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Spatial inequality of housing value changes since the financial crisis

Han Li [a,b], Yehua Dennis Wei [c,*]

[a] Department of Geography and Regional Studies, University of Miami, Coral Gables, FL, 33124, USA
[b] School of Economics & Management, Nanchang University, Nanchang, Jiangxi, 330031, China
[c] Department of Geography, University of Utah, Salt Lake City, UT, 84112-9155, USA

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ABSTRACT

The financial crisis has dramatically reshaped the map of inequality; in particular, wealth has been redistributed because of fluctuations in the prices of equities and housing. However, since the explanation of this issue has by default been seen as economists' responsibility, the spatial dimension of the financial crisis still remains unexplored, especially at the intra-urban level. This study examines the local geographies of the housing value bust (2008–2012) and boom (2012–2016) since the financial crisis, with an explicit emphasis on their impacts on urban inequality in Salt Lake County, Utah. We find that housing value changes differ across space and appear strongly associated with the spatial distribution of neighborhood conditions and urban amenities. Additional regressions confirm that a city's housing market volatility is amplified by uneven distribution of physical and service amenities and residential segregation. Moreover, the significance level of local attributes changes over the bust-boom cycle of the housing market. The comparison between bust and boom models suggests that the value of houses enjoying shade from trees and proximity to jobs, places of worship, and good public schools are more resilient, experiencing less value drop in an economic bust, but also less increase in a boom. Other amenities such as public transport, hospitals, parks, and restaurants could be interpreted as types of discretionary consumption, which positively contribute to housing value volatility. Neighborhood conditions, especially white-Hispanic segregation, significantly contribute to housing value fluctuation. Hispanic communities in Salt Lake County tend to experience more loss of property value in a bust and gain more in a boom. Thus, our study suggests that a more balanced urban distribution of employment, races, and amenities would significantly enhance local economic stability by smoothing fluctuations of business cycles at the local level.

1. Introduction

The financial crisis of 2008 was characterized by housing market volatility which has drastically increased wealth inequality and reshaped the map of urban inequality globally (Wei, 2015; Wisman, 2013). Also, since housing is the main financial asset for most households and many jobs are related directly or indirectly to the real estate sector, economic instability caused by recent swings in housing values and housing-related employment have resulted in even more severe macroeconomic and microeconomic consequences. Therefore, changes in housing values over time and across geographic areas have drawn substantial scholarly interest.

A rich body of literature, dominated by macroeconomic studies, has explored determinants of the booms and busts of housing prices in the United States. Such factors as business cycles, income growth, industrial production, employment rate, interest rate, money and credit supply, and global liquidity have been linked to housing-value changes in United States cities (Goodhart & Hofmann, 2008; Leung, 2004; Panagiotidis & Printzis, 2015). Also, institutional factors such as adjustments and changes of financial regulations and policies, as well as cultural factors like American obsession with home ownership, have been used by social scientists to explain price fluctuations in the U.S. housing market (Andrews, 2010; Dolde & Tirtirorglu, 2002). However, only a few studies have emphasized geographical variables, mainly at the international (Adams & Füss, 2010) and national levels (e.g., Hossain, 2007; Kakes & End, 2004; Mcgibany & Nourzad, 2004), as well as sub-national levels such as census regions and states (Gallin, 2006; Kuethe & Pede, 2011; Miller & Peng, 2006). The connections between the global financial crisis and residential segregation and the uneven distribution of physical and service amenities at the intra-urban level have rarely been investigated (Martin, 2011).

On the other hand, at the intra-urban level, current literature has

* Corresponding author.
E-mail addresses: han.li@miami.edu (H. Li), wei@geog.utah.edu (Y.D. Wei).

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been confined to the spatial variation of housing prices and its association with local attributes (Bruecker et al., 1999; Li, Wei, Yu, & Tian, 2016). Nevertheless, neighborhood attributes have rarely been linked to the changes in housing values. Only Cho, Kim, and Roberts (2011) find that consumers' marginal willingness to pay for a water view, developed open space, or wooded land decreased during the 2008 recession compared to the 2000–2006 real estate boom. Other kinds of amenities have rarely been examined. Moreover, while a few previous models have identified which amenity has the most significant effect on housing prices (Tian, Wei, & Li, 2017), the significance level of amenities and other local attributes may change over a bust-boom cycle in the housing market. Using housing value changes as dependent variables offers an innovative way to re-identify the temporally varying significance of amenity factors and to answer the question of which amenities are less discretionary.

Due to high fertility rates and growth of net in-migration of the Hispanic population, the urban spatial structure of Salt Lake County has been dramatically reshaped by suburbanization and urban sprawl since the 2000s (Wei, Xiao, Simon, Liu, & Ni, 2018; Wei, Xiao, Wen, & Wei, 2016). Although Utah historically has been less racially diversified, immigration has led to greater diversity. The majority of immigrants constitute an economically vulnerable minority, who tend to be less prepared for economic recessions. Hispanics formed the largest minority group in 2010 and accounted for 18.3% of the total population in 2017 (U.S. Census Bureau, 2001, 2018). Moreover, most of the Hispanic community is concentrated in the western part of Salt Lake County. Given the highly uneven ethnic distribution and race-oriented residential segregation, a better understanding of the spatial patterns and dynamics in home-value changes has become increasingly significant for social and economic stability.

This paper integrates multiple data sources, from assessed property values to open data, to investigate the geographical patterns and dynamics of single-family home value changes separately over the economic bust (2008–2012) and boom periods (2012–2018) in Salt Lake County, Utah. We aim to address the research question of how business cycles affect local urban inequality by altering people's residential preferences with respect to local amenities and services, as well as neighborhood conditions. Specifically, what are the geographic patterns of housing-value change in Salt Lake County? How did this spatial configuration change over the bust-boom period as regards residential segregation and the uneven distribution of jobs, service facilities, and natural amenities?

2. Literature review

Because housing is the most important asset for most households in developed countries, smoothing business cycles' influence on the housing market has been a top priority to U.S. macroeconomists for a long time (Case & Shiller, 1994). Thus, a large body of literature has investigated how national and subnational level housing markets and the macroeconomy have intertwined (e.g. Agnello & Schuknecht, 2011; Case & Shiller, 2004; Cohen, Coughlin, & Lopez, 2012; Leung, 2004). The growth of GDP (gross domestic product) and related variables have been examined (Davis & Heathcote, 2005). Scholars have pointed out that the growth of GDP has become increasingly significant for the housing market, especially over the short term (Adam & Fuss, 2010; Madsen, 2012). The interrelated relationship between GDP and the housing market has generated studies on how the housing market and the business cycle are correlated. The evidence derived from Greece, Spain, UK, as well as the United States, has consistently demonstrated that residential investment leads the cycle, whereas non-residential investment lags behind (Igan, Kabundi, Simone, Pinheiro, & Tamirisa, 2011).

Accordingly, cyclical variables, such as taxation and interest, have been widely related to the housing price change. Preferential tax treatment, such as subsidies and tax deductions, apparently encourages housing investments and further elevates a boom of housing prices (Andrews, 2010). Financial variables such as interest rate, money supply, global liquidity, and credit supply have been found related to housing-price changes across counties in the United States (Kennedy & Andersen, 1994). Mishkin (2007) argues that an increase in the interest rate can negatively affect the housing market in several ways, especially by increasing the user cost of capital and lowering expectations for future movements of prices. Other factors like income growth, industrial production, and employment rate have also appeared to be strongly interrelated with the boom and bust of housing prices (Hwang & Quigley, 2006).

The financial crisis in 2008 has turned scholarly attention from the traditional cyclical variables to collateral factors. Economic analyses have appeared to explain the presence of a housing price bubble, with an emphasis on the effects of policy and institutional implications. The failure of the banking system, especially regarding reckless lending and the invention of new instruments to fund that lending, the problem of financial globalization, as well as the lack of regulatory controls over the banks, have been seen as the primary causes of the financial crisis (Soros, 2009; Whalen, 2008).

Such studies are largely dominated by macroeconomists, who focus on the national level and sub-national level and aim to identify differences across countries, states, and metropolitan areas, whereas the literature on local geographies of housing price change is less developed (Martin, 2011). Moreover, due to the lack of local-level studies of housing price change, the microstructure of financial crisis and non-market interactions, such as the neighborhood effects and urban amenities, are under-explored (Leung, 2004). As there is an increasing tendency for both population and economic activities to cluster in cities, understanding housing market fluctuations at the intra-urban level will significantly contribute our knowledge of micro and spatial dynamics of housing price changes, and of the explanation of the financial crisis from the bottom.

At the intra-urban level, the current literature has explored the spatial variation of housing prices, as well as its relations with local attributes, especially amenities and neighborhood conditions (Bruecker et al., 1999). Evidence shows that the level of air pollution is negatively associated with property values in US metropolitan areas (Tian et al., 2017). Studies have also reported that urban green space provides aesthetic and natural amenities to homes and neighborhoods, thereby leading to an increase in housing prices and property values (Nilsson, 2014). In addition, previous research has shown a strong connection between school quality and households' location choice, especially if residents have school-aged children (Black & Machin, 2011).

Other neighborhood factors also affect housing prices. Variables such as median household income, unemployment rate, and education level are important factors in residential choices (Chen & Lin, 2011; Li et al., 2016). Residents with comparable socio-demographic characteristics have similar preferences for housing and communities. For example, high-income white households may choose to overpay in order to live in exclusive neighborhoods (Glaeser & Gyourko, 2005).

However, such local attributes have rarely been linked to housing market resilience and housing value changes. Previous models sought to answer the question, to what degree do various amenities and public services affect housing prices and place attractiveness, by comparing the magnitudes of coefficients. However, the significance levels of amenities and other local attributes may change over the boom-bust cycle of the housing market. The literature has demonstrated that declining housing prices combined with an economic recession adversely affect consumers' financial decision-making due to their decreased wealth and disposable income. Consumers tend to reduce expenses by purchasing lower-quality products, postponing purchases, or changing lifestyles (Barnes, 2007; Parker & Vissing-Jorgensen, 2009).

Only a few studies have considered how the value of amenities varies between boom and bust periods. Lee and Linneman (1998) suggest that the value of proximity to Seoul's greenbelt increased between 1970 and

1980 but declined between 1980 and 1989. Smith, Poulos, and Kim (2002) point out that as the stock of undeveloped land declined in North Carolina, the value of proximity to vacant land became statistically significant. Cho et al. (2011) find that consumers' marginal willingness to pay for a water view, developed open space, or wooded open space decreased during the 2008 recession compared to the 2000–2006 real estate boom.

Niedomysl (2010) proposes a hierarchical structure to categorize amenities and services sociologically into three groups: needs, demands, and preferences. Needs refer to basic requirements, while demands are non-negotiable factors that must be fulfilled. Preferences can be regarded as desirable but not strictly necessary. Elasticities also differ across these three groups. For instance, attributes such as the number of bedrooms, access to a good school district, or employment opportunities are likely grouped into the need or demand level. Considering houses as a good, these attributes could be identified as non-discretionary consumption (Rappaport, 2008; Wood, 2005). On the other hand, characteristics such as more bathrooms and proximity to parks and restaurants are discretionary and not absolutely necessary. These different functions and their varying degrees of reproducibility suggest that non-discretionary and discretionary amenities are valued differently across the bust and boom of a business cycle. As a result, it is not surprising that the values of amenities behave differently over time.

The role of neighborhood conditions may also follow the hypothesis mentioned. Existing literature has demonstrated that poor minorities are the most vulnerable social groups during a financial crisis and the bust of housing prices in the United States. There has been a long tradition of urban sociology focusing on the inequality of housing prices and residential segregation (Dwyer & Lassus, 2015; Hall, Crowder, & Spring, 2015). Neighborhoods characterized by low income, predominance of minority populations, and weak educational attainment tend to have a higher level of subprime loans (Allen, 2011; Hyra, 2013). Kim and Cho (2016)'s paper demonstrates that properties in neighborhoods with a higher percentage of Hispanics are more likely to be sold quickly in the financial crisis. Their findings suggest that minority neighborhoods tend to experience more property loss and foreclosures in the bust period, largely due to the predatory lending (Engel & McCoy, 2008).

As to the boom period, only a few studies have been conducted, and they focused on the experiences of Midwest metropolitan areas. They have concluded that single-family houses in African American neighborhoods are more likely to experience fewer price increases in the boom (Immergluck, 2008). However, the situation might be different for Latinos. Kuebler and Rugh (2013) point out that there are no significant differences in levels of homeownership between whites, Asians, and Latinos in the United States, from 2000 to 2010. Instead, socioeconomic status is the major contributor to the ethnic disparities of homeownership between Latinos, white and Asians. From 2012 to 2016, Latinos in the whole country, especially Western cities such as Salt Lake City, Denver, and Phoenix have enjoyed increasing incomes and on average have been significantly uplifted above the poverty line. At the same time, studies also have shown Hispanics have a unique enthusiasm for homeownership, and thus the Hispanic segment has become the majority of home buyers since 2012. Thus, the properties in a Hispanic neighborhood are more likely to have increased more than ones in a white-dominated community (Hyra, 2013; NAHREP, 2017).

This study has the following three motivations. First, the studies on the boom-bust cycle of the housing market are dominated by economic studies from a macroeconomic perspective, at the national and sub-national level (Leung, 2004; Martin, 2011). Few studies have examined the role of locational factors in explaining significant housing price swings under the booms and busts. The local geographies of housing price change, especially at the intra-urban level are less studied. Second, the effects of amenities and other external attributes on housing price distribution are largely temporally fixed. The question of how the prices of amenities behave throughout the bust-boom cycle remained unanswered. Temporally varying effects could be used to classify urban amenities into non-discretionary and discretionary groups, which would reflect that they correspond to different levels of homebuyers' needs. Last, methodologically comparison of different amenities' significance is limited by potential flaws in the modeling process, such as standardization, elasticity calculation, and the measurements of amenity factors. Using housing value changes as dependent variables could be an effective way to re-identify the significance of different amenity factors, which would address the question of which amenities are more discretionary.

3. Data and methodology

3.1. Study area and sampling

Salt Lake County, the main part of Salt Lake City metropolitan area, is one of the fastest-growing areas in the U.S. During the period of 2008–2016, its total population increased 7.16% from 1.019 million to 1.092 million, which was nearly 1.2 percentage points higher than the national average (U.S. Census Bureau, 2018). According to the assessor's data, there were 223,749 single-family homes in Salt Lake County in 2008. The number declined to 223,521 in 2012 and then increased sharply to 258,507 in 2016. Due to the limitations of our computing capacity, we followed Li et al. (2016) in systematically and randomly selecting samples for our analysis. In order to ensure that selected houses properly represent the study area and provide enough information on the distribution of single-family home values, we randomly selected 10% of detached houses from each census tract. After deleting outliers that have extreme values in housing prices, as well as and houses that have been rebuilt and remodeled, we were left with 20,944 observations in our sample.

3.2. Regressions

We adopted three types of regression in this study: ordinary least squares (OLS), spatially lagged model (SLR) and geographically weighted regression (GWR). The OLS equation (Eq. (1)) is as follows:

$$Y = C + X\beta + \varepsilon \cdot \varepsilon \sim N(0,\ \sigma^2 I) \quad \text{(Eq. 1)}$$

In which Y is the change in housing value, C is the constant, β is the parameter for explanatory variable X, ε is the error term.

Spatial effects have drawn considerable attention in housing studies because of the existence of housing submarkets and residential segregation (Li et al., 2016; Yu, Wei, & Wu, 2007). To examine the underlying spatial autocorrelation in housing value changes of Salt Lake County, global Moran's I test has been conducted. The test values are 0.556 for the bust period over 2008–2012, and 0.244 for 2012–2016, which indicates the need for the application of spatial econometrics. Moreover, the Lagrange-multiplier (LM) test additionally suggests the need for a spatial lag model (SLR). The spatially lagged model can be expressed as (Eq. (2)):

$$Y = \rho Wy + X\beta + \varepsilon \cdot \varepsilon \sim N(0,\ \sigma^2 I) \quad \text{(Eq. 2)}$$

In this equation, Y is the change in housing values, X is the explanatory variables, β represents the parameters of explanatory variables. Wy is the spatial lag operator, a weighted average of random variables at neighboring locations. In which, W is a 20944 × 20944 spatial weights matrix of these cities, y is a 20944 × 1 vector of observations of the random variable, ε is the zero-mean error term with common variance σ^2, and ρ is the autoregressive and moving average parameter.

In addition, we utilized the geographically weighted regression (GWR) to measure the complex local variation of regression parameters. In its most basic form, the GWR model takes the following equation (Eq. (3)):

$$Y_i = C_i + \sum_k \beta_{ki} X_{ki} + \varepsilon_i \quad \text{(Eq. 3)}$$

In Eq. (3), Y_i is housing value change to be regressed, C_i is constant, β_{ki} is the parameter for the explanatory variable X_{ki} $(k = 1, 2, 3 \ldots n)$, ε_i is the error term. We employed the Gaussian distance-based adaptive kernel function to maintain a certain number of nearest neighbors as local samples to ensures the degree of spatial heterogeneity.

3.3. Variables and data sources

3.3.1. Dependent variable

Variables were integrated from the open data source of Yelp.com, and multiple departments from local governments. The inflation fixed housing value changes of 2008–2012 and 2012–2016 at the parcel level reported in U.S. dollars were employed as dependent variables. We used the tax assessor's data for 2008, 2012, and 2016 to extract housing value changes in Salt Lake County for several reasons. First, although there have been studies pointing out that long-term residents might receive lower assessments (Li et al., 2016), the assessed value still can reflect a fair market price, and therefore have been widely used in housing and urban studies (Tian et al., 2017). Second, Utah is a nondisclosure state where property transactions are considered private and confidential, and thus most information concerning property transactions is not available for public access. Also, the transaction data cannot provide valuable information every year for each single-family house, which means transaction data cannot provide a whole picture of local housing market volatility. Thus, most research studying housing value change in the United States is based on assessed value (Bin & Landry, 2013; McKenzie & Levendis, 2010).

More importantly, adopting the tax assessment data maintains spatiotemporal consistency (Wu, Wei, & Li, 2019). The Salt Lake County Assessor's Office has maintained a consistent standard in evaluating housing value, which helps ensure the analytic integrity of our study. Although open data sources such as Zillow.com and Lianjia.com have become more and more popular in recent housing studies (Li, Wei, Wu, & Tian, 2019, Li, Wei, & Wu, 2019), housing values from tax assessors' offices are the only available dataset which can provide the historical data of housing values and property structural characteristics at the same time, which allows us to delete the houses that have been rebuilt during 2008–2016 to avoid the outliers caused by structural remodeling.

3.3.2. Independent variables

Definitions and data sources of independent variables included in this study are given in Table 1. We adopted three levels of independent variables: regional level factors focusing on accessibility of jobs, neighborhood external attributes such as public transit facilities, service amenities and socioeconomic conditions, as well as structural characteristics at the household level.

At the regional level, we included the number of producer service firms within 5 miles of the home and the percentage of regional employment that can be reached within 20 min by automobile. Both datasets were provided by the Wasatch Front Regional Council (WFRC) but are available only for 2010. Previous studies in Salt Lake County and other US cities have shown that homebuyers are likely to pay more for better accessibility to jobs (Li et al., 2016). However, the consistency of the job-accessibility factor's performance through a business cycle has never examined.

Regarding local factors at the neighborhood level, we turned our attention to service facilities, which have been widely corroborated as having a significant influence in previous housing price literature. We employed three subcategories of variables: discretionary amenities, non-discretionary amenities, and socioeconomic conditions.

Non-discretionary amenities refer to basic requirements that must be fulfilled, including forest coverage, performance evaluation of the nearest public school and residential services (Black & Machin, 2011). Forest coverage was estimated by neighborhood NDVI (normalized difference vegetation index), which was calculated by the focal function in ArcGIS. The NDVI images were extracted from the Landsat TM images (30 m resolution) in August 2008 and July 2012 by using the ENVI software. The data of Landsat TM images were gathered from the U.S. Geological Survey (USGS). The education data were reported by the Utah State Office of Education (UCAS scores) in 2010 and 2012, which generalized the performance of public schools to a score from 300 to 500, to capture the education attributes. Location of schools was collected from Wasatch Front Regional Council (WFRC) and Utah Automated Geographic Reference Center (AGRC). Residential services were collected by a crawling tool based on JavaScript and Python programming from Yelp.com in 2016. Only the facilities ranked at 3-stars and above were included in this study. Given Salt Lake County's

Table 1
Independent variables.

Explanatory Variables	Definition	Abbrev.	Data Source
Regional Level			
Accessibility to jobs	Number of producer service firms within 5 miles	*NPS*	*Wasatch Front Regional Council*
	Percentage of regional employments that can be reached within 20 min by auto	*PRC*	
Neighborhood Level			
Non-Discretionary amenities	Forest coverage (sum of NDVI)	*NDVI*	*Utah Department of Transportation; Utah Automated Geographic Reference Center; Wasatch Front Regional Council; U.S. Geological Survey; Utah State Office of Education; Yelp.com*
	Performance evaluation of the nearest public school	*PES*	
	Number of worships within 0.5 miles	*NWP*	
	Number of 3-star above residential services within 0.5 miles	*NHS*	
Discretionary amenities	Ln (distance to the nearest shopping center)	*LDSC*	
	Ln (distance to the nearest hospital)	*LDH*	
	Ln (distance to the nearest park)	*LDP*	
	Ln (distance to the nearest golf course)	*LDG*	
	Number of light-rail stations within 0.5 miles	*NTS*	
	Number of fire stations within 0.5 miles	*NFRS*	
	Number of libraries within 0.5 miles	*NLB*	
	Number of 3-star above groceries within 0.5 miles	*NG*	
	Number of 3-star above restaurants within 0.5 miles	*NRest*	
	Number of 3-star above financial services within 0.5 miles	*NFAS*	
Socioeconomic condition	Unemployment rate of the census tract	*UER*	*U.S. Census Bureau*
	Proportion of Hispanic people of the census tract	*PH*	
	Median household income of the census tract	*MHI*	
	Percentage of the residents with a bachelor's degree or above of the census tract	*PB*	
Household Level			
Structural attributes	House value at base year (2008 and 2012, respectively)	*BASE*	*Tax Assessor Office of Salt Lake County*
	Land area (acre)	*LA*	
	Floor area (m^2)	*FA*	
	Number of rooms	*NR*	
	Number of bedrooms	*NBe*	
	Number of bathrooms	*NBa*	
	Number of kitchens	*NKe*	
	House age	*HA*	

Note: Ln is the natural logarithm.

unique religious and cultural characteristics, we categorized worship facilities as a non-discretionary amenity. The places of worship were collected from the Utah AGRC, which was updated in 2011.

To a large extent, current literature has demonstrated that people are likely to pay more for the proximity to discretionary amenities, such as shopping centers and parks (Li et al., 2016; Tian et al., 2017; Wu et al., 2019). Thus, we also included 10 discretionary amenities in modeling. Facilities such as light-rail stations, shopping centers, hospitals, parks, golf courses, fire stations, libraries, groceries, restaurants, and financial services that can be regarded as preferences. The locations of light-rail (TRAX) stations in 2008 and 2012 were collected from the Utah Department of Transportation (UDOT) and complemented by AGRC. Between 2008 and 2012, two additional stops have been added in South Jordan and West Valley City. Limited by the availability of data from Wasatch Front Regional Council (WFRC) and Utah AGRC, locations of shopping centers, hospitals, parks, golf courses, fire stations, and libraries in 2010 were used in both period models. As with residential services, the 3-or-morestar groceries, restaurants, and financial services were obtained from Yelp.com in 2016.

Since the *American Community Survey 5-year Estimates* (U.S. Census Bureau, 2011) only provides the census tract level data after 2009, four factors at census tract level in 2009 (instead of 2008) and 2012 have been added into the model to measure the influence of socioeconomic environment. The unemployment rate, median household income, proportion of the Hispanic population, and percentage of residents who have at least a bachelor's degree were included as proxies for the factors of economic conditions, minority neighborhoods, and the lifetime earning potential.

At the household level, we employed land area, floor area, number of rooms, number of bedrooms, number of bathrooms, number of kitchens, and house age to capture structural attributes of the house. All the spatial interactions and geocoding processes were conducted in the environment of ArcGIS, and all the monetary variables were fixed based on the 2008-level to remove the influence of inflation. It is worth to point out that, due to the availability of data, for some amenities, such as fire stations, libraries, places of worship, shopping centers, hospitals, parks, golf courses, grocery stores, restaurants, and financial services, we cannot prepare different location datasets for 2008 and 2012, which might cause slightly biased result. However, unlike cities in China which might experience a dramatic development and redevelopment process in 4 years, Salt Lake County experienced only moderate development from 2008 to 2012, with a population growth nearly at 62,000. Therefore, we assumed that there were no significant differences in distributions of these amenities between 2008, 2010, and 2012.

4. Housing value changes in Salt Lake County: spatiotemporal characteristics

The 2000s and 2010s were turbulent times for U.S. housing markets. The 2008 financial crisis hit the U.S. housing market hard, but it has rebounded in the last few years, reaching pre-crisis levels in many cities. According to the Federal Housing Financial Agency, U.S. HPI (Housing Price Index) values plunged from 205 in early 2008 to 165 in late 2011 and recovered to 221 in 2016 (Fig. 1). A similar phenomenon has also been found in Salt Lake County. Based on the data from Federal Reserve Bank of St. Louis (2018), the HPI in Salt Lake County declined 20.24% from 155.64 in 2008 to 124.14 in 2011 and then rebounded 30.86% to 162.44 in 2016. Regarding assessed home values, the mean value of single-family houses in Salt Lake County plunged more than 26.67% from nearly $300,000 in 2008 to $220,000 in 2012 and then increased 19.55% to $263,000 in 2016 (Fig. 2). The similar trend and changes between HPI and assessment values suggests that using the change of assessed values can represent the volatility of the local housing market in Salt Lake County.

Geographically, the extent of the housing market's boom and bust in Salt Lake County differs across space and scale. Fig. 3 depicts housing value distributions in Salt Lake County in 2008, 2012, and 2016. Hotspot analysis of the Getis-Ord Gi* statistic was used to provide a better visualization of the clustering of housing value changes, which reflects whether the detached houses experiencing an above-average price increase or below-average price decline tend to be clustered. If a property's price increase is high and the price increases of neighboring properties are also high, it is part of a hotspot. From Fig. 3, one can see that housing market turbulence is more acute in northern and eastern areas than in the county's western and southern areas. Houses in the northern and eastern parts of Salt Lake County are relatively old and have relatively smaller floor and land area, while the southern and western regions have been characterized by the patterns of sprawling development, especially in terms of low level of mixed-use land, newly developed large houses, as well as long commuting time to job opportunities and the traditional CBD area (Li et al., 2016; Wu et al., 2019). Thus, this divided pattern suggests that houses with a smaller size and better access to job opportunities are more likely to experience less price increase in the boom period, and also less price decline in the bust

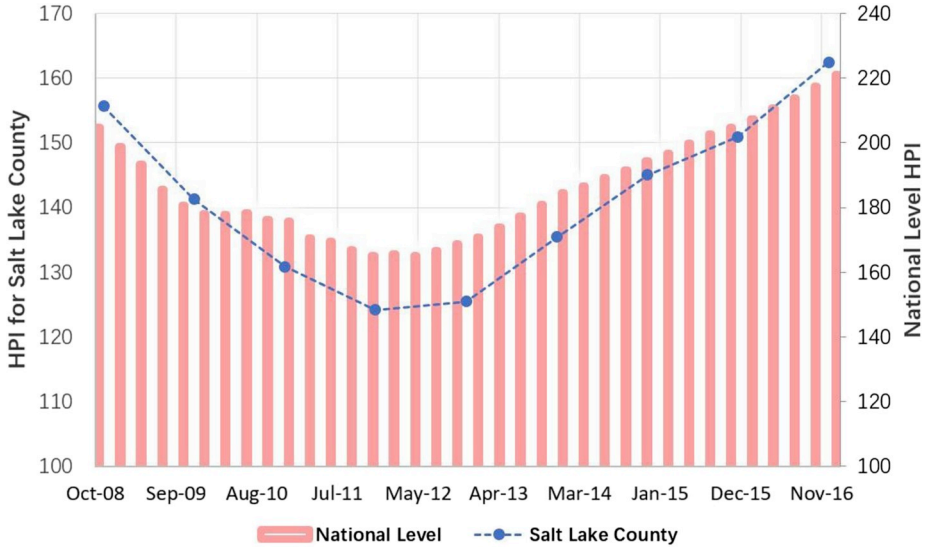

Fig. 1. The Change of U.S HPI values in Salt Lake County and the U.S. from 2008 to 2016 (seasonally adjusted). Source: Federal Housing Financial Agency and Federal Reserve Bank of ST. Louis.

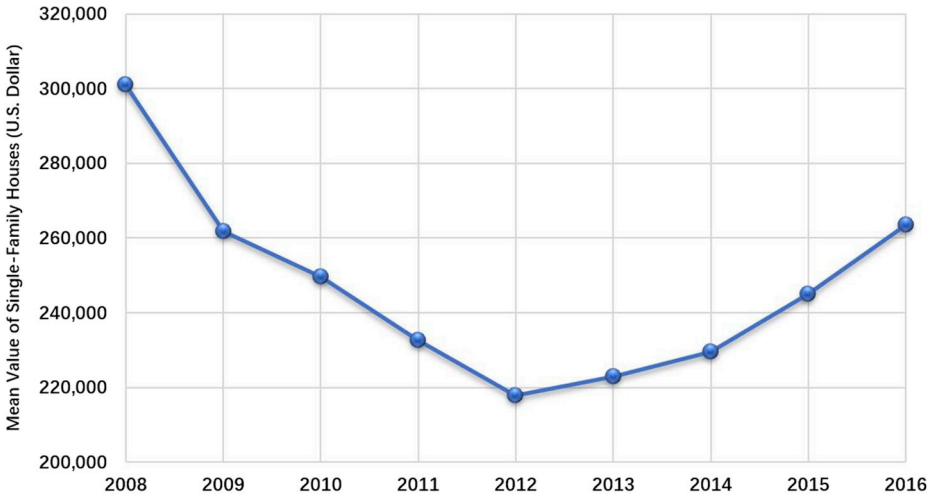

Fig. 2. The change of mean values of single-family houses in Salt Lake County. Note: The inflation is fixed based on the 2008-level. Source: Tax assessor office in Salt Lake County.

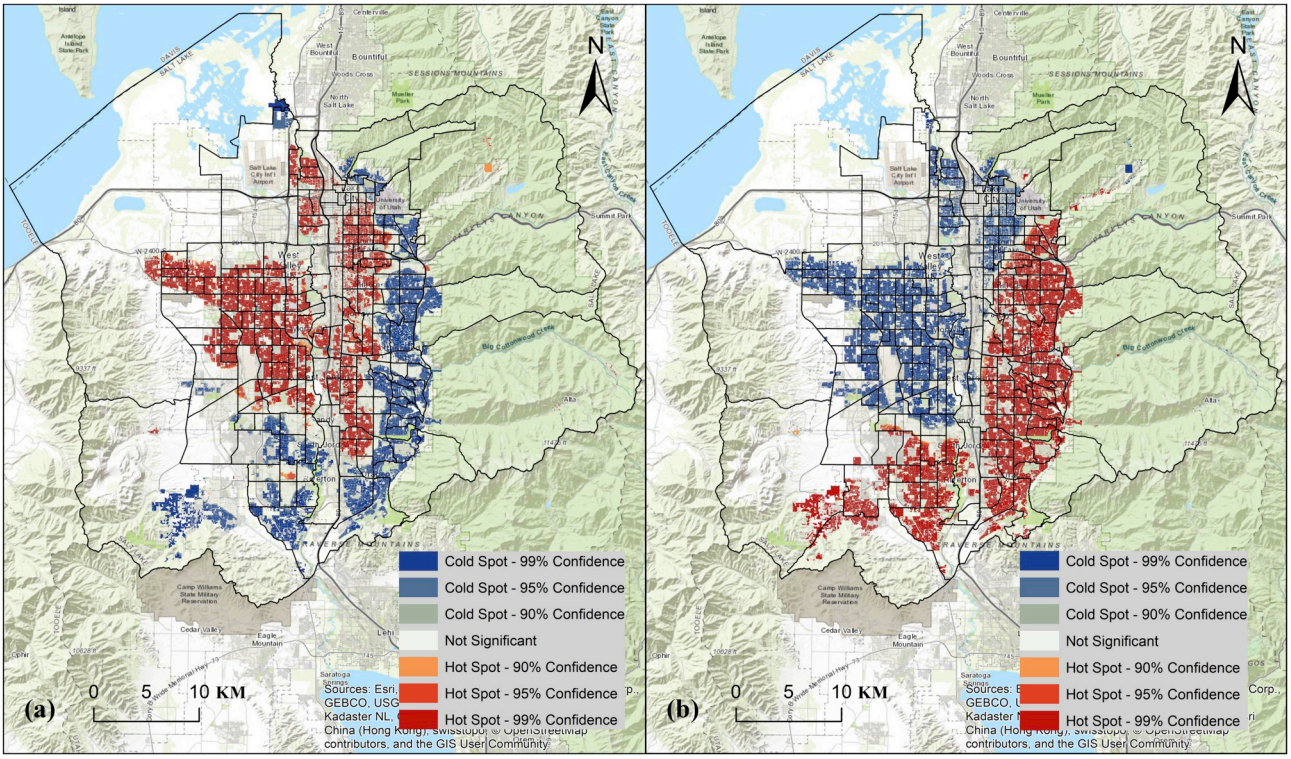

Fig. 3. Hotspot analysis of housing value change in Salt Lake County (a: 2008–2012; b: 2012–2016). Source: Tax Assessor Office of Salt Lake County.

period, while the natural amenities such as mountain view will positively contribute to the house's price-volatility during an economic crisis.

Previous studies have suggested that minority neighborhoods have been hit harder by economic recessions, in which regard houses in minority communities tend to lose more value in a bust period (Allen, 2011). Salt Lake County has shown a similar pattern for the period of 2008–2012. From Fig. 4, one can see that most western census tracts, where the percentage of Hispanic residents was higher than 40%, tended to experience disproportionately greater housing value declines from 2008 to 2012. Similar to African Americans in Midwest cities (Allen, 2011), Hispanic communities in Salt Lake County are more vulnerable to economic crises in terms of losing more property assets in the bust period (Immergluck, 2008; Kim & Cho, 2016).

However, a different pattern appeared for 2012–2016. In contrast to a study on African Americans in Midwest cities (Allen, 2011), Hispanic-dominated communities seemed to gain more during an upturn of the business cycle in Salt Lake County, relative to white-dominated neighborhoods. At the same time, comparing Figs. 3 and 5, we found that the effect of income on resilience is still consistent with previous studies (Hyra, 2013). Low-income communities are obviously more vulnerable to economic crisis, in terms of losing more value in a real estate bust period and obtaining less gain in the boom period.

The contrasting outcomes of Hispanic and low-income neighborhoods in principle could be due to a shift of socioeconomic status of

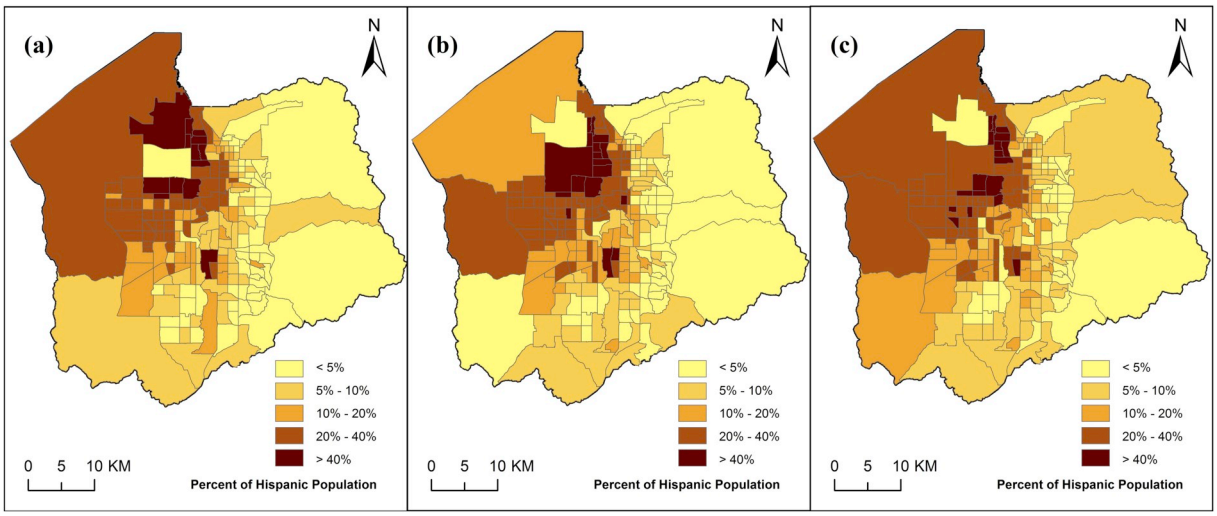

Fig. 4. Percent of Hispanic population at census tract level in Salt Lake County. (a: 2009; b: 2012; c: 2016). Source: U.S. Census Bureau.

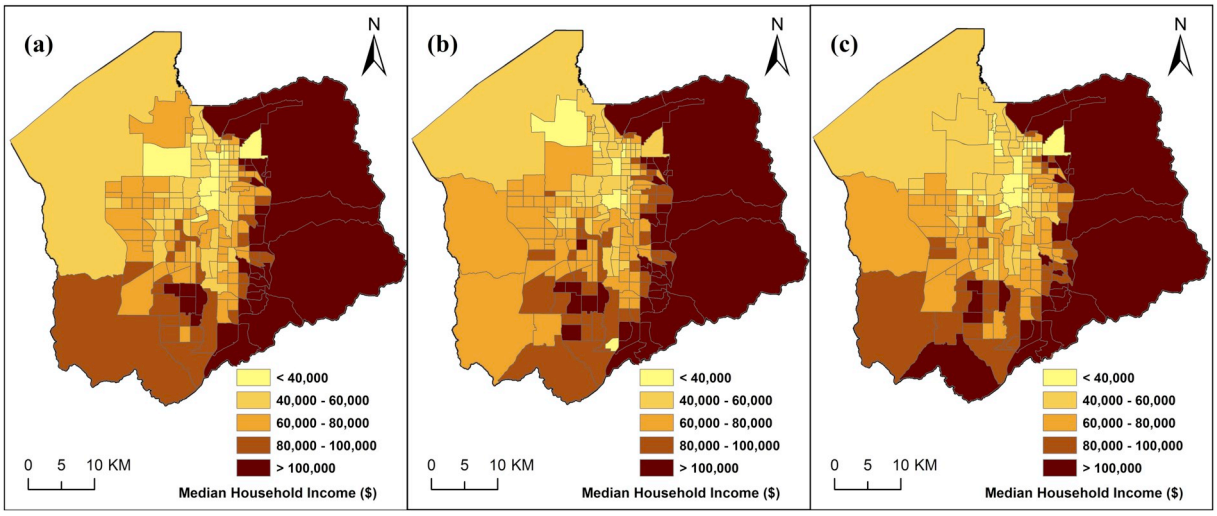

Fig. 5. Median household income at census tract level in Salt Lake County. (a: 2009; b: 2012; c: 2016). Source: U.S. Census Bureau.

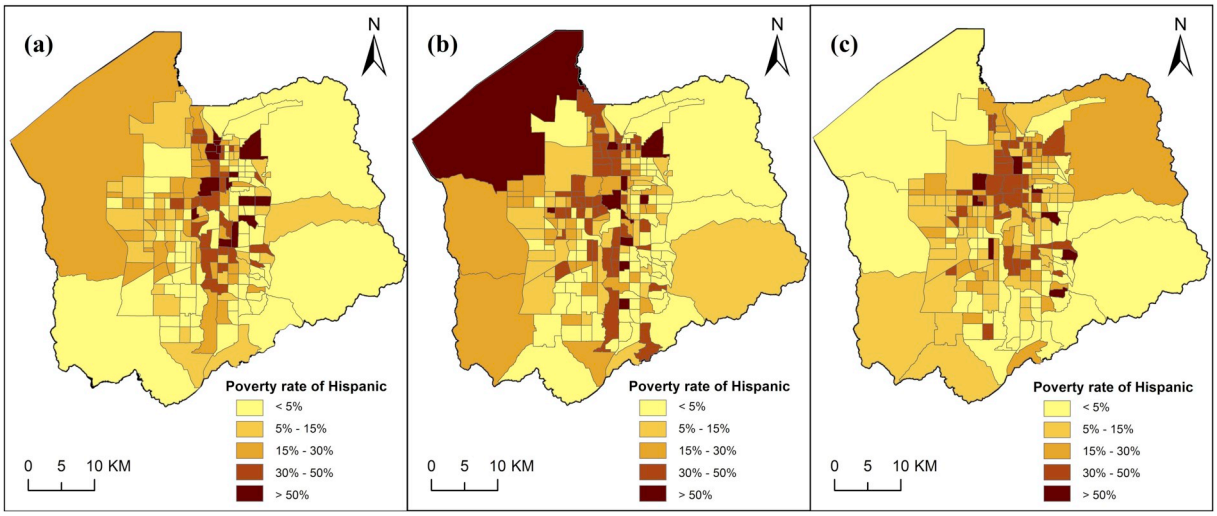

Fig. 6. Poverty rates of Hispanics at census tract level in Salt Lake County. (a: 2009; b: 2012; c: 2016). Source: U.S. Census Bureau.

Latinos in Salt Lake County from 2008 to 2016. Data from the U.S. Census Bureau (2011, 2013, 2016) show that the poverty rate of Latinos in Salt Lake County was 19.15% in 2008, and increased to 23.78% in 2012, but slightly declined to 22.30% in 2016. In order to look more closely at these changes, we mapped the poverty rate of Hispanics at the census tract level for 2008, 2012, and 2016 in Fig. 6. By comparing Figs. 4 and 6, we found the poverty of Hispanic communities has been largely stable during 2008–2012. More interestingly, the traditional Hispanic-dominant regions, such as the northwestern area of the county, have experienced a sharp decline of Hispanic poverty rates since 2012. The shift of economic status for Latinos in Salt Lake County, partly explains why Hispanics gained more in housing value during the upturn period, which also suggests that the influence of neighborhood conditions on housing market resilience is also sensitive to minority ethnicities.

Table 2 demonstrates the housing value change, change rate, and Hispanic population change across municipalities and townships in Salt Lake County. Based on Fig. 5 and Table 2, we can conclude that there is a consistent pattern as regards the role of the Hispanic minority in housing value changes in Salt Lake County. The cities of Bluffdale, Draper, and Riverton, whose population are disproportionately Hispanic, located in the southern area of Salt Lake County, experienced the largest average decline and increase of home values during 2008–2012 and 2012–2016, respectively. All three cities experienced more than a 25% reduction followed by nearly a 25% increase in housing values. In both periods, municipalities with relatively low proportion of Hispanic residents apparently experienced moderate housing value changes, which suggests a positive correlation between a community's proportion of Hispanic population and the volatility of the local housing market.

Fig. 7 shows the distribution of 3-star plus residential services and restaurants in Salt Lake County. In general, residential services appear to have a more balanced distribution than restaurants. Restaurants are primarily distributed along with major roads and concentrated in the shopping centers such as City Creek Center and Sugar House. The differences reflect the potential disparity in the distribution of non-discretionary and discretionary amenities. The discretionary amenities are spatially concentrated. Compared to discretionary amenities, the non-discretionary amenities, such as residential services, are more accessible to residents in Salt Lake County. The houses with better access to discretionary amenities are relatively rarer than houses with better access to non-discretionary amenities. This uneven distribution of discretionary amenities enhances our hypothesis that the significance level of amenities and other local attributes may change over the bust-boom cycle of the housing market.

In short, neighborhoods where housing value declined most acutely in the bust period (2008–2012) also experienced the largest value increase in the boom period (2012–2016). The spatial configuration of housing value changes appears strongly associated with the imbalanced distribution of urban amenities. The houses with higher values and more non-discretionary amenities are more vulnerable to the financial crisis, which fits the hypothesis that non-discretionary consumption has a much more stable price than discretionary consumption in the economic crisis. Also, Hispanics tend to cluster voluntarily and prefer an integrated community, which makes a community with 20%–40% Hispanic population even more attractive to them relative to an all-white neighborhood. Given that the majority of Hispanic neighborhoods in Salt Lake County fall into this range, the concentration of Latinos can be interpreted as discretionary consumption and a positive contribution to housing market volatility. Finally, proximities to discretionary amenities might be a significant determinant of local housing market elasticity.

5. The result of global and local regressions

Our analysis confirms the effects of spatial associations between locational attributes and housing value change in Salt Lake County. In addition, we conducted multiple types of regressions to explore causation. The variance inflation factors (VIF) of all explanatory variables are smaller than 3.5. Ultimately, in the models presented here, no notable signs of multicollinearity appear. The results from the estimations of OLS, SLR and GWR are shown in Tables 3 and 4. The significance of spatial weight (Rho) in SLR, and the significant decrease of AIC from OLS to SLR and GWR indicate that the spatial effect has a substantial influence on housing value change in Salt Lake County. The significant decreases of global Moran's *I* of residuals from OLS to SLR mean that the influence of spatial autocorrelation was controlled. Across all three models, one can see that regional, neighborhood, and household level factors jointly shape housing value change in Salt Lake County. The intercorrelation between housing value changes and urban amenities shows patterns similar to the performance of non-discretionary and discretionary consumption in the business cycles.

Table 2
Average changes of housing values across municipalities and townships.

Municipalities & Townships	Change over 2008–2012			Change over 2012–2016		
	Value	Rate (%)	Hispanic Population	Value	Rate (%)	Hispanic Population
Bluffdale	−185,333	−31.54%	−38	85,772	28.75%	−96
Cottonwood Heights	−111,650	−24.58%	−417	51,510	20.37%	615
Draper	−181,862	−31.64%	−46	74,219	24.29%	386
Herriman	−117,898	−27.40%	563	56,344	24.56%	326
Holladay	−168,480	−24.97%	313	88,419	28.99%	499
Kearns	−53,540	−30.33%	542	32,504	26.04%	912
Magna	−56,029	−30.30%	820	31,539	27.58%	1047
Midvale	−51,418	−22.11%	87	30,537	20.09%	−69
Millcreek	−94,412	−22.28%	258	49,666	20.95%	799
Murray	−52,576	−17.44%	1174	48,544	25.48%	1066
Riverton	−91,501	−27.29%	278	51,757	23.30%	646
Salt Lake City	−70,672	−19.36%	1907	43,233	23.39%	1251
Sandy	−92,728	−25.40%	606	43,405	20.02%	1956
South Jordan	−98,507	−23.91%	785	54,998	20.75%	479
South Salt Lake	−27,230	−14.14%	1557	25,738	21.35%	−1606
Taylorsville	−61,800	−26.81%	2272	38,019	23.86%	310
West Jordan	−70,303	−27.58%	3484	42,259	24.07%	1104
West Valley City	−62,581	−29.75%	7096	34,504	24.08%	8102
White City	−53,555	−25.16%	−54	27,642	17.94%	239

Data Source: U.S. Census Bureau and Tax Assessor Office of Salt Lake County.
Note: The inflation is fixed based on the 2008-level. Since Hispanic population for 2008 is not available in the American Community Survey 5-year Estimates, the 2009-level data were used.

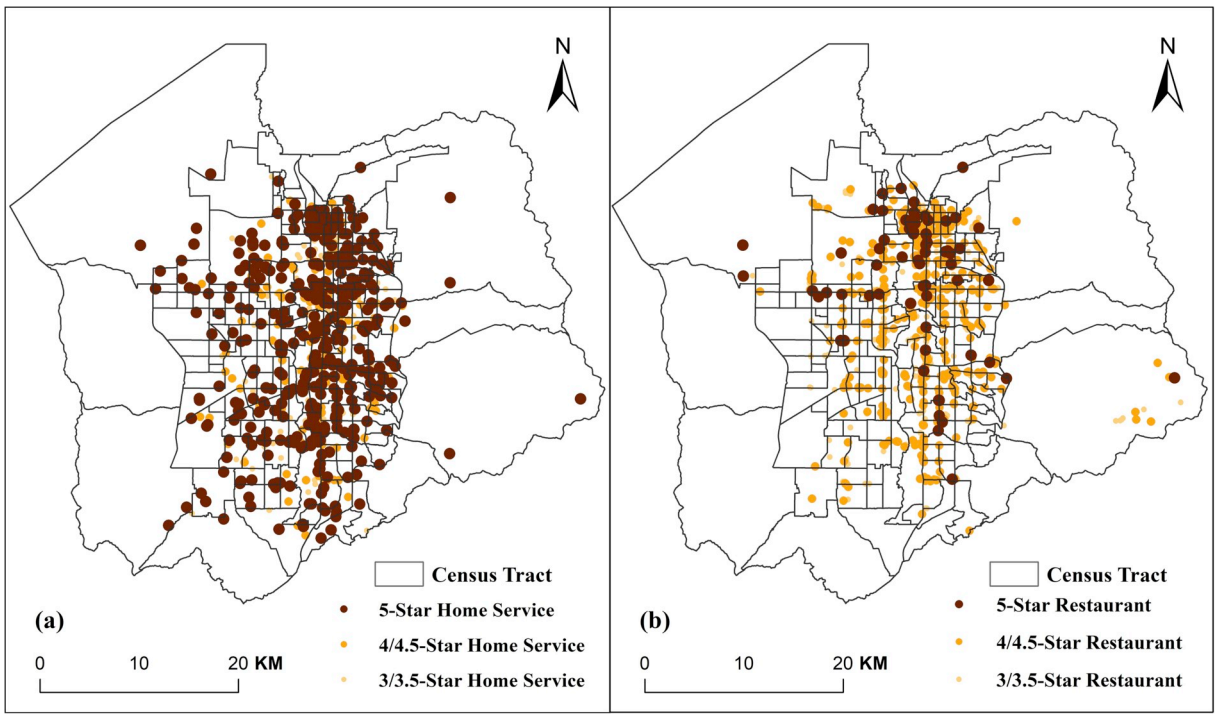

Fig. 7. Home services and restaurants in Salt Lake County. Source: Yelp.com.

5.1. Regional level: accessibility to jobs

At the regional level, we found that the percentage of regional employment that can be reached within 20 min (*PRC*) by auto significantly and positively contribute to the house's economic resilience, while the variable of numbers of producer service jobs within 5 miles has a significantly positive coefficient in the model of 2008–2012, and a negative coefficient in the model of 2012–2016. This means that proximity to employment would help houses retain/increase their value in the bust/boom cycle. Also, people in Salt Lake County are unlikely to sacrifice more time on commuting in exchange for a lower housing expense. To further investigate the spatial heterogeneity of determinants, we conducted an adaptive kernel based GWR and projected distributions of coefficients of *PRC* in Fig. 8. Over the period of 2008–2012, access to producer services has more positive effects on housing market resilience in the southern region of the county, which is a sprawling area with low job density distant from the CBD. During the recovery period of 2012–2016, reachable producer services jobs tended more to have the effect of increasing housing prices in the eastern areas, where the high-income white population is clustered.

5.2. Neighborhood level: amenities

With respect to neighborhood external attributes, consistent with Cho et al. (2011), some amenities, such as proximity to good schools, houses of worship, and residential services, could be categorized into non-discretionary consumption. Houses with access to such amenities will experience less value drop in an economic bust and also less value increase in the boom period. Forest coverage is the only variable that is significantly positive both for boom and bust periods, suggesting that no matter the state of the economy, residents in Salt Lake County are willing to pay more for better forest coverage. On the other hand, accessibility to hospitals, parks, light-rail stations, grocery stores, and restaurants belongs to the category of discretionary consumption. Houses nearby such amenities tend to lose more value in the bust period but will have a higher growth rate over the boom time.

Fig. 9 shows the spatially varying effects of grocery stores. In Sandy, a southeastern city with low density of commercial land-use, grocery stores are more positively correlated with home values' resilience to economic crisis over the period of 2008–2012, which is consistent with previous studies, which found that the effect of an amenity is strongest in the areas where the service providers are scarce (Li et al., 2016). However, it is interesting to find that proximity to grocery stores had a negative effect on housing value increase from 2012 to 2016 in Sandy but had a positive influence in the CBD and eastern areas (Wu et al., 2019). This comparison implies that the effect of discretionary amenities could be amplified by the agglomeration and diversity of services in the boom period.

5.3. Socioeconomic conditions at the census tract level

As regards socioeconomic conditions, our findings are largely consistent with the literature: both median household income and education level are positively associated with housing price changes, in both boom and bust periods (Glaeser & Gyourko, 2005). This means that a neighborhood characterized by upper-tier higher education and income levels will be very attractive to homebuyers. In the bust period, compared to sacrificing forest coverage and proximity to schools, residents in Salt Lake County are more likely to lower their preference to selective neighborhoods and gated communities to curtail housing expenses.

As regards the ethnicity factor, during the bust period, properties in neighborhoods with a higher percentage of Hispanics are more likely to be sold quickly at reduced prices, which is consistent with the existing literature (Kim & Cho, 2016). In contrast to a previous study of Midwest cities (Allen, 2011), in models for 2012–2016, Hispanic variable (*PH*) has a significantly positive coefficient, suggesting that housing values have a sharper upward trend in Hispanic communities relative to white-dominated neighborhoods in a boom period. A recent report of Hispanic homeownership (NAHREP, 2017) finds that Hispanics have contributed 46.5% of net U.S. homeownership gains since 2000, largely due to their increased income and enthusiasm for homeownership. In the areas with substantial growing Hispanic populations, such as Salt Lake County, the Hispanic segment has become the majority of home

Table 3
Regression results: OLS and SLR.

Variables	Coefficients			
	2008–2012		2012–2016	
	OLS	SLR	OLS	SLR
Regional Level: Accessibility to jobs				
NPS	24.46***	19.62***	−16.87***	−17.14***
PRC	201.7***	115.6***	29.75*	64.18*
Neighborhood Level: Non-Discretionary amenities				
NDVI	191.4*	551.4***	592.4**	355.9**
PES	14.8**	6.64*	−4.75*	−1.79**
NWP	450.9**	62.25*	−295.4*	−34.15**
NHS	108.8	−8.23**	−790.5**	−420.9*
Neighborhood Level: Discretionary amenities				
LDSC	82.13	293.6	393.2	−22.84
LDH	−977.5*	−672.9*	1,172*	757.2
LDP	−1,155***	−434.2**	1,525***	752.7***
LDG	104.7	−24.62	297.9	217.9
NTS	−2,106**	−1,133**	4,916***	2,847**
NFRS	−1,629**	−1,528**	−289.6	−138.4
NLB	−481.3	−549.7**	241.3	−11.27
NG	302.7*	−110.5**	27.81	299.2*
NRest	−58.87	−31.7**	320.7***	212.6
NFAS	−1,247***	−894.3**	341.1	224.5
Neighborhood Level: Socioeconomic condition				
UER	13,510*	4,707	−1,643	914.7
PH	−21,800***	−14,141***	15,740***	10,960*
MHI	−0.09***	−0.03	0.05*	−0.02
PB	32,160***	49,808***	−11,580*	−21,414*
Household Level: Structural attributes				
BASE	−0.38***	−0.34***	0.22***	0.18***
LA	900.7	2,701***	3,266	2,692***
FA	−0.17*	−0.11	0.09*	0.04***
NR	1,007***	1,059***	1,384***	1,282***
NBe	−616.90*	−1,031***	−3,153***	−2,606***
NBa	1,146**	1,137***	1,042*	701.2
NKe	−474.2	−749.1	3,138	2,598*
HA	−176.6***	−168.6***	155.4***	135.7***
Model Evaluation				
Intercept	18,600**	15,718***	−43,650***	−32,486***
Rho	*NA*	0.245***	*NA*	0.393***
Observations	20,944	20,944	20,944	20,944
R^a	0.855	*NA*	0.574	*NA*
AIC	488,669	487,180	510,948	510,000
MIR	0.205***	0.010	0.103***	0.011

Note.
1. ***, **, * represent the significance level of 1%, 5%, 10%, respectively.
[a] MIR: Global Moran's I for residuals.

buyers.

We further projected the coefficients of *PH* based on the result of GWR in Fig. 10, which shows a cluster of positive coefficients for 2008–2012 in the southwest region, and an agglomeration of positive coefficients located in the area of the University of Utah for 2012–2016. In contrast to amenities and producer service employment, spatial patterns of *PH* cannot be directly simplified as a reversed relationship between effects and the density of service providers. The relationship between the attractiveness of the neighborhood and its racial composition is largely due to the races of potential residents. Whites tend to favor predominantly white neighborhoods, while blacks and Latinos prefer integrated neighborhoods (i.e., a 50% white, 50% black neighborhood; 50% Latino, 50% white neighborhood (Charles, 2005). In Salt Lake County, the share of Latinos in most Hispanic neighborhoods falls into the range of 20%–40%. Thus, to achieve an integrated neighborhood, Latinos are willing to pay more to live in a neighborhood with an increasing share of Latinos, which further causes more value gains for the local housing market in the boom period. The shift of the clusters could be explained by racial composition change in the local neighborhood.

Table 4
Regression results: GWR.

Variables	2008–2012		2012–2016	
	Median of Coefficients	Positive %	Median of Coefficients	Positive %
Regional Level: Accessibility to jobs				
NPS	49.38	99.99%	−3.99	19.64%
PRC	29.29	31.61%	495.3	88.03%
Neighborhood Level: Non-Discretionary amenities				
NDVI	584.5	48.03%	997.6	54.51%
PES	10.15	45.15%	24.49	70.40%
NWP	397.2	58.37%	516.4	43.79%
NHS	105.5	50.51%	−365.7	8.70%
Neighborhood Level: Discretionary amenities				
LDSC	2,480	70.33%	2,997	73.69%
LDH	1,257	63.46%	2,527	79.55%
LDP	−386.9	0.03%	1,511	91.07%
LDG	1,488	48.43%	−92.90	23.52%
NTS	333.7	30.88%	5,049	63.66%
NFRS	10.28	25.68%	576.7	35.82%
NLB	−404.7	6.48%	1,285	84.98%
NG	676.8	65.99%	233.6	49.67%
NRest	63.17	48.98%	220.2	89.17%
NFAS	−127.5	15.75%	515.5	52.52%
Neighborhood Level: Socioeconomic condition				
UER	17,351	48.02%	52,686	67.57%
PH	−12,205	8.46%	17,351	67.34%
MHI	0.09	40.64%	0.15	72.08%
PB	50,147	92.83%	12,187	38.75%
Household Level: Structural attributes				
BASE	−0.36	0.00%	0.24	99.86%
LA	16,518	94.45%	24,130	98.58%
FA	−0.04	14.91%	0.20	68.25%
NR	1,445	82.07%	1,961	100.00%
NBe	−176.5	17.83%	−1,030	0.27%
NBa	1,596	81.04%	4,171	65.67%
NKe	2,544	59.00%	6,752	58.11%
HA	−115.5	0.04%	193.7	56.41%
Intercept	24,959	85.82%	−25,746	4.20%

5.4. Household level: structural attribute

In regard to structural factors, we found that most variables, such as the baseline values in 2008 and 2012, the number of bedrooms and kitchens, as well as square feet, are discretionary, and thus positively contribute to the amplitude of housing value changes. In general, larger, more luxurious and expensive homes are more attractive than smaller ones in the boom period, while they also lose more value in the bust period. This phenomenon can be explained by theories from behavioral economics. Economic recession significantly undermines consumers' confidence and alters their residential preference, by inducing them to stop overpaying for preferential external and locational attributes (Barnes, 2007). It is interesting that, no matter whether boom or bust, residents' willingness to pay a premium for more bathrooms is constant.

Overall, Salt Lake County's housing market volatility is intercorrelated with its uneven distribution of physical and service amenities and residential segregation. Moreover, the significance level of local attributes changes over the bust-boom cycle of the housing market. Houses with better forest coverage and proximity to jobs, houses of worship, and good public schools are more resilient, experiencing less value drop in the economic bust, but also less increase in the boom. Other amenities such as public transport, hospitals, parks, and restaurants are discretionary consumption, which positively contributes to housing value volatility. Neighborhood conditions, especially white-Hispanic segregation, also significantly contributes to housing price fluctuation. Hispanic communities in Salt Lake County tend to experience more loss of property value in a bust and gain more in a boom.

In addition, the uneven distribution of amenities and services further amplifies the performances of discretionary factors. In the boom period, the positive effects of discretionary amenities could be found in the areas

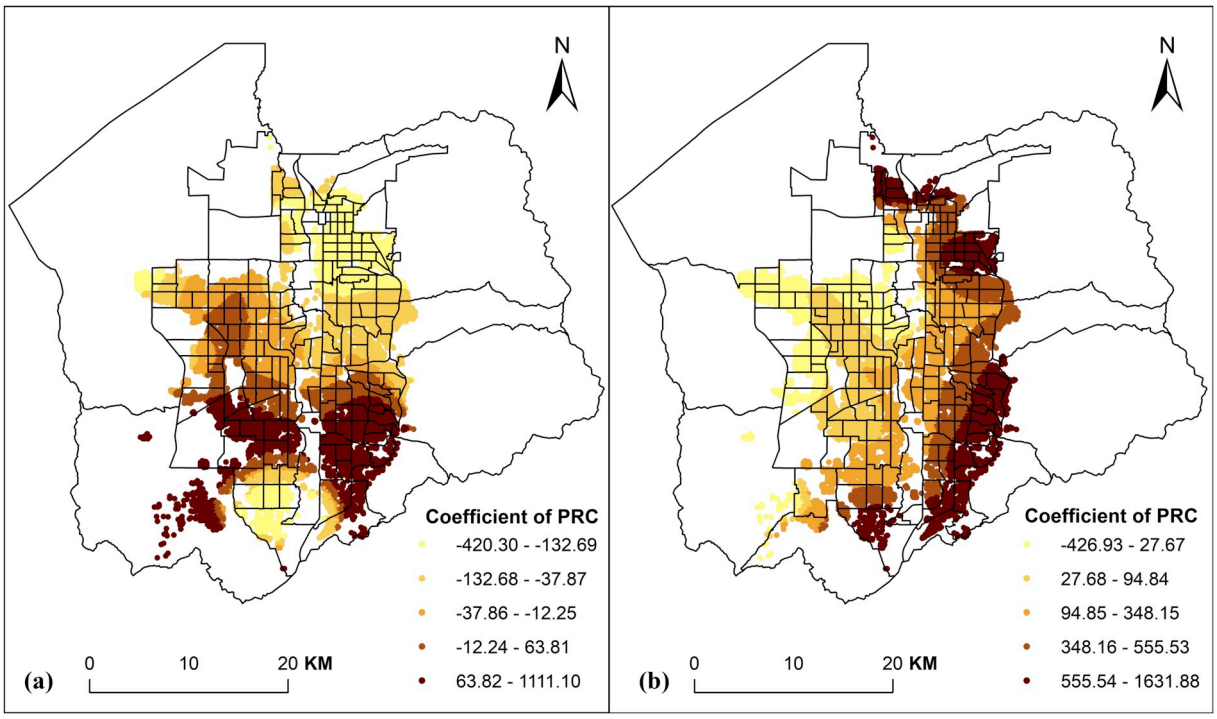

Fig. 8. GWR coefficients of ***PRC*** for 2008–2012 (a) and 2012–2016 (b).

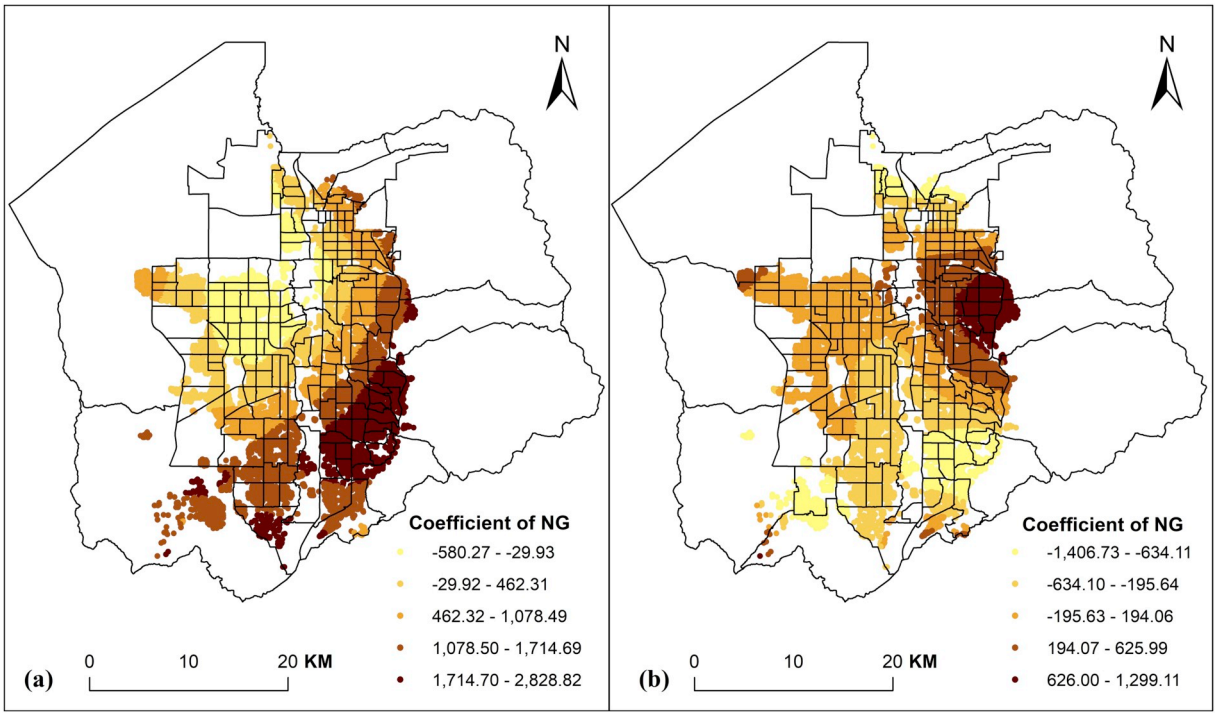

Fig. 9. GWR coefficients of ***NG*** for 2008–2012 (a) and 2012–2016 (b).

where the services are concentrated, largely due to agglomeration economies. In the bust period, houses in the areas where services are scarce, are more likely to experience more value plunges, because basic needs and demands cannot be adequately fulfilled.

6. Conclusion and discussion

The recent financial crisis, which was ignited by the bursting of the housing bubble in the United States, has renewed studies of the determinants of housing value changes. These studies are dominated by macroeconomic approaches focused on relatively large scales. Local geographies of housing value changes have rarely been studied. Amenities and other local attributes have only been used to explain the uneven distribution of housing value at a given moment but have been rarely been incorporated into a similar framework in order to explain a dynamic housing market. Focusing on housing value changes at the

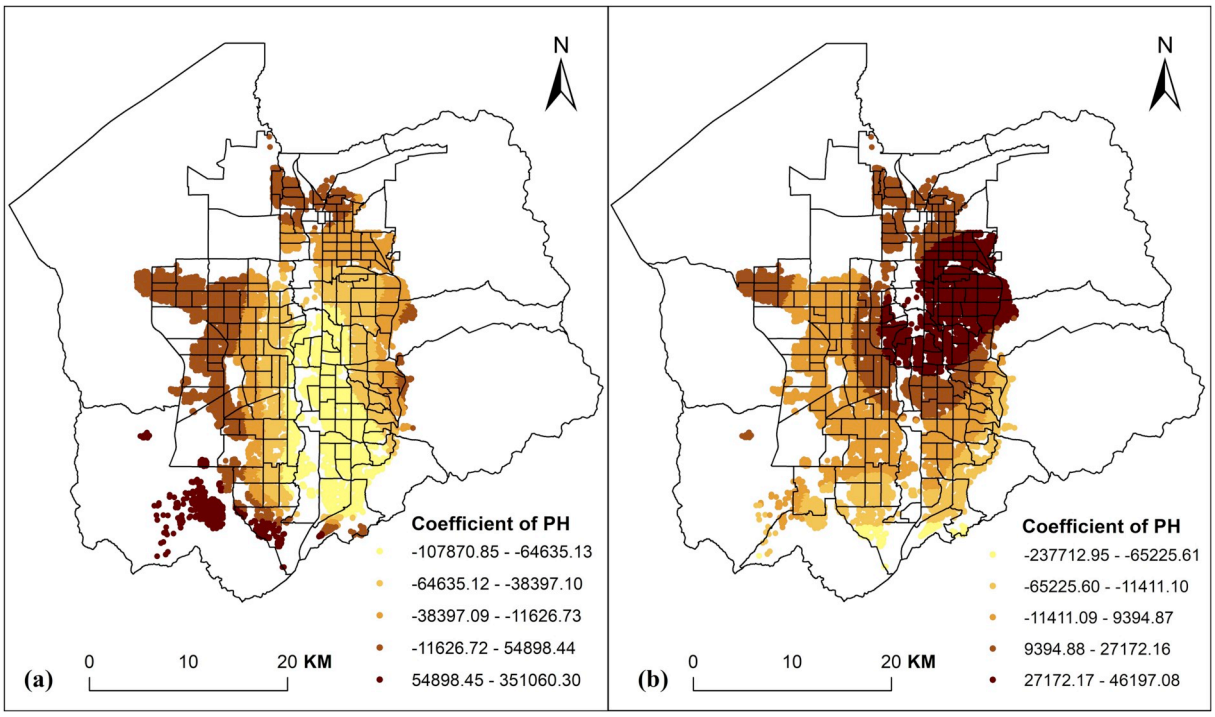

Fig. 10. GWR coefficients of ***PH*** for 2008–2012 (a) and 2012–2016 (b).

intra-urban level, to address how economic recessions affect local urban inequality by altering people's residential preferences to external neighborhood attributes, the current study enhances understanding of the spatiality and local dimension of housing price change, and this illustrates how urban inequality and the local housing market are intertwined with the global economic trends (Martin, 2011).

We provide a comprehensive analysis of spatial patterns and local dynamics of single-family house value changes in Salt Lake County and quantify effects from factors at multiple scales. Housing value changes in Sale Lake County differ across space and appear strongly and spatially associated with neighborhood conditions and urban amenities. Regressions confirm that the significance level of local attributes changes over the bust-boom cycle of the housing market. Homes with better forest coverage and proximity to jobs, places of worship, and good public schools will experience less value drop in the economic bust, but also less increase in the boom. Such a housing market is, therefore, more stable and resilient. On the other hand, proximity to public transport, hospitals, parks, and restaurants are all discretionary consumption, for which demand increases when income increases and decreases when income decreases (Parker & Vissing-Jorgensen, 2009; Rappaport, 2008). Also, neighborhood conditions, especially white-Hispanic segregation, significantly contribute to housing price fluctuation. Properties in neighborhoods with a higher percentage of Hispanics are more likely to be sold quickly in the bust period, experiencing more value loss, while the properties in a Hispanic neighborhood are more likely to have a higher increase than ones in a white-dominated community in the recovery period. Last, the spatially varying effects of amenities on housing market volatility also are sensitive to the bust-boom cycle. In the boom period, the diversity and agglomeration of amenities will amplify their positive contribution to housing value increase. In the bust period, such diversity and agglomeration could also be interpreted as a discretionary consumption, which means local access to various amenities would not prevent loss of home value in a recession.

Three key theoretical and policy implications are raised by our study. First, the influence of economic recessions on the housing market is spatially imbalanced. The patterns may not only differ from a metropolitan area to another but also vary across communities and neighborhoods in one urban area. Therefore, local spatial patterns of the financial crisis and subsequent housing market volatility are worthy of further study, since such phenomena have both macro- and micro-geographical dimensions. To economists, the macroeconomy cannot provide the whole picture to explain the boom and bust of housing prices. Behavioral economics that aims to explore how a financial crisis affects people's consumption habits and lifestyles, is also an important piece of the puzzle. People's consumption habits and lifestyles are inevitably embedded in the context of local culture and environment. Thus, local perspectives should not be excluded from studies of the financial crisis. The crisis is not only a valid subject for geographical inquiry but also presents an opportunity for geographers to examine how the local economic activities respond to global changes (Martin, 2011).

Second, the process of neoliberal globalization enhances the influence of economic crises on socioeconomically vulnerable groups, and thus increases the wealth gap between the poor and the rich. Moreover, such influence may vary among minority ethnic groups and be amplified by geographical inequalities. The spatially varying effects of amenities further confirm that individual preferences for externalities could magnify minorities' and the impoverished population's vulnerability to economic recessions (Forrest & Murie, 1994). Thus, the local government needs to promote a more even distribution of good public schools at a metropolitan statistical area (MSA) level or county-level, to smooth the sharper fluctuations that Latinos experience.

Third, geography is naturally dynamic, especially for areas that are experiencing dramatic ethnic, economic, and social changes. However, current studies on urban inequality and the housing market have largely ignored the dimension of time, emphasizing instead static patterns and dynamics. With the help of increasingly available open data and temporally variable location-based data, urban geographers are capable of providing a more insightful understanding of the evolution and trajectories of urban spatial change at a fine scale. Development decisions about amenities and services should also consider temporal changes of people's preferences. That is, cost-benefit analyses for development projects using data from the boom period to estimate structural, amenity, and service values from a hedonic model may overestimate their

values for the recessionary period. Accordingly, the weights and coefficients of the hedonic model used in the tax assessor's office should be revised to allow for changes associated with the business cycle.

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References

Adams, Z., & Füss, R. (2010). Macroeconomic determinants of international housing markets. *Journal of Housing Economics, 19*, 38–50.
Agnello, L., & Schuknecht, L. (2011). Booms and busts in housing markets: Determinants and implications. *Journal of Housing Economics, 20*, 171–190.
Allen, R. (2011). The relationship between residential foreclosures, race, ethnicity and nativity status. *Journal of Planning Education and Research, 31*(2), 125–142.
Andrews, D. (2010). *Real house prices in OECD countries: The role of demand shocks and structural and policy factors. OECD economics department working papers*. OECD Publishing. No. 831.
Barnes, P. (2007). Minsky's financial instability hypothesis, information asymmetry and accounting information: The UK financial crises of 1866 and 1987. *Accounting History, 12*(1), 29–53.
Bin, O., & Landry, C. E. (2013). Changes in implicit flood risk premiums: Empirical evidence from the housing market. *Journal of Environmental Economics and Management, 65*, 361–376.
Black, S. E., & Machin, S. (2011). Housing valuations of school performance. *Handbook of the Economics of Education*, 485–519.
Brueckner, J. K., Thisse, J. F., & Zenou, Y. (1999). Why is central Paris rich and downtown Detroit poor? *European Economic Review, 43*, 91–107.
Case, K. E., & Shiller, R. J. (1994). *A decade of boom and bust in the prices of single-family homes: Boston and Los Angeles, 1983-1993*. New England Economic Review. March/April.
Case, K. E., & Shiller, R. J. (2004). Is there a bubble in the housing market? *Brookings Papers on Economic Activity, 2*, 2003.
Charles, C. Z. (2005). Can we live together? Racial preferences and neighborhood outcomes. In X. De Souza-Briggs (Ed.), *The geography of opportunity: Race and housing choice in metropolitan America* (pp. 45–80). Washington, DC: The Brookings Institution Press.
Chen, C., & Lin, H. (2011). Decomposing residential self-selection via a life-course perspective. *Environment & Planning A, 43*, 2608–2625.
Cho, S. H., Kim, S. G., & Roberts, R. K. (2011). Values of environmental landscape amenities during the 2000-2006 real estate boom and subsequent 2008 recession. *Journal of Environmental Planning and Management, 54*(1), 71–91.
Cohen, J. P., Coughlin, C. C., & Lopez, D. A. (2012). The boom and bust of U.S. housing prices from various geographic perspectives. *Federal Reserve Bank of St. Louis Review, 94*(5), 341–367.
Davis, M., & Heathcote, J. (2005). Housing and the business cycle. *International Economic Review, 46*(3), 751–784.
Dolde, W., & Tirtirorglu, D. (2002). Housing price volatility changes and their effects. *Real Estate Economics, 1*, 41–66.
Dwyer, R. E., & Lassus, L. A. P. (2015). The great risk shift and precarity in the U.S. housing market. *The Annals of the American Academy of Political and Social Science, 660*, 199–216.
Engel, K., & McCoy, P. A. (2008). From credit denial to predatory lending: The challenge of sustaining minority homeownership. In J. H. Carr, & N. K. Kutty (Eds.), *Segregation: The rising costs for America* (pp. 81–124). London: Routledge.
Forrest, R., & Murie, A. (1994). Home ownership in recession. *Housing Studies, 9*(1), 55–74.
Gallin, J. (2006). The long-run relationship between housing prices and incomes: Evidence from local housing markets. *Real Estate Economics, 34*, 417–438.
Glaeser, E. L., & Gyourko, J. (2005). Urban decline and durable housing. *Journal of Political Economy, 113*(2), 345–375.
Glaeser, E. L., Gyourko, J., & Saks, R. E. (2005). Why have housing prices gone up? *The American Economic Review, 95*(2), 329–333.
Goodhart, C., & Hofmann, B. (2008). House prices, money, credit, and the macroeconomy. *Oxford Review of Economic Policy, 24*(1), 180–205.
Hall, M., Crowder, K., & Spring, A. (2015). Variations in housing foreclosures by race and place, 2005-2012. *The Annals of the American Academy of Political and Social Science, 660*, 217–237.
Hossain, B. (2007). Determinants of housing price volatility in Canada: A dynamic analysis. *Applied Economics, 39*, 1–11.
Hwang, M., & Quigley, J. M. (2006). Economic fundamentals in local housing markets: Evidence from U.S. Metropolitan Regions. *Journal of Regional Science, 46*(3), 425–453.
Hyra, D. S., Squire, G. D., Renner, R. N., & Kirk, D. S. (2013). Metropolitan segregation and the subprime lending crisis. *Housing Policy Debate, 23*(1), 177–198.
Igan, D., Kabundi, A., Simone, F. N. D., Pinheiro, M., & Tamirisa, N. (2011). Housing, credit, and real activity cycles: Characteristics and comovement. *Journal of Housing Economics, 20*(3), 210–231.
Immergluck, D. (2008). From the subprime to the exotic: Excessive mortgage market risk and foreclosures. *Journal of the American Planning Association, 71*(1), 59–76.
Kakes, J., & End, J. (2004). Do stock prices affect house prices? Evidence for The Netherlands. *Applied Economics Letters, 11*, 741–744.
Kennedy, N., & Andersen, P. S. (1994). *Household saving and real house prices: An international perspective*. BIS Working Paper No. 20.
Kim, J., & Cho, G. H. (2016). Unending foreclosure crisis: Uneven housing tenure trajectories of post-REO properties. *Applied Geography, 70*, 49–58.
Kuebler, M., & Rugh, J. S. (2013). New evidence on racial and ethnic disparities in homeownership in the United States from 2000 to 2010. *Social Science Research, 42*, 1357–1374.
Kuethe, T. H., & Pede, V. O. (2011). Regional housing price cycles: A spatio-temporal analysis using US state-level data. *Regional Studies, 45*(5), 563–574.
Lee, C. M., & Linneman, P. (1998). Dynamics of the greenbelt amenity effect on the land market: The case of Seoul's greenbelt. *Real Estate Economics, 26*(1), 107–129.
Leung, C. (2004). Macroeconomics and housing: A review of literature. *Journal of Housing Economics, 13*(4), 264–267.
Li, H., Wei, Y. H. D., & Wu, Y. (2019). Analyzing the private rental housing market in Shanghai with open data. *Land Use Policy, 85*, 271–284.
Li, H., Wei, Y. D., Wu, Y., & Tian, G. (2019). Analyzing housing prices in Shanghai with open data: Amenity, accessibility and urban structure. *Cities, 91*, 165–179.
Li, H., Wei, Y. H. D., Yu, Z., & Tian, G. (2016). Amenity, accessibility and housing values in metropolitan USA: A study of Salt Lake county, Utah. *Cities, 59*, 113–125.
Madsen, J. B. (2012). A behavioral model of house prices. *Journal of Economic Behavior & Organization, 82*(2), 21–38.
Martin, R. (2011). The local geographies of the financial crisis: From the housing bubble to economic recession and beyond. *Journal of Economic Geography, 11*, 587–618.
Mcgibany, J. M., & Nourzad, F. (2004). Do lower mortgage rates mean higher housing prices? *Applied Economics, 36*, 305–313.
McKenzie, R., & Levendis, J. (2010). Flood hazards and urban housing market: The effects of Katrina on New Orleans. *The Journal of Real Estate Finance and Economics, 40*, 62–76.
Miller, N., & Peng, L. (2006). Exploring metropolitan housing price volatility. *The Journal of Real Estate Finance and Economics, 33*, 5–18.
Mishkin, F. S. (2007). *Housing and the monetary transmission mechanism. Proceedings - Economic Policy Symposium* - (pp. 359–413). City: Jackson Hole, Federal Reserve Bank of Kansas.
NAHREP (The National Association of Hispanic Real Estate Professionals). (2017). *State of hispanic homeownership report*. San Diego, CA: Hispanic Wealth Project.
Niedomysl, T. (2010). Towards a conceptual framework of place attractiveness: A migration perspective. *Geografiska Annaler Series B Human Geography, 92*(1), 97–109.
Nilsson, P. (2014). Natural amenities in urban space. *Landscape and Urban Planning, 121*, 45–54.
Parker, J., & Vissing-Jorgensen, A. (2009). Who bears aggregate fluctuations and how? *The American Economic Review, 99*(2), 399–405.
Rappaport, J. (2008). Consumption amenities and city population density. *Regional Science and Urban Economics, 38*, 533–552.
Smith, V. K., Poulos, C., & Kim, H. (2002). Treating open space as an urban amenity. *Resource and Energy Economics, 24*, 107–129.
Soros, G. (2009). *The new paradigm for financial markets: The credit crisis of 2008 and what it means*. London, UK: Public Affairs Publishing.
Tian, G., Wei, Y. H. D., & Li, H. (2017). Combined effects of accessibility and environmental health risk on housing price: A case of Salt Lake county, UT. *Applied Geography, 89*, 12–21.
U.S. Census Bureau. (2001). *Census 2000*. Available online: https://www.census.gov/main/www/cen2000.html.
U.S. Census Bureau. (2011). *2007-2011 American community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov.
U.S. Census Bureau. (2016). *2012-2016 American community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov.
U.S. Census Bureau. (2018). *2013-2017 American community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov.
Wei, Y. H. D. (2015). Spatiality of regional inequality. *Applied Geography, 61*, 1–10.
Wei, Y. H. D., Xiao, W., Simon, C. A., Liu, B., & Ni, Y. (2018). Neighborhood, race and educational inequality. *Cities, 73*, 1–13.
Wei, Y. H. D., Xiao, W., Wen, M., & Wei, R. (2016). Walkability, land use and physical activity. *Sustainability, 8*(1), 65.
Whalen, C. (2008). Understanding the credit crunch as a Minsky moment. *Challenge, 51*, 91–109.
Wisman, J. D. (2013). Wage stagnation, rising inequality and the financial crisis of 2008. *Cambridge Journal of Economics, 37*(4), 921–945.
Wood, M. (2005). Discretionary unplanned buying in consumer society. *Journal of Consumer Behaviour, 4*(4), 268–281.
Wu, Y., Wei, Y. H. D., & Li, H. (2019). Analyzing spatial heterogeneity of housing prices using large datasets. *Applied Spatial Analysis and Policy*. https://doi.org/10.1007/s12061-019-09301-x.
Yu, D., Wei, Y. H. D., & Wu, C. (2007). Modeling spatial dimensions of housing prices in Milwaukee, WI. *Environment and Planning B: Planning and Design, 34*, 1085–1102.