer-ring suburbs declined during the study period. In contrast, both the inner- and middle-ring suburbs had more clustered poverty with an increasing number of moderate and high-poverty neighborhoods. Similarly, Holliday and Dwyer (2009) suggested that urban poverty was not simply shifting into inner-ring suburbs only. They pointed out that in 2000, about 20 percent of poor census tracts were located in suburban areas, among which only a third of the neighborhoods were inner-ring, implying that a majority of suburban poverty areas were located outside of the inner-ring suburbs.

Drivers of Poverty Change Dynamics

What drives such patterns of poverty changes? Scholars have explored a range of factors that operate at different scales from various theoretical perspectives. For instance, Séguin et al. (2012) highlighted the importance of globalization, economic restructuring, and changes in government policies as major factors that could shape the spatial patterns of poverty distribution in metropolitan areas. Others suggested that residential segregation, decentralization of employment opportunities, and the resultant spatial mismatch between low-skilled jobs and inner-city minorities could be largely associated with spatial patterns of poverty dynamics (see e.g., Kasarda 1989, 1990; Massey & Denton 1993; Jargowsky 1997; Kraus, 2004).

Our knowledge, however, about the reasons behind the current dispersion of poverty is limited. One could explain this from an ecological perspective stemming from the Chicago school (Burgess, 1925; Hoyt, 1939). In other words, poverty expansions outside inner cities would be a result of evolutionary process of diffusion. Although previously poverty was concentrated in the inner cities, poverty concentration has moved out towards areas that are close by, mostly referred to as inner-ring suburbs (see e.g., Lucy & Phillips, 2000; Orfield, 2011). However, it is difficult to answer why the dispersion became so obvious in the last two decades, while the changes had not taken place at the same rate earlier. Furthermore, Holliday and Dwyer (2009) suggested that the new emergence of suburban poverty cannot be simply explained by the expansion of inner-city poverty as the ecological theories suggest. Instead, poor suburban neighborhoods had shown quite distinct characteristics from the poor neighborhoods in inner-city areas. They also reported that major poverty determinants and their impacts also differed between inner-city and suburban areas.

Neighborhood-level poverty change dynamics can also be explained by place stratification theories putting emphasis on the importance of “structural sources of inequalities ...

[and] structural impediments to residential assimilation, which include mechanisms of both public and private discrimination” (p.244, Logan & Alba, 1993). Although those who have lived in high-poverty neighborhoods desire to move into locations with more opportunities and resources, there are structural barriers often associated with race/ethnicity as well as economic class that prevent these moves. Therefore, low-income households, particularly underrepresented minority groups, are likely to stay in relatively disadvantaged neighborhoods and thus aggravate poverty concentration problems (Crowder, 2000).

The recent trend of poverty expansion to suburbs, however, can motivate us to question whether these structural barriers have weakened or operated in a new way under the influences of other factors/forces. It has been reported that the degree of racial segregation in newly developed locations can be smaller than that of inner cities or previously developed areas due to factors such as rapid housing supply and “relative lack of a history of who lives where” (p.347, Pfeiffer, 2012a). One could also attribute the recent trend to various forms of government intervention, such as urban renewal or regeneration initiatives, Moving to Opportunity, HOPE VI, and other programs to relocate or replace public housing services, while a single factor would not completely explain what has happened over the last two decades.

Valuable insights can be drawn from some studies in the urban economics/planning literature that place emphasis on the importance of housing vintage and neighborhood development cycles. Brueckner (1980) provided an early theoretical exploration of the role of residential succession dynamics in creating irregular patterns of the spatial distribution of different income groups that took place in reality, which cannot be explained by static urban models effectively. More recently, Brueckner and Rosenthal (2009) again contended that static models would not allow us to fully understand the real dynamics of neighborhood evolution and

its significant implications for household distribution in an urban landscape. By developing a dynamic model with explicit consideration of neighborhood housing cycles, the authors tested their hypothesis that “the usual positive association between income and distance may be weakened or reversed after controlling for the effect of dwelling ages” (p.726) and found adding a control for dwelling age variation “reduce[d] current central-city/suburban income differentials by up to 10 percentage points, holding constant other factors” (p.727). The significant role of housing (or subdivision) vintage has also been reported by other recent studies, such as Lucy and Phillips (2006) and Bitter (2014). More specifically, according to Lucy and Phillips (2006), it is important to pay attention to the decade in which housing was built “rather than treating housing age from new to old ... in a roughly linear direction” (p. 170) given the uniqueness of each decade in terms of housing design, development location and neighborhood layout. The authors reported that there has been an increasing tendency for neighborhoods specialized in pre-1940 housing to prosper economically compared to neighborhoods dominated by residential development in the 1950s or 1960s for multiple reasons related to housing/neighborhood development cycles. Housing units built in the 1950s and 1960s were generally small in size and lacked air conditioning or other structural/design features that are necessary for comfortable living by current standards. Furthermore, the post-war (1950-1960s) neighborhoods were typically “designed as single-use, residential-only districts, where walking to other functions and activities was difficult” (p. 174, Lucy & Phillips, 2006).

Such dynamics can make the process of poverty (re)distribution complex and require a careful investigation of the spatially-explicit poverty change. Turbulent real estate investment patterns in contemporary metropolitan areas can affect where poor households are eventually located or are forced to be located, given their limited financial or socio-political capacities.

Rapid gentrification in selected core areas can push them out, while exclusionary land use regulations in suburban communities may keep limiting their location choice options. It is important, however, to note that the evolution of poverty distribution can significantly vary across regions or time periods. In the case study of the San Francisco Bay Area, for instance, the forces of racialized restructuring and real estate market dynamics resulted in a distinct pattern of change that can be better understood when the metropolis was divided into multiple zones with consideration of the history of development rather than a binary core-versus-periphery classification (Schafran & Wegmann, 2012; Schafran, 2013). In Southern California, although not completely different, the process may have been largely shaped by “the region’s rapid housing construction [particularly in exurban Inland Empire locations and] relative lack of a history of who lives where” (p.347, Pfeiffer, 2012a).

The so-called endogenous gentrification (Guerrieri et al., 2013) also provides a clue to understanding the dynamics of neighborhood-level poverty changes. While other researchers have focused on each neighborhood’s evolutionary trajectory, recent poverty change dynamics can be better explained as a spatially-dependent process. Traditionally wealthy neighborhoods tend to have high-quality services and amenities and generate a substantial amount of positive externalities, including good access to better education (Durlauf, 1993; Baum-Snow & Hartley, 2016). When housing demand increases, areas that are in close proximity to these wealthy neighborhoods can have a more rapid appreciation in housing prices (Guerrieri et al., 2013). As a consequence, poor people who are no longer able to afford the housing cost increase may be involuntarily pushed out. This implies that locations close to wealthy neighborhoods can have a larger decline in poverty rates than areas that are farther away from the wealthy neighborhoods

and during this process, wealth clustering can take place, while poverty is redistributed over space.

It is important to note that poor individuals' residential relocations can occur due to various reasons both voluntary and involuntary. In addition to the possible moves induced by the gentrification process mentioned above, poor households move through various dispersion or mobility programs, some of which are known to be voluntary (see e.g., Goetz, 2002; Thomas Kingsley, Johnson, & Pettit, 2003; Gans, 2010; Ruel, Oakley, Ward, Alston, & Reid, 2013) or due to their life events or preferences (see e.g., Fitchen, 1994; Clark, 2010). "However, the boundaries between involuntary and voluntary (or self-) segregation are not hard and fast. People with limited incomes—even those in the middle class—are not choosing their residences entirely voluntarily ... In fact, no social being, animal or human, has completely free choice of where to live" (p.354, Gans, 2008). Nevertheless, all these moves are likely to contribute to the dynamics of poverty distribution in contemporary metropolises and deserve policy attention.

Study Area, Data, and Methodology

To examine the dynamics of poverty distribution in contemporary urban space, in this study, consideration is given to the Los Angeles-Long Beach CSA, which consists of five counties in Southern California: Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties. While the region has kept growing (and it is now home to over 17 million people), poverty rate has increased and remained high. Even though it experienced a poverty rate decline in the 2000s, Los Angeles still has a higher poverty rate than any other big cities in the U.S. (Bergman, 2016)

and is regarded as the “capital of poverty” (The San Diego Union-Tribune Editorial Board, 2016). It has also been reported that minorities in this region have increasingly moved from core areas to the Inland Empire for more affordable housing and other reasons in recent years (see e.g., Pfeiffer, 2012b).

For this large study region encompassing over three thousand census tracts, poverty patterns are measured decennially at a neighborhood scale between 1990 and 2010. More specifically, both 1990 and 2000 poverty data for each census tract within the two counties are compiled using the Geolytics’ Neighborhood Change Database (NCDB), which provides a wide range of Census information based on a consistent 2010 tract boundary definition.¹ For 2010, the American Community Survey’s (ACS) 5-year estimates (2008-2012) are directly obtained from the U.S. Census.

To understand how poverty distribution has changed recently within the study area, this study first analyzes the tract-level poverty clustering patterns in each decennial year by computing the Anselin’s Local Moran’s I and Getis-Ord Gi spatial statistics in ArcGIS. These two analyses enable us to identify statistically significant high- and low-poverty clusters and thus give helpful information as to how the spatial pattern has evolved over the last two decades. In exploring the patterns revealed through the statistics, multiple rings are created to spatially group the tracts and capture the poverty distribution changes in the study area in a more systematic manner. As shown in figure 1, these rings are partitioned based on the distance to downtown Los Angeles (Central Business District – CBD) that is falling in the middle of large areas with high poverty rates.

<< Insert figure 1 about here >>

¹ The original sources of information are Census 1990 and 2000.

In addition, multivariate regression analyses are conducted to determine what leads to neighborhood-level poverty rate changes from 1990 to 2000, from 2000 to 2010, and from 1990 to 2010. In doing so, to handle the spatial dependence among neighborhoods, spatial error and spatial lag models are employed and compared in order to determine which model specification works better and obtain meaningful insights from the outcomes of the model estimation with better performance.

For the spatial error models, we have:

$$y = X\beta + \varepsilon, \quad \varepsilon = \lambda W\varepsilon + \delta$$

where, y refers to tract-level poverty rate changes in each time period (i.e., 1990-2000, 2000-2010, and 1990-2010); X and β represent a set of socio-demographic characteristics and locational attributes that can shape the poverty dynamics and their coefficients to be estimated, respectively; W is a spatial weights matrix; λ (lambda) is a scalar spatial error parameter; and δ is an error term which is assumed to be uncorrelated and homoskedastic. For the spatial lag models, we have:

$$y = \rho W y + X\beta + \mu$$

where ρ (rho) refers to a spatial autoregressive parameter; and μ is a conventional iid error term.

Once estimated through a maximum likelihood approach, the models can reveal the associations between poverty rate changes (y) and a set of potentially influential (independent) variables (X). For each model, the independent variables are constructed in the initial year, i.e. 1990 values are used for the models explaining the poverty change from 1990 to 2000, such that the outcomes of the analyses can be applied in an inferential and predictive way. Given that poverty dynamics tend to have different patterns among inner cities, suburbs and outskirts (as mentioned in the *Literature Review* section), a variable of the (logged) distance from each census

tract to the central business district (*Distance.CBD*) is included to explore the association between the census tract's relative location and its poverty dynamics.

Furthermore, a spatial lag of median household income (*Spatial.Lag.HH.Income*) is constructed and tested in the regression analysis. The spatial lag variable is the weighted average of the neighboring values of a census tract computed based on a queen contiguity weights matrix. Through examining the relationship between poverty change and the spatial lag household income, we expect to show how wealth clustering, which is known to generate significant influences on local housing price dynamics (Guerrieri et al., 2013), can shape the evolution of poverty distribution. As discussed in Guerrieri et al. (2013), living close to wealthy areas can bring benefits, such as low crime rates, high-quality public services, and other amenities. These consumption externalities can attract more affluent (or middle-class) households, reduce the affordability of housing in nearby areas, and thereby make it difficult for low-income families to keep living there.

Consideration is also given to housing vintage and neighborhood development cycles. More specifically, the following four proportion variables are included to capture when each neighborhood was primarily developed and how the development timing/history is associated with poverty change dynamics over the last two decades: *Built.Before.1939.Share*, *Built.1940-1949.Share*, *Built.1950-1959.Share*, and *Built.1960-1969.Share* (see table 1 for the description of these variables). As mentioned in the previous section, each decade had distinct patterns of housing design and formation of built environments, making it more appropriate to use these variables all together than a single housing age metric (Lucy & Phillips, 2006).

In addition to the aforementioned variables, several socio-demographic indicators are deemed to be associated with neighborhood-level poverty change. For instance, female-headed

households are likely to have higher poverty rates due to a variety of challenges they have (see e.g., Hanratty & Blank, 1992; Levernier, Partridge, & Rickman, 2000). People with lower-skilled occupations are also more likely to experience poverty, while other occupation groups can function as a predictor of gentrification or poverty decline (Juhn, Murphy, & Pierce, 1993; Acemoglu & Autor, 2011). The percentages of minority populations are also known to be related to poverty rates due to structural barriers that exist in labor and housing markets (see e.g., Smith & Welch, 1986; Kirschenman & Neckerman, 1991). The impacts of foreign-born population on poverty change are not very straightforward but deserve consideration. While immigrants have often been found to live in high poverty neighborhoods due to their limited access to resources and their socio-cultural isolation from the host society, they can build vernacular networks and make unremitting efforts to improve their economic outcomes or achieve spatial assimilation (Chapman & Bernstein, 2003; Jargowsky, 2009). Table 1 summarizes all the variables used in this study with their means and standard deviations.

<< Insert table 1 about here >>

Exploratory Analysis Results

As mentioned in the previous section, an exploratory analysis was conducted with a spatial grouping of census tracts with multiple rings, and the results are summarized in table 2. First of all, from 1990 to 2000, while all of the nine areas (eight rings and the remainder) showed poverty rate increases (in terms of the mean of tract-level poverty rates), the magnitude of increase varied across space. The fifth and sixth ring areas experienced more dramatic increase

rates than other areas: the poverty rate of fifth ring increased by 40.8%, (from 0.074 to 0.105), while other areas showed 11.0~30.4% increase rates, and sixth ring areas showed the greatest amount of increase in terms of absolute change, +3.9 percentage points (from 0.126 to 0.165). This result is largely consistent with previous studies reporting that poverty tended to spread from the core outwards in the 1990s.

<< Insert table 2 about here >>

Basically, this trend of poverty expansion appeared to continue in the 2000s. The first and second ring areas had declining poverty rates, while the seven outer areas (third to eighth rings and the remainder) continued to experience poverty rate increases. More specifically, the mean tract-level poverty rate in the core area had decreased from 0.250 to 0.234. Similarly, that of the second ring areas had decreased from 0.152 to 0.148 during the first decade of the twenty-first century. In contrast, the other areas had poverty rate increases by 10.5% (outermost area, from 0.159 to 0.175) to 19.9% (sixth ring area, from 0.165 to 0.197), showing a clear pattern of poverty expansion into suburban space.

In addition, the Anselin Local Moran's I analysis identified four categories of census tracts: High-High (HH), High-Low (HL), Low-High (LH), and Low-Low (LL), each of which represents a unique cluster/outlier pattern of poverty distribution (Figure 2).² The number of census tracts identified as each category (HH, HL, LH, and LL) in each year was summarized in table 2. In 1990, among 853 census tracts within the core area, 357 tracts were classified into HH, while this area had only four LH outliers and two LL cluster tracts. The number of HH

² An HH census tract indicates a neighborhood that has a high poverty level itself and high-poverty neighbors, comprising a statistically significant cluster of high poverty areas. An HL census tract refers to a high poverty tract (outlier) surrounded by low poverty tracts, while LH (i.e., another type of outlier) represents a low poverty area surrounded by high poverty neighbors. The last category, LL, shows a cluster of low poverty neighborhoods.

tracts in the core declined substantially during the two decades—decreased by 3.9% (from 357 to 343) from 1990 to 2000, and further decreased by 28% (from 343 to 247) from 2000 to 2010. On the contrary, the number of LL tracts had increased from 2 to 18 in the 1990s, while it dropped to 15 in the 2000s. As shown in figure 2, the newly identified LL tracts were located in the greater Pasadena area, which is known as an affluent place having new light-rail stations in the 2000s (Bernhardt, 2014; Kim & Houston, 2016).

<< Insert figures 2 about here >>

Unlike the core area, other zones had a relative larger number of LL census tracts. Most of the eight outer areas showed a similar pattern of change in terms of the number of low poverty clusters (LL category): increased or remained similar during the first decade (1990s) and decreased in the 2000s (e.g., 200 – 222 – 151 in the case of the third ring), while the sixth ring area showed a significant decrease in the 1990s. However, these areas differed from one another in terms of high poverty clusters (HH tracts). The second ring had shown a 50% increase (from 64 to 96) between 1990 and 2000, but the number of HH tracts decreased back to 61 in the 2000s. The high poverty clusters in the third ring area remained 13 in the 1990s, but declined to 4 from 2000 to 2010. In contrast, more HH census tracts seemed to appear in outer areas, and the new clusters were seen to be located in or around Palmdale, Victorville, and San Bernardino.

A closer look would reveal that poverty change is a spatially dependent process, in which a certain tract's poverty status is likely to be influenced by the economic characteristics of its neighbors. For instance, the Hancock Park area shown in figure 3 (Neighborhood A, Tract #06037211000) is a historically affluent neighborhood in the City of Los Angeles. In 2000, this neighborhood was not identified as any of the four categories mentioned above, although it showed a very low poverty rate (0.064 compared to the regional average of 0.156), because its

neighbors did not have a clear high or low value pattern (with an average rate of 0.113). In 2010, the Hancock Park neighborhood was newly identified as a Low-Low cluster as its neighbors had a significant poverty reduction during the 2000s (with an average rate of 0.082). One could view this case as an example of wealth clustering (or the so-called endogenous gentrification – Guerrieri et al., 2013) that can take place in urban areas.

Another neighborhood in figure 3 (Neighborhood B, Tract #06037980006) showed a similar transition. In 2000, the poverty rate of the neighborhood (located in the City of Hawaiian Garden) was much higher than the regional average (0.291 compared to 0.156), but it was surrounded by relatively wealthier neighbors with an average poverty rate of 0.074 and thus was identified as an extreme High-Low outlier. From 2000 to 2010, this neighborhood experienced a substantial decline in poverty rate by 44.7%, maybe due to its close proximity to low poverty areas.

<< Insert figure 3 about here >>

The bottom section of table 2 showed the mean of the Getis-Ord G_i^* spatial statistics for each zone, where a larger absolute value of the G_i^* score indicates a more significant clustering of high or low poverty. The result is generally consistent with that from the Anselin Local Moran's I analysis in the sense that the high poverty neighborhoods were mostly clustered in the core area, although the trend was decreasing over decades (i.e., from 1.295 to 1.220 in the 1990s, and from 1.220 to 0.950 in the 2000s). The second ring had a modest level of poverty clustering in 1990, but the concentration has gradually disappeared. In contrast, the sixth ring showed a significant increase in high-poverty clustering over the last two decades (from 0.173 to 0.233 in the 1990s, and to 0.428 in the 2000s), emerging as a high poverty location in Southern California. Other ring areas, except the outermost zone, were more likely to have relatively low

poverty levels. To be more specific, their mean values ranged from -0.012 to -0.476 in 1990, and they showed a similar trend, that is, they all had a more significant low-poverty clustering between 1990 and 2000, but the degree of clustering became weaker from 2000 to 2010.

Spatial Regression Results

Multivariate regression was also conducted to further analyze the factors behind changes in poverty distribution. Ordinary Least Squares (OLS) was found to result in spatially auto-correlated residuals. Therefore, two widely used spatial regression approaches– i.e., spatial error and spatial lag models – were used to examine the poverty dynamics in the study region, as explained in section *Study Area, Data, and Methodology*.

The two spatial regression approaches were compared in order to determine which model performed better through a likelihood ratio test (see e.g., Cliff & Ord, 1972). The results of the test suggested that spatial error models performed better, although spatial lag models could also improve the OLS estimation results. In addition, the pseudo R-squared values from the models indicated that spatial error models could explain a larger extent of variation. Furthermore, the residuals from spatial error models no longer showed statistically significant autocorrelation. Thus, this section will mainly discuss the results from spatial error models, while the estimation outcomes from spatial lag and OLS models are also presented in table 3.

<< Insert table 3 about here >>

Model 1 examined what factors shaped changes in poverty distribution from 1990 to 2000. Results showed that poverty rate changes were significantly associated with poverty rates

in the initial year (1990), that is, a census tract with a higher poverty rate in 1990 tended to have a decreased value in the following decade, indicating a tendency of convergence. The racial/ethnic composition of neighborhoods were likely to influence poverty dynamics: among Whites, Hispanics, and African Americans, the shares of Hispanics and African Americans both showed significantly positive associations with poverty rate changes, which is to say, with all other factors constant, a neighborhood with a larger share of Hispanic or African American population was more likely to have an increase in poverty. In addition, some other socio-economic attributes were found to play an important role in determining poverty change as well. Specifically, a census tract tended to have an increased poverty rate from 1990 to 2000, if it had a higher percentage of renter-occupied housing units, more foreign-born people, a smaller proportion of young population in 1990, and a longer distance to the CBD. Additionally, the spatial error coefficient (i.e., λ) was found to be significant, suggesting the presence of spatial interdependence.

More importantly, housing vintage and neighborhood development cycles appear to matter in determining neighborhood-level poverty change dynamics in the 1990s. Specifically, the proportion of housing units built before 1940 showed a negative effect on neighborhood poverty rate changes, consistent with the findings of Lucy and Phillips (2006). According to Model 1, a higher percentage of the housing units built in the 1940s and 1950s also exhibited a negative association, suggesting that these neighborhoods tended to have a relative poverty decline during the 1990s in the Los Angeles-Long Beach CSA.

Furthermore, the spatial lag of median household income (*Spatial.Lag.HH.Income.90*) showed a significant, negative effect on poverty changes. In other words, holding all other variables constant, a census tract surrounded by wealthier neighbors in 1990 tended to attain a

poverty rate decline in the following decade. On the other hand, poverty tended to be intensified in the areas where their neighbors were generally poor in the beginning year. That is to say, there has been a sort of wealth clustering process operating at this scale, and this process significantly shaped the way poverty distribution changed in Southern California. It is important to note that adding this variable (*Spatial.Lag.HH.Income.90*) to the model improved the model's explanatory power significantly.

Model 2 investigated a more recent trend from 2000 to 2010. To some extent, its results were similar to those from Model 1, even though the new decade differs from the 1990s in many respects. The mean tract-level poverty rate in the beginning year (year 2000) had a significant, negative impact on poverty rate changes. This result, consistent with Model 1, suggested a trend of convergence that low poverty areas were more likely to experience an increased poverty rate. In addition, similar to Model 1, the result showed that a poverty rate increase was associated with a larger share of Hispanic population, a higher renter-occupied housing ratio, a longer distance to CBD, and a smaller share of housing units built between 1950 and 1959. Furthermore, the spatially lagged household income variable again showed a significant effect on poverty dynamics in this period of time, suggesting the importance of spatial dependence.

However, there were some notable differences. The shares of African American population, foreign born population, and young population turned out to be less significant in Model 2 compared to their impacts in the 1990s. Similarly, the share of housing units built before 1940 or between 1940 and 1949 was not influential in explaining poverty change between 2000 and 2010, whereas these variables were significant in the case of Model 1. Additionally, the 2000 unemployment rate exhibited a significant, positive association with poverty change from 2000 to 2010, suggesting that labor market dynamics became more influential in this period of

time. While still significant, the magnitude of lambda in this model was found to be much smaller than that for the 1990s.

An additional exploration was conducted through Model 3, which investigated poverty changes from 1990 to 2010. Similar to the other two models, long-term poverty rate changes were significantly associated with initial poverty rates, spatial lag of median household income, share of Hispanic population, share of renter occupied housing units, and share of housing built before 1959. The long-term poverty change was also found to be influenced by the share of African American population, a pattern detected in Model 1. However, in this case, the influence of foreign-born population turned out to be insignificant.

Discussion and Conclusions

This study examined how poverty distribution has changed in the Los Angeles-Long Beach CSA and why. More specifically, it attempted to capture the detailed changes of neighborhood-level poverty rates over the last two decades through an explorative analysis using spatial statistics. Spatial regression was also conducted to reveal forces behind the poverty distribution changes in the 1990s (where poverty started to be less concentrated compared to previous decades) and the 2000s (in which the Great Recession took place, while poverty rates had declined quite substantially during the first seven years of the decade) with careful consideration of housing vintage effects and various forms of spatial interdependence that can play a part in determining neighborhood-level poverty dynamics.

The exploratory analysis suggested that poverty was spreading out from the core to the inner-ring suburbs and more remote locations, with areas that were 40-60 miles away from the CBD showing the most significant poverty increases. In general, the two decades showed a similar pattern in that high poverty areas had stretched over space, not in a way that expanded their overall size but in a way that increased the degree of spatial fragmentation, indicated by the emergence of small poverty concentrations. A close look into the pattern, however, suggested that intra-metropolitan poverty change dynamics are far from a simple diffusion process. Rather, the dynamics could be better explained when consideration is given to socio-economic forces, some of which were newly emerging in contemporary metropolises where structural sources of segregation and stratification are prevalent. While one could argue that the long-standing poverty concentration in inner city areas has started to disappear, the new reality seems to pose significant challenges to some suburban communities, particularly those with limited resources, and thus requires more attention from researchers and policy makers.

It should be stressed that some notable differences were detected between the two decades examined. For instance, the second ring area experienced an increase in the number of high poverty clusters (HH) from 1990 to 2000, but that number decreased during the next decade. Results also showed that the number of low poverty clusters (LL) had increased or at least remained similar in many zones during the 1990s, but that count dropped substantially in the 2000s.

Differences were also seen in the multivariate regression results. Unemployment rates, for instance, showed a more substantial influence on poverty dynamics in the 2000s when the economy underwent dramatic restructuring. In contrast, larger shares of minority and foreign-born population groups showed a higher association with poverty increases in the 1990s, which

could be a result of structural barriers that prevented these groups from getting access to high-quality neighborhoods, as suggested by place stratification theories. Additionally, the share of housing units built before 1940 showed an insignificant impact on neighborhood-level poverty rate changes in the 2000s, whereas this variable was significant in the 1990s model consistent with Lucy and Phillips' (2006) study, indicating temporal variation in the influence of housing vintage on the rise and fall of neighborhoods.

More importantly, neighborhood poverty change itself is not an independent, self-reinforcing process. The results of spatial regression analyses suggested that neighborhood-level poverty dynamics were highly dependent on the conditions of their surroundings. It was found that a neighborhood's poverty change was highly associated with that of its surroundings, indicated by significant, positive spatial lag and error coefficients. Furthermore, proximity to wealthier people appeared to play a significant role in shaping poverty dynamics in the 1990s and 2000s, which can possibly be explained by the attraction of middle-class households into areas adjacent to affluent neighborhoods where they can take advantage of some unique amenities and positive externalities. Although this endogenous gentrification process may have resulted in positive changes within some neighborhoods, it can be a threat to the well-being of low-income residents that triggers involuntary relocations.

The patterns and determinants of poverty distribution revealed from the spatial analyses may indicate that the poverty dynamics in contemporary urban space are increasingly shaped by forces that gather wealthier households together and push out the poor. These forces seem to create a complex distribution of poverty within a metropolitan area, which cannot be simply explained by the distance to CBD any longer. The findings also raise a concern of rising income segregation and displacement. Future research may tackle the emerging patterns of poverty

dynamics with more explicit consideration of their connection to displacement, segregation, and other important urban phenomena and provide further lessons for planners and other policy makers concerning these problems all together.

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