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Resilient Urban Housing Markets: Shocks vs. Fundamentals

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Resilient Urban Housing Markets: Shocks vs. Fundamentals [*]

Amine Ouazad [†]

Abstract/Résumé

In the face of a pandemic, urban protests, and an affordability crisis, is the desirability of dense urban settings at a turning point? Assessing cities' long term trends remains challenging. The first part of this chapter describes the short-run dynamics of the housing market in 2020. Evidence from prices and price-to-rent ratios suggests expectations of resilience. Zip-level evidence suggests a short-run trend towards suburbanization, and some impacts of urban protests on house prices. The second part of the chapter analyzes the long-run dynamics of urban growth between 1970 and 2010. It analyzes what, in such urban growth, is explained by short-run shocks as opposed to fundamentals such as education, industrial specialization, industrial diversification, urban segregation, and housing supply elasticity. This chapter's original results as well as a large established body of literature suggest that fundamentals are the key drivers of growth. The chapter illustrates this finding with two case studies: the New York City housing market after September 11, 2001; and the San Francisco Bay Area in the aftermath of the 1989 Loma Prieta earthquake. Both areas rebounded strongly after these shocks, suggesting the resilience of the urban metropolis.

Keywords/Mots-clés: Cities, Urban Economics, Resilience, Long Term Growth, Disasters

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[†] Associate Professor of Economics, Research Professorship in "Urban and Real Estate Economics", HEC Montreal. 3000, Chemin de la Côte Sainte Catherine, Montreal H3T 2A7, Canada. CIRANO, Montreal, Canada. amine.ouazad@hec.ca.

1 Introduction

Between 55% (United Nations Population Division) and 85% (European Commission) of world population lives in urban areas. Such population is concentrated on a small share of the world's landmass: between 0.45% (Liu, He, Zhou, Wu, 2014) and 1.5% (European Commission) depending on the estimates. The spatial concentration of location choices can be explained by agglomeration economies: a key mechanism that enables the description of the spatial distribution of location choices and economic activity using the tools of general equilibrium. The basic mechanisms of agglomeration economies were described as early as in Marshall's (1890) Principles of Economics, and are the essential ingredient in spatial models, including Fujita & Thisse (1996) and Behrens & Robert-Nicoud (2015). Agglomeration enables the sharing of common resources, the matching with potential employers, buyers, sellers, partners; it also enables learning and social interactions. Dense urban living makes workers more productive (Puga 2010). Agglomeration economics underpin the emergence and growth of cities (Duranton & Puga 2004). Efforts to estimate the magnitude of agglomeration economies are described in Rosenthal & Strange (2004), Melo, Graham & Noland (2009) and Combes & Gobillon (2015).

Recent events have raised concerns that the benefits of agglomeration may be declining, affecting the desirability of urban living; perhaps even triggering an exodus from cities. The high density of urban setting suggests that, over long periods of time, the benefits of agglomeration have typically outstripped the costs of living in urban settings. These include traffic congestion (Duranton & Turner 2011), potential health hazards (Moore, Gould & Keary 2003)[1], labor poaching (Combes & Duranton 2006).

At least two shocks have affected urban areas in 2020: the Covid-19 pandemic and urban protests. Anecdotal evidence, statements by public officials as well as descriptive statistics suggest a positive correlation between urban density and the number of confirmed Covid-19 cases per capita.[2] In addition, urban protests focusing on racial justice have taken place in 43% of the 917 metropolitan

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[1] The causal impact of urbanization on health is ambiguous. For instance Singh & Siahpush (2014) displays a life expectancy that is 2.7 year longer in urban areas vs rural areas of the United States. Urbanization can lead to worse health outcomes in urban slums (Riley, Ko, Unger, Reis). While statistical correlations also suggest that urbanization is a necessary condition for growth, there are examples of urbanization without growth, e.g. in Sub-Saharan Africa and in South Asia (Annez and Buckley, Chapter 1 in Spence, Annez, Buckley, 2009; Chauvin, Glaeser, Ma, Tobio, 2017).

[2] Table 1 presents regressions suggesting a statistically significant positive correlation between county population density and confirmed cases per capita.

areas in May 2020.[3] Thus a key question is whether the multiple short-run shocks to urban housing markets are likely to cause a long-term decline in metropolitan population growth. Will advances in information technology coupled with the challenges of living in dense neighborhoods lead to a decline of urban living, with a population living farther away from the densest cities? The answer is ultimately an empirical question, that can be informed by the analysis of (i) the nature of recent short-run *shocks* to local housing demand, and (ii) the importance of short-run shocks versus long-run *fundamentals* for the growth of metropolitan areas.

This chapter presents an analysis of the *short-run* shocks to the housing market in 2020 using Zip-level housing data. As the long-term prospects of U.S. urban housing markets cannot yet be assessed, the chapter turns to the past to inform the future. The chapter performs an analysis of the *long-term* 1970-2010 growth trends of 306 metropolitan areas. It then presents two Zip-level case studies of the long-term resilience of New York City's housing market after September 11, 2001, and of the long-term resilience of the San Francisco Bay area after the 1989 Loma Prieta earthquake.

By combining micro data on Covid-19 infections, geocoded urban protests with census demographics, house prices, inventories, and rents, the chapter documents the large magnitude of the series of shocks that affected U.S. housing markets in 2020: prices, inventories, rents all experienced large movements. Yet, despite such large shocks, the dynamic of prices is consistent with the market's *expectations of resilience.* There is also evidence that, within metropolitan areas, housing demand is increasing faster in less dense neighborhoods and in neighborhoods farther away from the center of the metropolitan area. This is consistent with, at least in the short-run, households' *adaptation* to changing conditions by demanding housing in locations farther away from the impact of the short-run shocks.

The second part of the chapter uses longitudinal time series of census tracts with consistent 2010 boundaries to estimate the impact of fundamentals and shocks on the population growth in 306 metropolitan areas.[4] Results suggest no statistically significant impact of shocks such as hurricanes and urban protests. This may be surprising given the experience of New Orleans: in 2018 population was 16% lower than its pre-hurricane 2005 level. Yet, in other metropolitan areas, billion dollar

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[3] This statistic uses geocoded protest location data and Zillow's definition of metropolitan area boundaries. These data are described in Section 2.4.

[4] Recent data includes information on more than 900 metropolitan areas. The 1970-2010 longitudinal data of the Neighborhood Change Database allows an analysis of 306 metropolitan areas.

events such as hurricane Harvey and hurricane Sandy had no discernible impact on metropolitan population levels. Beyond differences in the hydrology and topography of New Orleans, Houston, and New York, a set of economic differences in fundamentals may explain the divergent long-term paths in response to short-run shocks. This may also explain why Collins & Margo (2007) finds a long-run impact of the 1967 Detroit riots (a short-run shock) on long-run population growth and on property values. Detroit's population peaked in 1950, 17 years before the riots. Glaeser (2011) argues that Detroit's industrial mono-culture may have hindered innovation. Hence the shock of the riots may have been correlated with or driven by economic fundamentals such as Detroit's relatively lower industrial diversification and high level of racial segregation. This chapter's description of the importance of shocks vs. fundamentals does not establish that shocks do not affect metropolitan population growth (Boustan, Kahn, Rhode & Yanguas (2020) describes impacts on outmigration and income) but rather that fundamentals may outweigh their impacts.

The chapter also presents a case study of the resilience of local housing markets in the aftermath of September 11, 2001 in New York. There is evidence of a short-run reversal of the gradient between price appreciation and distance to the Central Business District during the September–December 2001 period. Yet the gradient returns to its prior, long-term, negative slope whereby price appreciation is higher in the CBD. There is no impact of the event on house price appreciation from 2002 onward. Similar findings emerge in this chapter's second case study, the impact of the 1989 Loma Prieta earthquake on San Francisco's housing markets. While there are visible population outflows in the 1990 Census in areas affected by the earthquake, there is no long term difference in population trends across areas with different earthquake risks. Large corporate headquarters have sprung up in those areas at risk of earthquakes. Overall the metro-level and the neighborhood-level evidence are consistent with the resilience of urban housing markets, whereby fundamentals drive metropolitan growth rather than short-run shocks.

This chapter's findings are consistent with prior literature. Davis & Weinstein (2002) documents the evolution of Japanese cities from the Stone Age to the modern era, with a specific focus on the impacts of World War II bombing on the growth of Japanese cities. They document a strong recovery in the years immediately after such an unprecedented shock to city population. Brakman, Garretsen & Schramm (2004) documents that this is also true of German cities strategically bombed during World War II: the impact on city growth is only temporary. Davis & Weinstein (2002) emphasizes the importance of locational fundamentals. This chapter emphasizes the importance of fundamentals such as education, industrial composition, and urban segregation. In other words, it can be argued that while resources such as coal or proximity to major streams may have determined the emergence of cities, it is their education levels, their diverse economic activity, and the opportunity to interact and learn that is the modern foundation of urban living.

This chapter's results also suggest that housing supply elasticity is a positive driver of metropolitan population growth. Limited housing supply elasticity in some metropolitan areas might be driving recent population outflows from California to more affordable housing markets in Texas, Arizona, Nevada, and other states. Zabel (2012) finds that the cost of housing is a driver of labor mobility across metropolitan areas during the 1990-2006 period. Limited housing supply elasticity may be hindering recovery after shocks. Koster, van Ommeren & Rietveld (2012) argues that planning policies may have hindered the rebuilding of bombed areas in Rotterdam after World War II.

Finally, this chapter's findings are also consistent with prior work on pandemics and housing markets. Francke & Korevaar (2020) finds only short-run impacts on house prices and rents of the 17th century plague in Amsterdam of 19th century cholera in Paris. These effects are short-lived as they do not last more than a year. These results are also consistent with the Canadian experience of the SARS pandemic. On April 23, 2003, the World Health Organization issued a travel advisory for Toronto recommending postponing all but essential travel. There is however no evidence of impacts of SARS infections on the growth of Toronto's housing markets (prices and transaction volumes) in 2003 and beyond. The Teranet index displays a 5% year-on-year house price increase throughout 2003. Price increases remain strong in subsequent years, reaching 7-9% between October 2007 and May 2008. This may be due to the relatively limited number of SARS cases in Toronto. This is also consistent with a model in which house prices capitalize the entire flow of future rents and thus are resilient in the face of short-run shocks such as pandemics.

Overall, the results described in this chapter imply that metropolitan areas may be on an equilibrium path, and that shocks are short run deviation from this single dynamic equilibrium. Davis & Weinstein (2008) finds no evidence of multiple equilibria in cities' dynamics, using data for 114 Japanese cities. This paper finds that industrial composition and the size of the manufacturing sector are unchanged after large shocks to city population and employment. This resilience may be due to the quality of institutions of high-income countries (Kahn 2005).

This chapter proceeds as follows. Section 2 describes the ongoing shocks experienced by U.S. housing markets since March 2020, and their impact on market dynamics. Section 3 describes long-run 1970–2010 evidence of the drivers of metropolitan population growth, as well as new evidence of the impact of September 11, and the 1989 Loma Prieta earthquake on neighborhood dynamics. Section 4 provides a cautious forecast of urban resilience in the face of the 2020 shocks.

2 The U.S. Housing Market in 2020: Resilience and Adaptation

2.1 Short-Run Aggregate Dynamics: Insights from Prices and Rents

Time series of house prices, listings, and rents suggests that 2020 is a major shock to real estate dynamics. It also provides evidence about the market's expectation of resilience. We describe the dynamics using Zillow's time series data and interpret them using standard principles of real estate: while rents reveal the current flow value of housing, prices capitalize current and future flow values. This section uses metro-level time series. In the next section we focus on smaller, more granular, local housing market dynamics at the 5-digit ZIP code level.

Figure 1a presents the year-on-year change in the Zillow House Value Index (ZHVI) between January 31, 2015 and July 3, 2020. This price index is built using a repeat-sales methodology similar to Case & Shiller (1987). The bold line is for the United States, the dashed line for the tristate metropolitan area of New York; and the dotted line for the metropolitan area of Los Angeles. All three series suggest that after a deceleration of prices in 2019, transaction prices experienced an accelerating growth from January till July 2020. Perhaps surprisingly, such deceleration did not soften during the Covid-19 pandemic, but rather price growth accelerated, reaching year-on-year levels above 4% in July.

The dynamic of rents is rather different, and reconciling this apparently contradictory dynamics provides new insights. Figure 1b displays the year-on-year change in the Zillow Observed Rent Index (ZORI), which measures changes in asking rents over a sample of properties. By measuring rents for the same units, this index is akin to a "repeat-rent" index. Hence this index is built with a similar method as the house value index. The figure suggests that rent growth not only decelerated, but rents decreased in the metro area of New York, dropping by more than 2% year-on-year in

July 2020. In the United States overall and in Los Angeles, rents are close to declining. Figure 1d presents the metro-level distribution of average year-on-year changes during the March to August 2020 period, for the 100 largest metropolitan areas. It suggests that overall prices have increased faster than rents, with a significant number of metropolitan areas experiencing rent declines or stagnation; while there is only one metro area with price declines.

Listings experience the largest drop. Figure 1c suggests that listings started decreasing significantly at the beginning of the pandemic, dropping year-on-year by 20% in the U.S. and by up to 40% in Los Angeles, with a rebound in June-July 2020. This presents a first hypothesis for the seemingly paradoxical increase in prices. A first hypothesis is selection bias. Houses that do not transact during a given time period do not contribute to a repeat sales index by construction, and houses in the lower part of the price distribution are more likely to experience no transaction during downturns (Ouazad & Rancière 2019). While houses that do transact experience price increases, houses whose value is declining might not contribute to the set of observations of the price index. Hence part of the index's fluctuations may simply be due to dynamic selection (Gatzlaff & Haurin 1997). This possibility nevertheless is unlikely to explain the observed price and rent trends. First, both the price index and the rent index are vulnerable to this selection bias. Second, one econometric approach to correcting for such selection bias, the inverse time weighting approach (Ambrose, Coulson & Yoshida 2015), does not typically yield significant differences in the price index.

Three alternative mechanisms rationalize the evolution of the housing market's trends. The simplest way to express them is using the Gordon & Shapiro (1956) approach. Such approach capitalizes expected rents using a constant discount factor and a constant expected growth rate of rents. Rents are net of maintenance costs, property taxes, and potential credit costs. Formally,

$$\frac{R}{P} = r - g, \tag{1}$$

where R is the current net rent, P the current value of the asset, r the required capital yield, and g the growth rate of net rents. This can be written as $P = \frac{R}{r-g}$, suggesting that prices may increase even as *current* rents fall whenever (i) the expected growth rate of rents increases, (ii) the rate of return r declines, (iii) net rents increase relative to gross rents due, for instance, to a decline in credit costs.

Figure 2a shows that as expected, the increase in prices and the decline of rents implies a declining rent-to-price ratio, which is the outcome of at least these three potential mechanisms. First, the decline in the 30-year fixed rate mortgage average (Figure 2b) lowers interest costs and pushes prices up at given rents. The impact of cheap mortgage credit on house prices has been documented (Adelino, Schoar & Severino 2012, Favara & Imbs 2015, Justiniano, Primiceri & Tambalotti 2019). Second, the decline in the AAA corporate bond yield (Figure 2c) suggests that prices are increasing in a search for yields. The required rate of return on capital can be approximated by such a safe bond yield plus a risk premium. Third, the increase in prices and the decline of the price-to-rent ratio is consistent with expectations of rent growth; while current rents may be low, buyers are arguably expecting substantial *future* rent growth. Figure 2d plots expectations of price and rent growth using the time series of Fannie Mae's National Housing Survey. While expectations of rent growth (g) fall sharply in June 2020, they rebound and become positive again in July 2020, suggesting that housing market participants expect a short-lived trough in rents rather than a prolonged slowdown.

2.2 Covid-19 Cases: Greater Frictions, Declining Rents, Resilient Prices

The global Covid-19 pandemic affected housing markets throughout the world. Yet, the spatial distribution of confirmed cases and deaths is uneven. The pandemic emerged in the United States as a significant measurable phenomenon in the first half of March 2020. While daily confirmed cases were below 70 a day on March 5th, they grew to a peak of more than 77,000 cases a day on July 16th 2020 for a total of 5.9 million cases as of August 29, 2020.[5] On the same day, Canada had reached a total confirmed number of cases of more than 129,000 cases.

Figure 3a presents the spatial distribution of cases per capita across Zillow's metropolitan housing markets. The colors corresponds to quantiles of cases per capita. This map suggests that Covid-19 infections reached most housing markets, with an average number of confirmed cases per 100 residents of between no confirmed case (three metros of Utah: Cedar City, Price, and Saint George) and a maximum of 9 cases per 100 residents (Alta, Indiana). As expected, the largest metropolitan areas host the largest number of total confirmed cases, with 543,000 cases in New York, 282,476 in Los Angeles. With the exception of Riverside, California, the largest numbers of

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[5] This chapter was written in September 2020.

cases are all in the 10 largest metropolitan areas by population.

Table 1 performs a county-level regression of confirmed cases per capita on a range of variables from the American Community Survey. Density is measured by the ratio of county population on the county's area in squared kilometers. The log density is a more relevant measure than density itself as the regression is less driven by extreme observations. The regression includes state fixed effects – results are unaffected by the inclusion of state fixed effects. The table displays an economically and statistically significant correlation between county log density and confirmed cases per capita regardless of the inclusion of additional controls.

We match such cases by population to shifts in inventories to document a substantial and significant correlation between the decline in real estate inventories and the number of cases per population. This is depicted in Figure 3b. The vertical axis is the average year-on-year percentage change in inventories over the March to August 2020 period. The horizontal axis is the number of cases per population, where the total number of confirmed cases is from the Johns Hopkins Coronavirus Research Center; and county-level population aggregated to Zillow's metro areas is from the 2018 American Community Survey.[6] The pandemic affected the ability of homeowners to sell and of buyers to acquire a property, likely increasing search frictions and leading to inefficiencies. There is no metropolitan area with cases per population above the median *and* inventory growth above the median. Charleston, South Carolina, with more than 3 cases per 100,[7] experienced a 4% decline in inventories. New Orleans, with 3.1 cases per 100, experienced a 3.7% decline in inventories. In contrast, some of the largest increases in inventories happened in metropolitan areas with low case numbers: San Francisco, with only 1.1 cases per 100, experienced a +3.2% increase in listings.

There is no detectable metro-level correlation between house price dynamics and the number of confirmed cases, suggesting that the impact of the pandemic may be more likely to stem from the economic consequences of the pandemic rather than through the avoidance of infection probabilities. Figure 3c plots the average monthly change in prices for each of the largest 100 metros against the number of cases per population. It suggests that prices are largely unrelated to confirmed cases,

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[6] While 2020 county-level population numbers have not yet been released, a similar correlation would arguably hold with updated data.

[7] Confirmed cases are also reported as cases per million. Using this alternative scaling does not affect this chapter's analysis.

with a large variance of up to 20 percentage points, in house price changes for metros with low infection numbers. And no significant difference between metros with low infection numbers and metros with high infection numbers.

Evidence may come from the correlation between rents and infection numbers. Figure 3d plots the average change in rents against the number of cases per population. Metro areas with large numbers of cases per population experienced lower than average rent growth. In contrast, metropolitan areas with low case counts per population experienced some of the largest rent growth levels.

These three pieces of evidence (on inventories, prices, rents) suggest a substantial short-run impact of the pandemic on the flow utility of housing in metro areas affected by the pandemic, but a long-run expectation of resilience whereby the pandemic does not significantly affect buyers' expectations of the value of living in metro areas with large cases per population.

2.3 Evidence of Short-Run Suburbanization

While house prices are overall on the rise, there may be *within-city* shifts in demand towards neighborhoods that are less dense and farther away from the central business district, which are arguably less exposed to the pandemic. Anecdotal evidence[8] suggests that cities may become more resilient when households increase their demand for less dense areas where the propensity for infections is perceived to be lower.[9] To perform this analysis, we turn to neighborhood-level evidence from the New York City metro area.

Figure 4 presents the example of two neighborhoods with two extreme density levels. The upper panel (a) presents the Upper East Side, with a population density of 53,029 residents per squared kilometer as of 2018. It features condominium towers and other high density urban developments. Such density is higher than the average density of the densest cities in the world. This stands in contrast with New York's Great Neck Peninsula (lower panel (b)), on the northern side of Long Island, with a population density 18 times lower, of 2,968 residents per squared kilometer. While commuting time from Great Neck to downtown Manhattan is less than half an hour, this neighborhood has more than 20 parks across 9 villages, and features "verdant residential areas."[10]

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[8] "New Yorkers Look To Suburbs And Beyond. Other City Dwellers May Be Next", National Public Radio, July 8, 2020. "New Yorkers Are Fleeing to the Suburbs: 'The Demand Is Insane"', New York Times, August 30, 2020.

[9] While many other factors than density explains the variance of cases across locations, there is a significant and positive correlation between population density and cases per capita, as displayed in Table 1.

[10] Marcelle Sussman Fischer, the New York Times, July 2016.

We test whether neighborhoods such as the Upper East Side have seen a decline in demand relative to neighborhoods such as Great Neck during the period of March to August 2020. We do so by regressing shifts in prices on 1) the distance to the population-weighted center of the metropolitan area, 2) population density, as the ratio of the 2018 ACS population over the area of the ZIP Code Tabulation Area in squared kilometers.

The results are presented in the scatter plot of Figure 5 and in Table 2. These scatter plots and the regression table suggest a *reversal* in patterns of housing demand during the pandemic. Indeed, the correlation between house price appreciation and density is positive in the three months of March-May 2019. That is also true for other periods outside the pandemic. The correlation between house price appreciation and urban density is also positive in the same time period of 2019, one year before the pandemic. Yet these two correlations turn negative and significant at 1% in the three months of March to May 2020. As the supply of housing moves slowly in the short-run, fluctuations in house prices between March and August are likely a good measure of the shift in the demand for housing units, vacating less desirable locations, and searching for housing in more desirable locations. Hence correlations between the characteristics of neighborhoods and shifts in transaction prices are likely a relevant proxy for shifts in tastes. These results suggest that, in the short-run, household demand has adapted by shifting to less dense and more peripheral neighborhoods.

2.4 Local Housing Markets and the May 2020 Urban Protests

The year 2020 saw a second series of shocks affecting urban housing markets. Urban protests in response to alleged actions by the police started in May 2020 and quickly spread to a substantial number of U.S. metropolitan housing markets. Figure 6a presents the geographic location of the May 2020 protests with more than 100 participants according to the geocoded crowdsourcing of the Wikimedia foundation.[11] The spatial extent of these protests exceeds those of the 1968 protests as documented by Stanford University's Susan Olzak in her collection of *Ethnic Collective Action in Contemporary United States.* This suggests that the 2020 urban protests may be the largest protests in U.S. history. Whether protests lead to positive reforms that improve the desirability of

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[11] Other potential sources of recent geocoded data include the *Crowd Counting Consortium.* Further literature may focus on *Factiva*'s news archive as an alternative source of information on protests.

urban living; or whether protests lower the quality of life in urban metros is an empirical question.

Collins & Margo (2007) uses decennial Census data between 1950 and 1980 to describe the long-term impact of the 1960s riots on property values. They suggest that riots led to a decline of property values, and in particular to a decline in black-owned property values, with no rebound in the 1970s. The perhaps most salient example of such decline is the city of Detroit. In this context, Glaeser & Gyourko (2005) argues that shocks may lead to a long decline in metropolitan areas as the supply curve of housing is L-shaped: a decline in housing demand may lead to a decline in house prices down to the marginal cost of housing, leading to larger vacancy levels, attracting lower productivity workers and lowering the benefits of agglomeration economies.

Figures 6b and 6c present a correlational analysis of urban protests and house prices in the metropolitan area of Los Angeles. Figures 6b presents evidence that George Floyd protests extended from the northern neighborhood of San Fernando to the southern neighborhoods of Laguna Niguel. Figure 6c compares house price appreciation in ZIP codes where a protest happened (red line) to house price appreciation in ZIP codes where a protest did not occur (black). While the hypothesis that the appreciation rates are parallel cannot be rejected statistically prior to May 2020, the appreciation rate declines and *crosses* the appreciation rate of ZIP codes where a protest did not occur. Hence, while on average across the United States, house price increases suggest expectations of urban resilience, there is local evidence of some expectations of decline in specific neighborhoods affected by the urban protests. This may be driven by the shift of demand towards neighborhoods less exposed to risk.

The endogeneity of riots may cast doubt on the causal interpretation of such event studies that rely on a pre-post analysis of the impact of riots on urban growth and decline. DiPasquale & Glaeser (1998) finds support for a Beckerian mechanism in which protests are the outcome of a comparison between the opportunity cost of time and the potential cost of punishment, and consistent with evidence by Esteban & Ray (2011), the paper finds that ethnic diversity matters. In the case of Los Angeles in May 2020, evidence suggests significant differences in the demographics of Zips with urban protests and without urban protests.

	Mean				
	Protest Zips	**Other Zips**	**Difference**	**S.E.**	**t**
Frac. African American	0.054	0.084	−0.029	(0.019)	−1.56
Frac. Hispanic	0.372	0.406	−0.034	(0.041)	−0.82
Frac. Asian	0.219	0.186	+0.032	(0.025)	+1.27
Frac. Owner Occupied	0.545	0.479	+0.066	(0.033)	+1.98
log(Median Household Income)	11.257	11.116	+0.141	(0.063)	+2.22
Frac. Poverty	0.124	0.154	−0.030	(0.016)	−1.82
Frac. No Health Coverage	0.113	0.133	−0.020	(0.012)	−1.70

In particular, this table suggests that protests occurred in neighborhoods that had significantly higher household income, lower shares of African Americans and Hispanics, higher shares of owner-occupied housing, lower poverty rates, and lower fractions of households with no health coverage. In the future, longer time series combined with sound identification strategies may allow for a causal analysis of the 2020 protests on urban housing markets.

3 Housing Markets in the Long Run: The Role of Shocks vs. Initial Conditions

The previous section described the short-run response of U.S. housing markets to the pandemic and the urban protests. The long-run prospect is yet unknown. The past can nevertheless inform our perception of future trends. This section describes the long-run evolution of metropolitan areas between 1970 and 2010 using longitudinal census tract data. It sheds light on the drivers of the rise and decline of cities. Are cities that experience large short-run shocks rebounding or are the typical impacts permanent shifts in population levels? Prior literature (Gabaix 1999, Ioannides & Overman 2003) has described the relative stability of city size distributions, which follow Zipf's law, where the log population is a linear relationship to the log rank of the metropolitan area. Yet, within such distribution, metro areas rise and fall. Understanding which observable characteristics drive such rise and fall is the focus of the first section 3.1. While metropolitan area rankings tend to be stable, the desirability of specific neighborhoods within metropolitan areas changes more dramatically over time. This is the focus of subsections 3.2 and 3.3. We present two case studies: the New York housing market in the aftermath of September 11; and the dynamic of San Francisco's neighborhoods after the 1989 Loma Prieta earthquake.

3.1 Explaining Metropolitan Growth in the Long Run

The relative ranking of metropolitan areas is stable over time: data from the *Neighborhood Change Database* suggests that the correlation between a metropolitan area's population rank in 1970 and its rank in 2010 is 0.8, implying that the best predictor of a city's future is its past. Rankings are also stable in other dimensions than population: Kerr & Robert-Nicoud (2020) shows that 1975-1980 annual patent count is a strong predictor of 2013-2018 patent count. Yet, some metropolitan areas experience rapid population shifts: the Dallas-Fort Worth-Arlington went from being the 11th most populus metro to the number 4 rank. The Atlanta metropolitan area went from the 19th to the 9th rank, joining the 10 largest metro areas. In contrast, Pittsburgh went down 13 notches, from the 9th most populous metro to the 22nd most populous, as the steel industry declined. Two of the largest relative growth levels were observed in Las Vegas, going from the 102nd to the 31st largest; and the Austin–Round Rock metropolitan area, jumping 58 spots to the 35th rank.

The largest relative decline is that of Johnstown, Pennsylvania going from the 150th to the 249th spot, with a 50.6% decline in population; this metropolitan area experienced three major floods, the most recent in 1977. This major flood could be a candidate for a causal driver of the city's decline. Another competing explanation for this decline is Johnstown's *specialization* in the steel industry, with steel mill plants in the heart of its downtown.

Hence, for Johnstown as for other metropolitan areas, a key question is whether shocks (here floods) or fundamentals (here industrial composition) explain their rise and fall? We use data from a range of sources to estimate the correlation between urban growth and (i) natural disasters, (ii) urban protests, (iii) industrial composition, (iv) education levels, (v) urban segregation, and (vi) housing supply elasticity. Each of these hypothesis has received support in the literature. The analysis of this chapter is not comprehensive, yet provides an overview of the potential drivers of urban growth and decline.

The "Shocks" Hypothesis

- *Natural Disasters*

Natural disasters may cause either temporary or permanent shifts in population levels. We use data from NOAA's significant storm events, which provides damages and fatalities at the county level since January 1950. We count the number of billion dollar storms for each county in the 1970-2010 period. The metropolitan area with the largest number of such storms is the New Orleans–Metairie, LA CBSA, with 12 billion dollar storms. Then comes the Gulfport-Biloxi-Pascagoula, MS CBSA, with 6 such storms, and the Houston-The Woodlands-Sugar Land, TX CBSA, with also 6 such storms. The New Orleans CBSA is also the metropolitan area with the largest amount of billion dollar damages. We consider three variables explaining metropolitan growth: the number of events, the total property damages, and whether there was any event.

- *Urban Protests*

We test the urban protest hypothesis using data collected by Susan Olzak on Ethnic Collective Action in the United States Olzak & West (1995). The list of events was compiled from the New York Times Index and from microfilms of New York Times articles. We focus on protests occuring between 1970 and the last date of the file, 1992. The data reports the number of protestors, the involvement of police, damage to property, the presence of non residents, and other features, for each metropolitan area. We match the now deprecated Standard Metropolitan Area (SMSA) geographies to the 2010 Core Based Statistical Area, which is the most recent definition of metropolitan boundaries.

The "Fundamentals" Hypothesis

We compare the impact of shocks to the impact of the following fundamentals: education, industrial composition, segregation, and housing supply elasticity. In each case, we describe the associated literature and the data used.

- *Industrial Composition*

Initial industrial composition may matter for long term metropolitan growth through a number of channels. First, specialization in industries with strong global demand for their products may lead to a greater demand for labor in the metropolitan area. This is the intuition of Bartik (1991) and Blanchard & Katz (1992).[12] Second, the diversity of industries initially present in a metropolitan

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[12] For a discussion of this empirical approach, see Goldsmith-Pinkham, Sorkin & Swift (2018).

area may foster the growth of a variety of industries that depend on an economic fabric of different suppliers and different customers. This is the industrial diversification hypothesis, perhaps most saliently popularized by Jane Jacobs in the Death and Life of Great American Cities: "*Typically [small manufacturers] must draw on many and varied supplies and skills outside themselves, they must serve a narrow market at the point where a market exists, and they must be sensitive to quick changes in this market. Without cities they would simply not exist. [...] City diversity itself permits and stimulates more diversity.*" (Chapter 7, The Generators of Diversity).

We estimate the correlation between industrial composition (either specialization or diversification) using the earliest wave of publicly available data from the County Business Patterns. These data provide establishment numbers for each Standard Industrial Classification (SIC) 2-digit code. We aggregate such county level data to the boundaries of 2010 Core Based Statistical Areas, the same boundaries as those of the Neighborhood Change Database – this allows for measuring the growth of metropolitan areas. To test the specialization hypothesis, we use 2-digit SIC codes, leading to the following categories: Agriculture, Fishing and Forestry; Metal, Mining and Oil; Construction; Manufacturing; Transportation and Utilities; Finance, Insurance, and Real Estate; Non Classifiable; Retail. The measure of industrial specialization is the Herfindahl index (HHI), which is equal to the sum of the squares of the 2-digit SIC industry establishment shares:

$$HHI_m = \sum_k \left(Share_k\right)^2, \tag{2}$$

where m is the metropolitan area, k is the 2-digit SIC code, and $Share_k$ is the proportion of establishments in industry k. We use the share of establishments as this variable is well filled in the US Census Bureau's County Business Patterns. Given the large asymmetry and the fat tails of the HHI measure, results of the linear regression are more robust when regressing on four indicator variables for the four quantiles of HHI, from least specialized (Q1), to most specialized (Q4).

- *Education*

In Moretti (2012), the author describes the diverging paths of Menlo Park and Visalia, CA, and suggests that Menlo Park experienced significantly stronger growth thanks to its higher share of educated residents. In the *Rise of the Skilled City*, Glaeser & Saiz (2003) describes the higher growth of more educated cities, even after controlling for a range of covariates. This chapter's measure of education is the fraction of college graduates in 1970, according to the 1970 Census Count 4Pa, provided by the National Historical Geographic Information System at the University of Minnesota.

- *Segregation and Inequality*

Our third measure of metropolitan area fundamentals is urban segregation. A number of papers suggest that urban racial segregation affects welfare. Li, Campbell & Fernandez (2013) argues that urban segregation has effects on metropolitan economic growth beyond its effects on minorities and poor residents. Thus urban segregation may be a concern for both distributional and efficiency reasons. Card & Rothstein (2007) suggests that neighborhood segregation has a consistently negative impact on the SAT scores of black students. Watson, Carlino & Ellen (2006) describes the negative correlation between income segregation and metropolitan population growth.

We build a measure of Black--White urban segregation in 1970, at the beginning of our time period. The dissimilarity index measures the difference between the distribution of black residents across neighborhoods and the distribution of white residents across the same set of neighborhoods. We use 1970 census tract demographics. The dissimilarity index is a popular measure of segregation, notably developed in Duncan & Duncan (1955) and used in Cutler, Glaeser & Vigdor (1999). The dissimilarity measure used in this paper is:

$$D_m = \frac{1}{2} \sum_j \left| \frac{w_{m,j}}{w_m} - \frac{b_{m,j}}{b_m} \right|, \tag{3}$$

where m is one of the 306 metropolitan areas, j indexes neighborhoods, $w_{m,j}$ (resp. $b_{m,j}$) is the number of white (resp. black) residents in neighborhood j, w_m (resp. b_m) the number of white (resp. black) residents in metropolitan area m. Results using other pairs of races and ethnicities are available from the author. Notable examples of segregated metropolitan areas include the Chicago-Naperville-Elgin, IL-IN-WI metropolitan area (0.90), Oklahoma City, OK (0.89), Los Angeles-Long Beach-Anaheim, CA (0.89), and Detroit-Warren-Dearborn (0.88). Alternative segregation indices such as the exposure or the normalized exposure indices (Cutler et al. 1999, Ouazad & Rancière 2016) provide different rankings, yet these three indices are strongly correlated.

- *Housing Supply Elasticity*

Our final hypothesis is that constraints on housing supply, stemming either from geographic or regulatory constraints, are a barrier to the development of metropolitan areas; they indeed constrain the growth of the housing stock (Mayer & Somerville 2000, Glaeser, Gyourko & Saks 2006, Saks 2008), and make housing more expensive for productive workers whose productivity gains are transferred to the owners of land.

There is a variety of available housing supply elasticity measures, starting with Saiz (2010). We use recent metro-level elasticity measures from Gorback & Keys (2020), yet using Saiz's (2010) measures does not affect the regression estimates. We control for an indicator variable for a missing elasticity measure, as housing supply elasticity is typically not available for smallest metropolitan areas.

- *Other possible fundamentals*

Other fundamentals could be included in a further analysis: innovations measured by the number of patents per capita (Kerr & Robert-Nicoud 2020), market access and transportation costs (Redding 2010), public transportation infrastructure (Kahn 2007, Gonzalez-Navarro & Turner 2018), the proximity to deepwater ports (Brooks, Gendron-Carrier & Rua 2018), the flow of credit due to the structure of the banking sector in the metropolitan area (Clarke 2004, Ouazad & Rancière 2016), and other fundamentals.

Estimation Results: Shocks and Fundamentals

Results of the analysis are presented in Table 4. The first columns present the covariates separately (education, industrial composition, segregation, elasticity, shocks), and the last columns performs the regression with all previous covariates simultaneously. In all 11 regressions the dependent variable is the change in the metropolitan area population rank between 1970 and 2010. A first notable fact is the strong correlation of black-white urban segregation, education, and industrial specialization, with a metropolitan area's relative growth. More segregated areas grow less than other, more integrated areas. Metropolitan areas with larger shares of college-educated residents grow significantly more. Areas with less diverse industrial composition (an HHI in the 4th quartile) tend to grow significantly less – consistent with Jane Jacobs' hypothesis. Regressions indicate that it is the concentration in one or a few industries that predicts urban decline rather than the specialization in manufacturing.

Notably, none of the shocks – urban protests and storms – have a statistically significant impact at 5%. There is no significance whether one looks at the number of riots, whether there is any riot, the dollar amount of property damages due to storms, the number of storms, or whether there is any storm. In some cases the sign is as expected: a larger number of riots with damages to property has a negative impact on a metropolitan area's population growth; yet the impacts are not significant.

The last column includes all of the previous covariates simultaneously. Interestingly, both urban segregation and industrial specialization remain strongly significant (at 1%), again consistent with the central tenets of Jane Jacobs' the *Death and Life of Great American Cities*. Shocks remain non significant. Perhaps notable is the significance of the housing supply elasticity measure: when controlling for other fundamentals, metropolitan areas with higher housing supply elasticities experience significantly higher growth (significant at 5%).

3.2 The Resilience of the New York City Housing Market After September 11

While city rankings by population size are stable, the ranking of neighborhoods tends to fluctuate substantially over time. Evidence from the Neighborhood Change Database suggests that the correlation between a tract's ranking in 1970 and the same population ranking in 2010 is only 0.2. This suggests that cities may be resilient when urban residents adapt their location and housing consumption by using the variety of amenities, housing stocks, and access to jobs to respond to shocks.

September 11 2001 presents a case study for the impact of a terrorist event on the desirability of living in dense urban spaces. The event had dramatic consequences on the welfare of central New York City residents: Galea, Ahern, Resnick, Kilpatrick, Bucuvalas, Gold & Vlahov (2002) suggests that adults experienced symptoms consistent with post traumatic stress disorder (PTSD), with a prevalence of PTSD up to 20% for those living south of Canal Street near the World Trade Center. In a set of respondents with an oversampling of children new the World Trade Center, Hoven, Duarte, Lucas, Wu, Mandell, Goodwin, Cohen, Balaban, Woodruff, Bin et al. (2005) finds that 29% of children experienced anxiety disorders.

This may have impacts on the New York housing market. In Israël, Elster, Zussman & Zussman (2017) using hedonic and repeat sales approaches to show that attacks led to a 6 to 7% decline in house prices and rents. They also find that these effects are perisistent beyond the 2000--2012 period, and suggest this is consistent with a perception of a continued threat. Bram, Haughwout & Orr (2004) suggests that the September 11 events caused a sharp contraction of business activity. In the long run, Eisinger (2004) claims that "few lasting effects on city life are evident," and suggests that city dynamics are affected by long-term forces rather than even very significant short term ones.

We provide quantitative neighborhood-level evidence of the dynamics of housing markets during and in the aftermath of September 11 using 5-digit ZIP code price data since 1996. We are thus able to estimate pre-existing trends, the impact of the events during the September to December 2001 period, and during the post 2001 period. We can also test whether these events affected the desirability of central city living in New York.

Evidence suggests a strong rebound of price growth in the October to December 2002 period compared to the October to December 2001 period. Monthly year-on-year price appreciation for the New York MSA as a whole and for the central New York City ZIP codes suggests that prices increased significantly a year after September 11 2001. There is no immediate discernible negative impact of September 11 on price appreciation in the New York MSA as a whole, suggesting that even shocks that a have strong negative impact on residents' welfare have not been capitalized into long run house prices.

Yet, Figure 7 does present evidence that September 11 temporarily shifted demand away from central New York City and to the suburbs. Panel (a) shows that price appreciation is up to twice stronger in ZIP codes close to the central business district than for neighborhoods in the 10 to 60 kilometer range (6 to 37 miles) from the central business district. This relationship is almost flipped in September and October 2001, wher price appreciation is larger in ZIP codes farther away from the Central Business District (CBD) than close to it. Yet, panel (d) suggests this is only a temporary phenomenon, as price appreciation is again decreasing with the distance to the CBD between 2002 and 2020. This evidence suggests that while September 2001 did affect the demand for central New York residential housing, these effects did not last beyond 2001, at least in terms of price appreciation for residential units in the densest parts of New York.

The dramatic shock of September 2001 also affected the demand for central city residential housing in other cities. Abadie & Dermisi (2008) suggests that 9/11 increased Chicago's residents perception of the probability of terrorist attacks. They show that vacancy rates increased in the vicinity of the Sears Tower, the Aon Center, and the Hancock Center. This section's result do not however provide evidence of long run impacts of these events on residential housing markets.

3.3 Rebuilding San Francisco After the 1989 Loma Prieta Earthquake

The Loma Prieta earthquake was an earthquake of magnitude 6.9 on the Richter scale that shook the San Francisco Bay area on October 17, 1989. According to the California Department of Conservation, it caused 63 fatalities, 3,737 injuries, and 6 billion dollars in property damage. Its epicenter was only 32.5 miles from Cupertino and 48 miles from Menlo Park, both of which were and still are, major centers of technological innovation.

A study published in the years following the earthquake (Murdoch, Singh & Thayer 1993) analyzed the dynamic of house prices in six counties that were affected. The study used all residential home sales between January 1988 and November 1990. Results controlling for a substantial range of covariates suggested that the disaster caused an overall decline in property values as well as a gradient between house prices and measures of earthquake risk such as soil type and seismic zone designation. Yet, a key question is whether these price declines persisted and whether local amenities were affected in the long run.

In this last section, we perform an analysis of the long-run impact of the earthquake on neighborhood-level population flows using data from the California Conservation Department[13] on earthquake risk, and data from the Neighborhood Change Database. In a first step, we estimate the liquefaction risk for each block of the San Jose-San Francisco-Oakland Combined Statistical area. According to the Geological Survey, liquefaction takes place "when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking."[14] Liquefaction risk is a predictor of damage to structures (Cubrinovski, Bray, Taylor, Giorgini, Bradley, Wotherspoon & Zupan 2011, Towhata, Yasuda, Yoshida, Motohashi, Sato & Arai 2016) as the nature of the soil leads to greater impacts on land at a given earthquake magnitude.

In a second step, we matched such block-level liquefaction data with the Neighborhood Change Database's tract level population levels. We compute the share of a tract's area that is in the liquefaction area. Prices are harder to analyze over such a long period nevertheless population level

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[13] CGS Information Warehouse: Regulatory Maps.

[14] "What is liquefaction?", Natural Hazards, U.S. Geological Survey.

are an indicator of the immediate impact of the earthquake on living conditions, and long-term population changes are an indicator of the quality of neighborhood amenities. Owens III, Rossi-Hansberg & Sarte (2020) argues that neighborhood population levels can decline below a threshold that yields large amounts of vacancies.

Table 4 indeed suggests that population declined significantly in the immediate aftermath of the earthquake. Census data was collected in 1990, only a few months after the earthquake that shook the metropolitan area in October 1989. The first column of the upper panel of the table suggests that population declined 12% between 1980 and 1990 in tracts that are entirely in the liquefaction area. This is significant at 1%. The first column of the lower panel provides the regression where the dependent variable is the tract's population rank. A tract within the liquefaction area lost 35.9 ranks on average in 1990. Columns 2 and 3 nevertheless suggest that the effect of the earthquake is relatively short-lived: tracts in the liquefaction area experience no different population growth in the two decades following the devastating earthquake. There is no straightforward evidence that the earthquake is a major long-term driver of population dynamics.

This is also clear in Figure 8, which focuses on Mountain View. While a substantial share of Mountain View is in the liquefaction area, including the headquarters of Google at 1600 Amphitheatre Parkway, there is no discernible impact of the liquefaction area on population dynamics. In other words, a regression discontinuity design at the boundary of such area would likely yield no significant impact. This suggests that the 1989 Loma Prieta earthquake, with damages estimated to 6 billion dollars (Stover & Coffman 1993), had only a minor impact on the San Francisco Bay Area's long term population trend.

4 Conclusion

The total magnitude and the length of both the Covid-19 pandemic and the urban protests are, at the time of writing this chapter, yet unknown. The past can nevertheless provide a sliver of hope for the future. The evidence and the literature presented in this chapter suggest that, over the span of four decades, metropolitan areas are remarkably resilient to shocks – fundamentals rather than short-run shocks drive long-run population trends. Such resilience of urban housing markets suggests that the benefits of agglomeration play a key role in residents' welfare; sharing, matching, and learning are key motives that explain the desirability of urban living. These benefits have, over the long run, arguably been greater than the negative externalities of agglomeration. High levels of education, a diversified industrial composition, and racially integrated neighborhoods are keys to the resilience of metropolitan areas.

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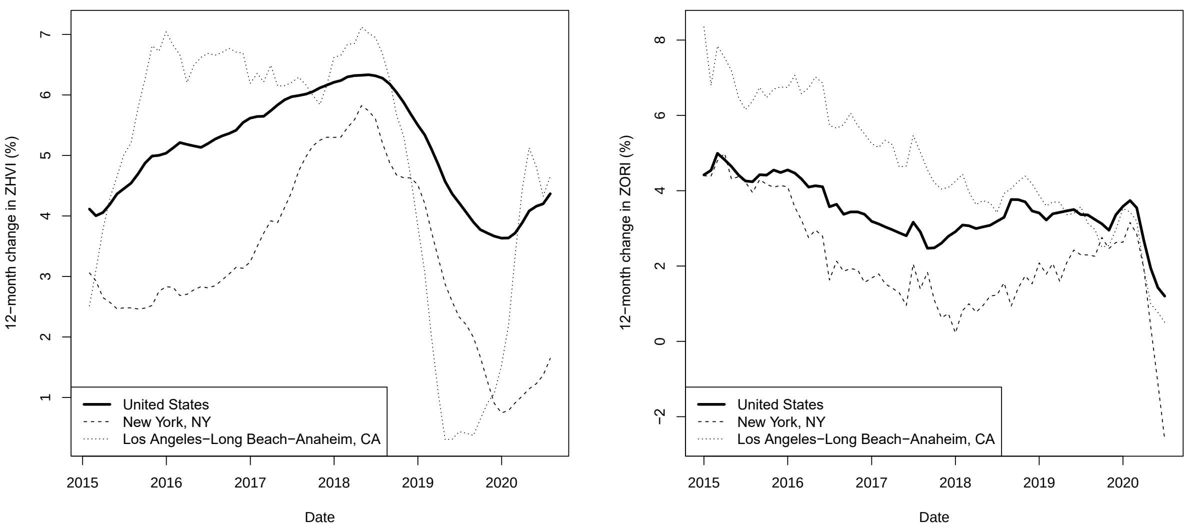
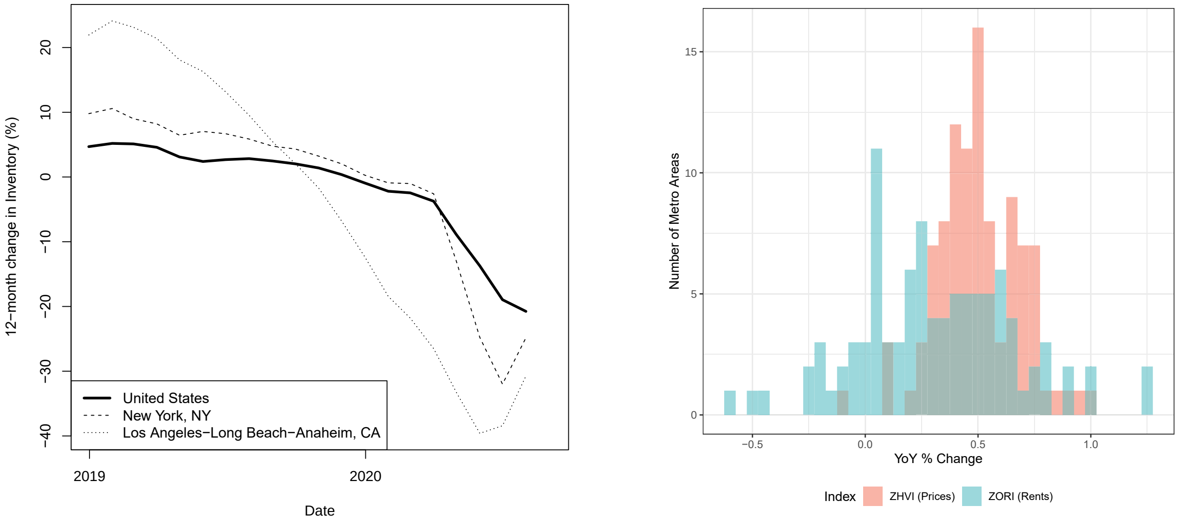
Figure 1: The U.S. Housing Market in 2020: Aggregate Dynamics

Panels (a), (b), (c) provide simple statistics on year-on-year changes in house values, rents, and inventories for the US (bold line) and for the two largest metropolitan areas (dotted and dashed lines). Inventories are not available for the same time period as prices. Panel (d) presents two histograms of price changes in red (resp. rent changes in blue) for the 100 largest metropolitan areas.



(a) YoY Changes in Estimated House Values

(b) YoY Changes in Estimated Rents

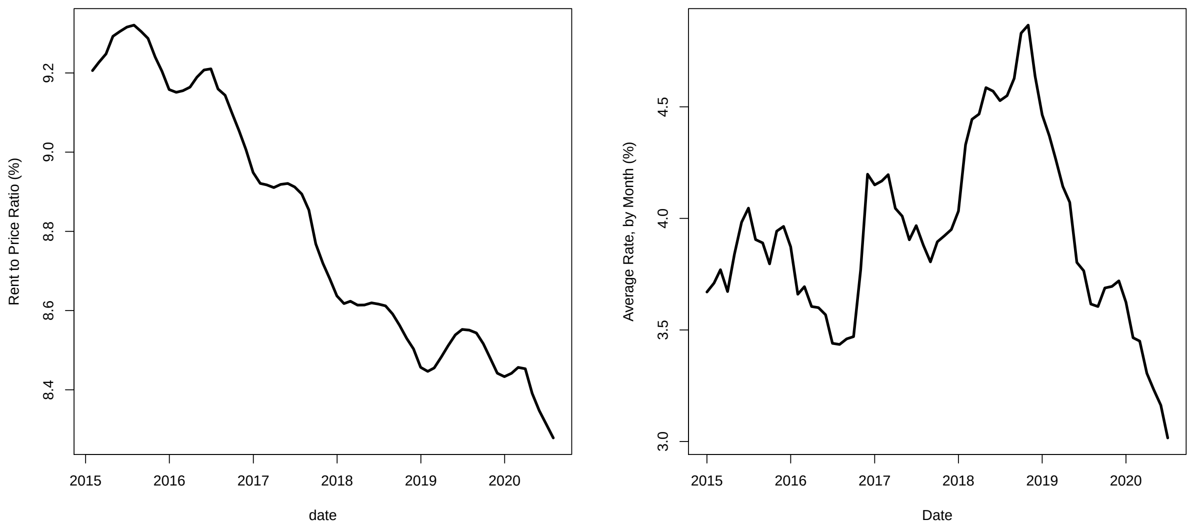


(c) YoY Changes in Inventories

(d) Distribution of Price Changes Across Metro Areas, March to August 2020

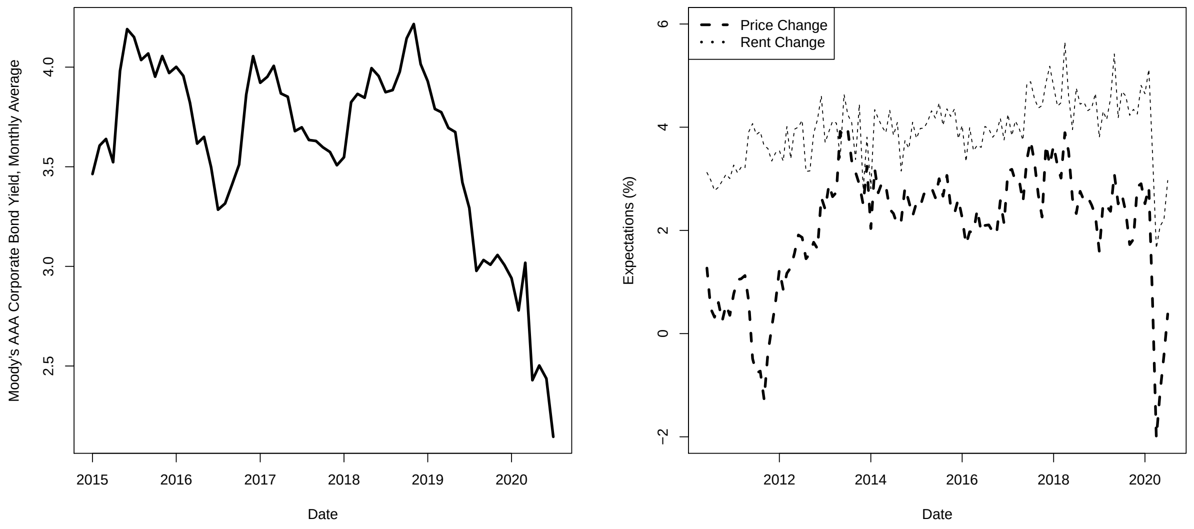
Figure 2: The U.S. Housing Market in 2020: Explaining the Resilience of Prices

These graphs describe the decline in the rent-to-price ratio, net of maintenance costs and property taxes (figure (a)), and three key components of the Shapiro-Gordon valuation formula: (b) the 30-year fixed rate mortgage average, which measures credit costs and affects net rental yields; (c) the AAA corporate bond yield, a proxy for the yield on capital; and (d) expectations of rent growth.



(a) Estimated Net Rent-to-Price Ratio

(b) 30-Year Fixed Rate Mortgage Average

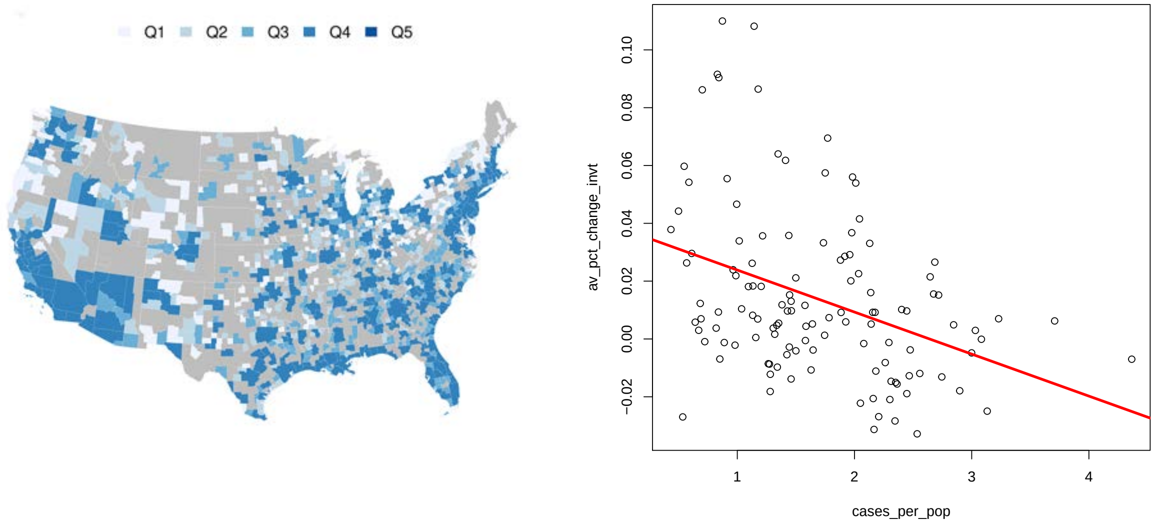


(c) Moody's Seasoned AAA Corporate Bond Yield

(d) Expectations of Rent and Price Growth

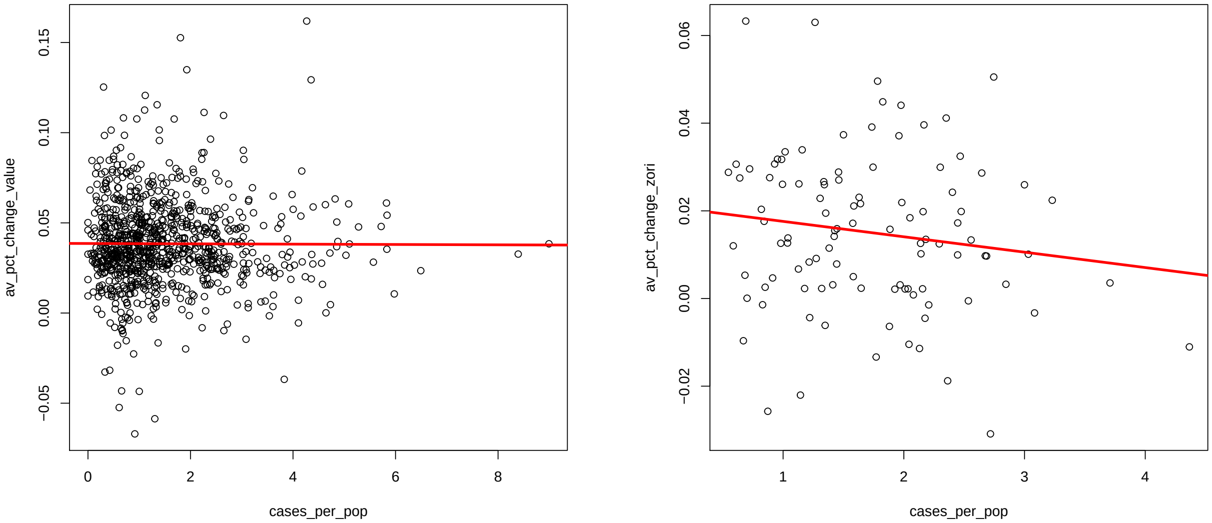
Sources: Zillow ZHVI and ZORI for the rent-to-price ratio. Maintenance cost from Harding, Rosenthal & Sirmans (2007). Average property tax rate from Malm & Pomerleau (2015). Federal Reserve of St Louis series DAAA and MORTGAGE30US. Fannie Mae's July 2020 National Housing Survey.

Figure 3: The U.S. Housing Market in 2020: Covid-19 Infections and the Housing Market



(a) Confirmed Covid-19 Cases Per Capita across Metro Areas

(b) Covid-19 Cases and Inventories



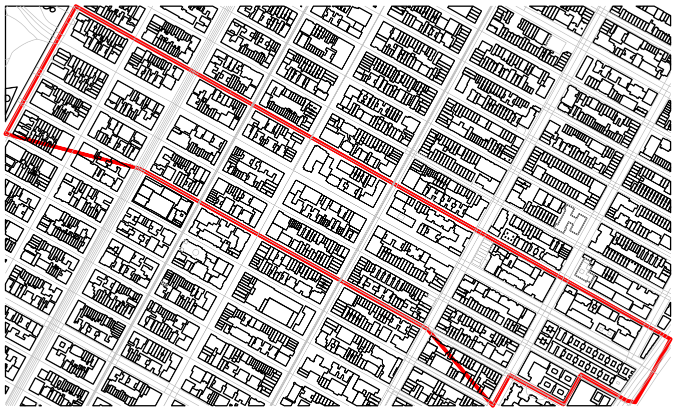
(c) Covid-19 Cases and House Prices

(d) Covid-19 Cases and Rents

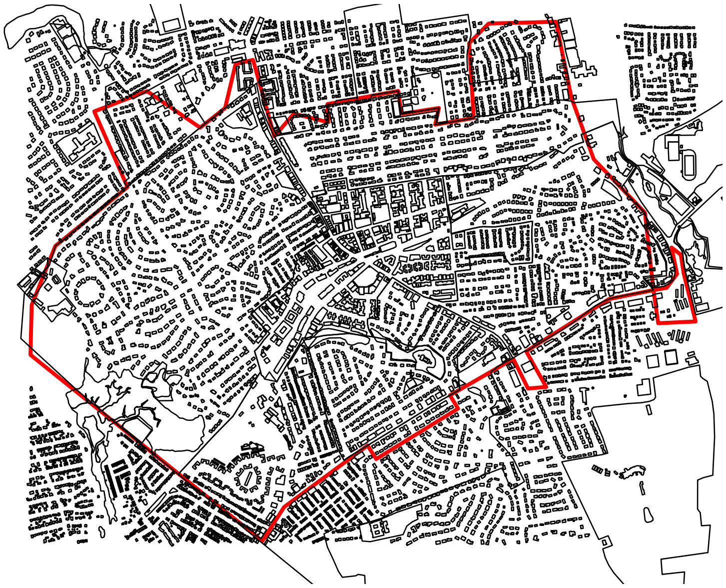
Figure 4: Low- and High-Population Density ZIP Codes: Two Typical Examples

These two maps present the layout of buildings and roads in two sample ZIP codes. The ZIP code of the upper panel is part of New York's Upper East Side, with a high population density of 53,029 residents per squared kilometers, 18 times that of the ZIP of the lower panel. Such ZIP code includes the Great Neck Estates on the northern part of Long Island. It has a population density of 2,968 residents per squared kilometers. Maps have different scales.

(a) Higher Density: The Upper East Side, ZIP 10075



(b) Lower Density: Russell Gardens, Great Neck Plaza, Great Neck Estates ZIP 11021

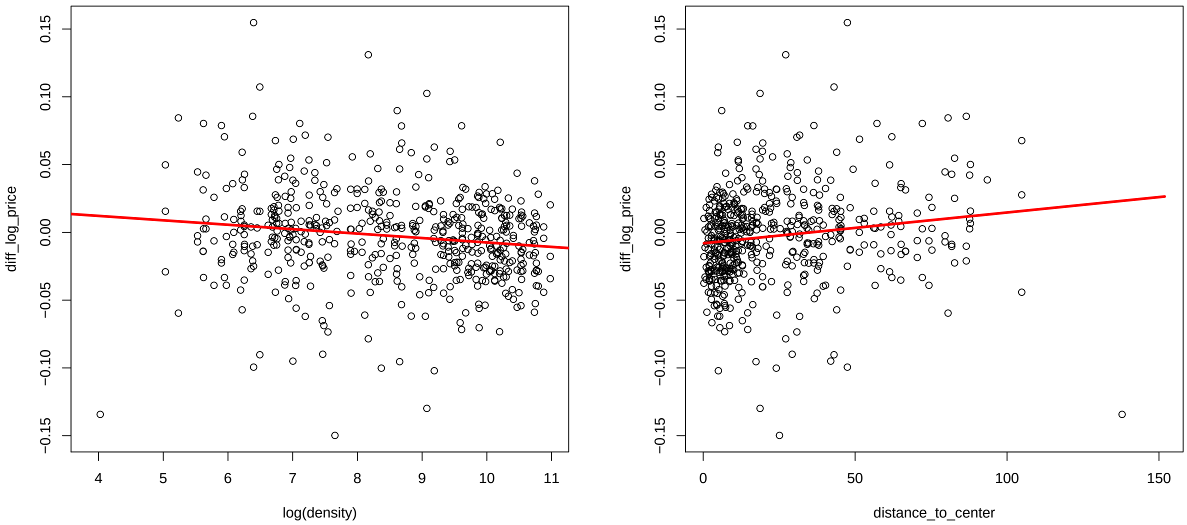


ZIP boundaries projected according to the Census 2010 boundaries. Building footprint and roads current as of 2020 from Open Street Map. Population counts from the 5-year averages of the 2018 American Community Survey.

Figure 5: The U.S. Housing Market in 2020: Evidence of Suburbanization

(a) YoY % Price Changes and Distance to the Center, 2019

(b) YoY % Price Changes and Distance to the Center, 2020



(c) YoY % Price Changes and Density, 2019

(d) YoY % Price Changes and Density, 2020

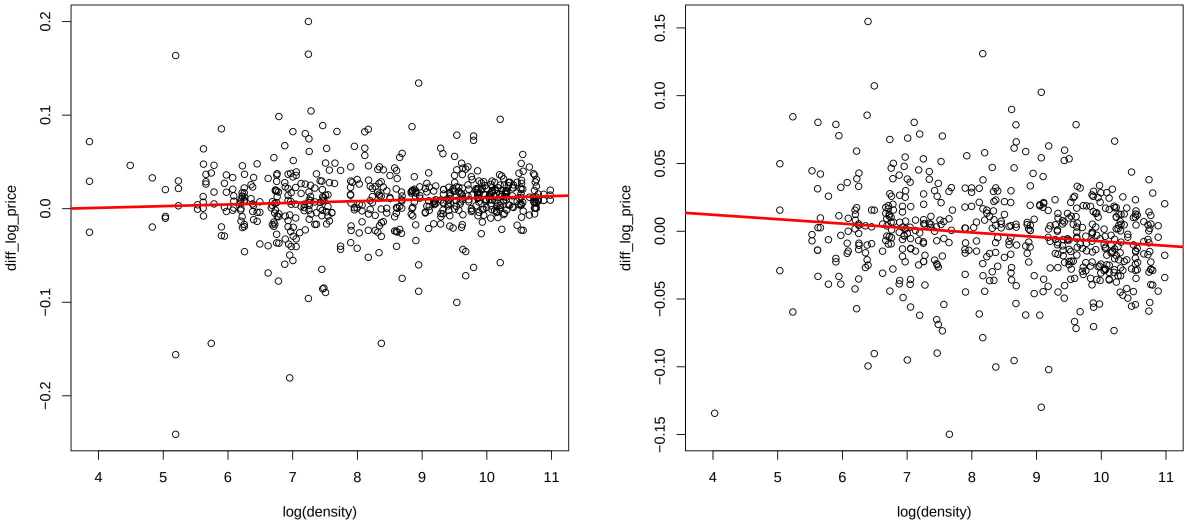
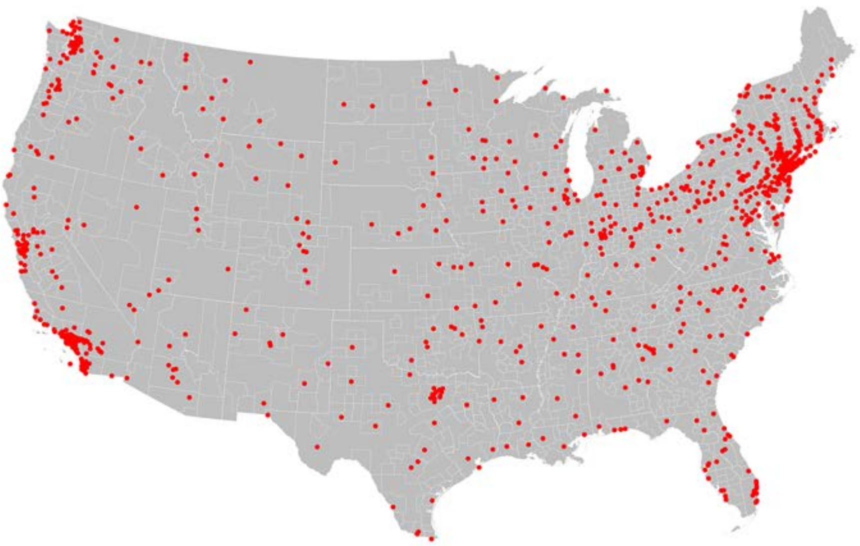
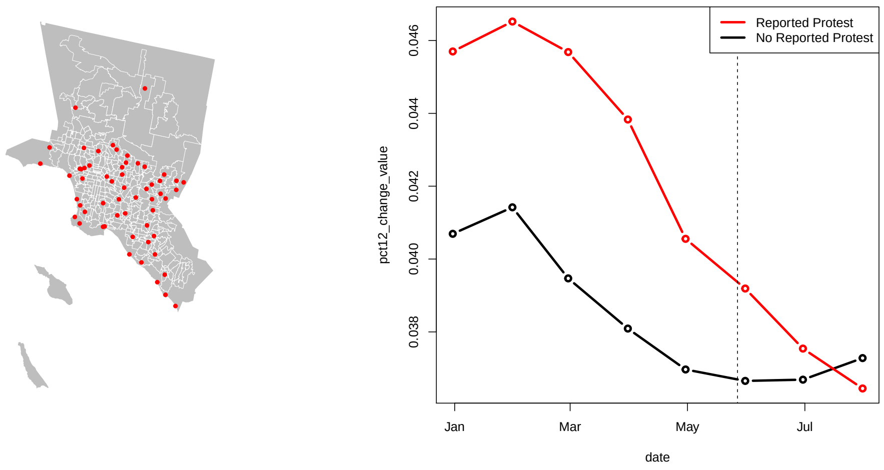


Figure 6: The U.S. Housing Market in 2020: George Floyd Protests and Urban Housing Markets



(a) The Spatial Extent of the May 2020 Protests



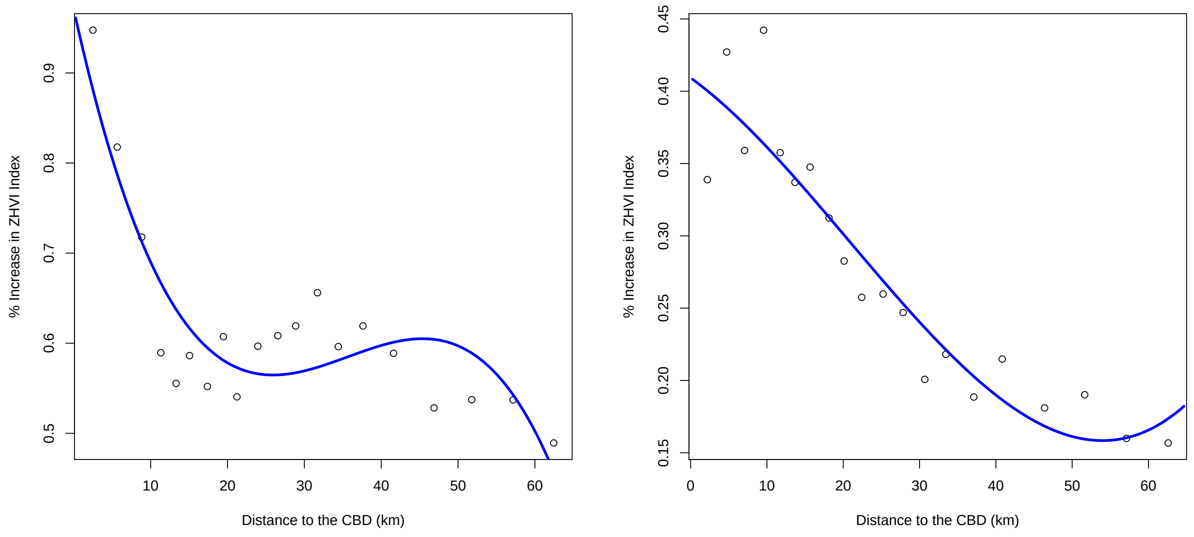
(b) George Floyd Protests in Los Angeles

(c) Comparing Price Appreciation Across Neighborhoods in Los Angeles

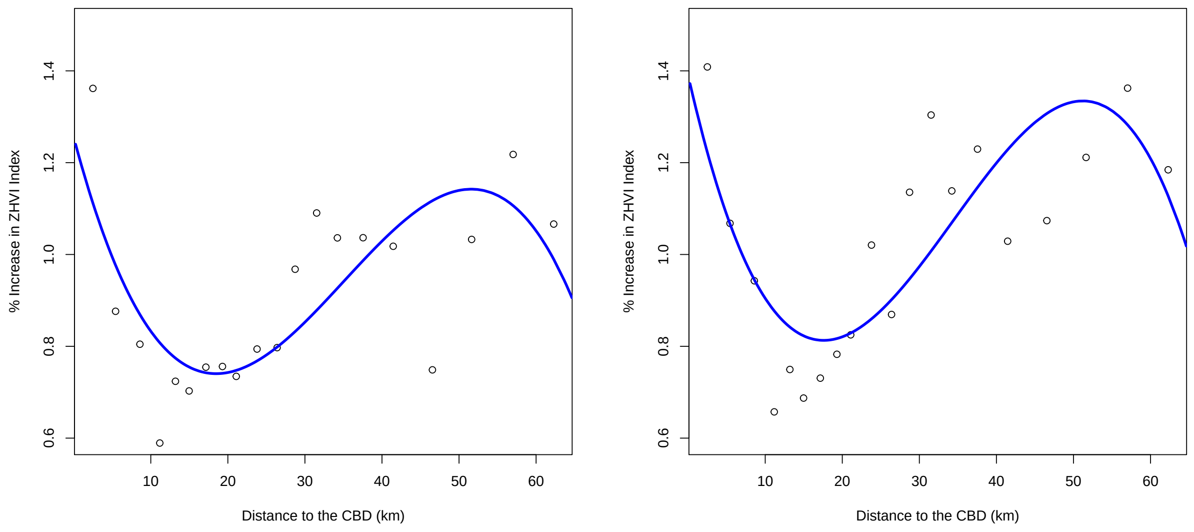
Source: Crowdsourced May 2020 George Floyd protest data through the Wikimedia foundation.

Figure 7: Within-City Adaptation to Shocks: Short-Run Suburbanization in NYC In September-December 2001

These four graphs present the average price appreciation (using the ZHVI index) for bins of neighborhoods ordered by their distance to the Central Business District of the New York metropolitan area. Figures (b) and (c) suggest that the relationship changed sign, before going back to the average negative gradient observed prior to September 11.



(a) Before 2001: Higher Price Increase in the CBD (b) 2002 to 2020: Higher Price Appreciation in the CBD

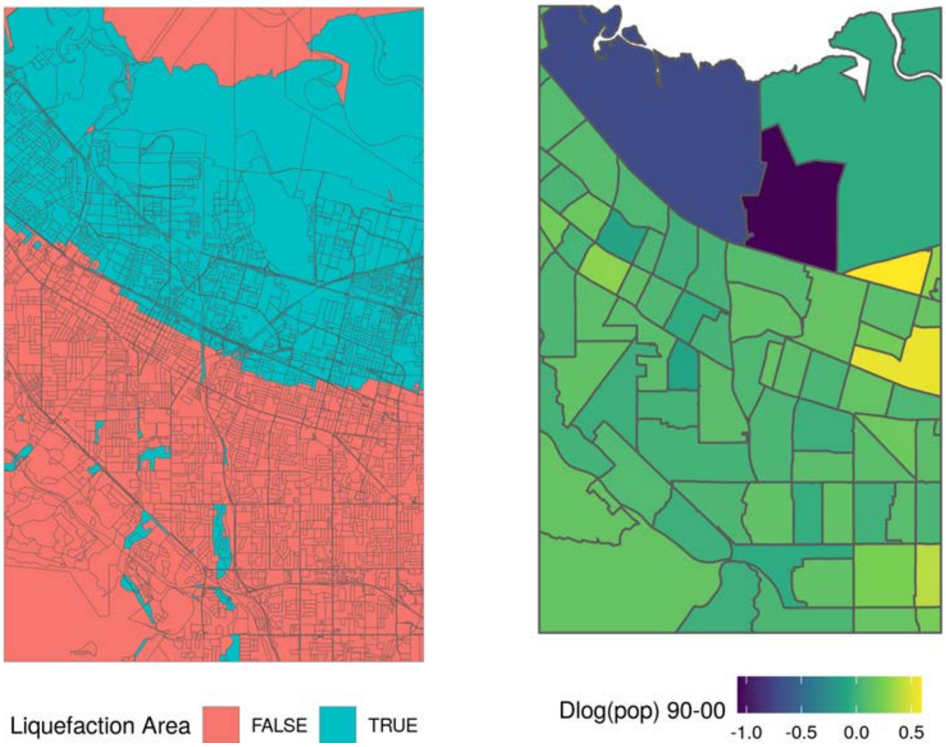


(c) September 2001: Appreciation in the Periphery (d) October 2001: Appreciation in the Periphery

Zip-level ZHVI index from Zillow. Appreciation is month to month in this graph.

Figure 8: Within-City Adaptation to Shocks: The SF Bay Area After the 1989 Loma Prieta Earthquake

Table 4 showed that liquefaction areas, while losing population compared to the rest of the metropolitan area between 1980 and 1990, display no significantly different population growth trend in the next decades (90s and 2000s). These two maps show that indeed, population growth in 1990–2000 in Mountain View is not discontinuous at the border of the liquefaction area.



(a) Liquefaction Areas

(b) Population Changes 1990-2000

Source: California Department of Conservation's regulatory liquefaction maps (left), matched to 2010 Census blocks. Geolytics Neighborhood Change Database 1990-2000 at the tract level (right).

Table 1: Confirmed Covid-19 Cases Per Capita and County Demographics

This table correlates county Covid-19 cases per capita with population density and Census demographics. Regressions include a state fixed effect.

	Dependent Variable: Confirmed Covid-19 Cases Per Capita							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Density)	0.13^{***}		0.04^{*}	0.03^{*}	0.04^{**}	0.05^{**}	0.07^{***}	0.07^{***}
	(0.01)		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Median Age		-0.06^{***}	-0.03^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
log(Median household income)			-0.15	0.45^{**}	0.53^{***}	0.50^{**}	0.64^{***}	0.64^{***}
			(0.09)	(0.15)	(0.15)	(0.15)	(0.16)	(0.16)
Frac. Black			2.47^{***}	2.37^{***}	2.45^{***}	2.48^{***}	2.47^{***}	2.47^{***}
			(0.16)	(0.16)	(0.16)	(0.17)	(0.17)	(0.17)
Frac. Hispanic			3.31^{***}	3.32^{***}	3.00^{***}	3.01^{***}	3.08^{***}	3.08^{***}
			(0.18)	(0.18)	(0.19)	(0.19)	(0.19)	(0.19)
Frac. Asian			-0.88	-1.38	-1.20	-1.05	-1.29	-1.29
			(0.77)	(0.77)	(0.77)	(0.79)	(0.79)	(0.79)
Frac poverty				2.66^{***}	1.75^{**}	1.77^{**}	1.44^{**}	1.44^{**}
				(0.54)	(0.55)	(0.55)	(0.55)	(0.55)
Frac. no health coverage					2.73^{***}	2.72^{***}	2.57^{***}	2.57^{***}
					(0.38)	(0.38)	(0.38)	(0.38)
Frac owner occupied						0.23	-0.32	-0.32
						(0.29)	(0.30)	(0.30)
Frac mobile home							1.60^{***}	1.60^{***}
							(0.27)	(0.27)
Num. observations	3220	3220	3219	3219	3219	3219	3219	3219
R^2 (full model)	0.38	0.42	0.51	0.51	0.52	0.52	0.53	0.53
R^2 (proj model)	0.03	0.10	0.23	0.24	0.25	0.25	0.26	0.26
Adj. R^2 (full model)	0.37	0.41	0.50	0.50	0.51	0.51	0.52	0.52
Adj. R^2 (proj model)	0.01	0.09	0.22	0.23	0.24	0.24	0.25	0.25
Num. of State Fixed Effects	52	52	52	52	52	52	52	52

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Sources: County-level confirmed cases as of August 20, 2020, from the Johns Hopkins Coronavirus Research Center. County population and other demographic characteristics from the 2018 American Community Survey. Density is the ratio of ACS population over the area of the county in squared kilometers using the Census Bureau's boundary shapefile and the U.S. National Atlas 2163 projected coordinate reference system.

Table 2: Within-City Adaptation: Short-Run Suburbanization in New York, March-July 2020

This table uses the ZIP-month Zillow House Value Index (ZHVI) for the Zip codes of the New York-Newark-Jersey City, NY-NJ-PA Metropolitan Statistical Area to regress the year-on-year appreciation (in logs) on the distance to the center (upper panel) and the logarithm of population density (lower panel). The distance to the center is the kilometer distance from the centroid of the Zip code tabulation area to the central business district. Population density computed using the Census Bureau's 2018 American Community Survey and the 2010 boundaries of Census Zip code tabulation areas.

	Dependent variable: YoY Price Appreciation		
Time period	2015–2019	March-July 2019	March-July 2020
(Intercept)	-1.116^{***}	-0.622	2.523^{***}
	(0.208)	(0.782)	(0.816)
log(density)	0.032	0.179^{**}	-0.327^{***}
	(0.021)	(0.091)	(0.094)
Additional controls		Year fixed effects	
R^2	0.013	0.007	0.022
Adj. R^2	0.012	0.005	0.020
Num. obs.	13439	581	541

	Dependent variable: YoY Price Appreciation		
Time period:	2015–2019	March-July 2019	March-July 2020
(Intercept)	-0.750^{***}	1.067^{***}	-0.806^{***}
	(0.102)	(0.204)	(0.211)
Distance to center (km)	-0.004^{***}	-0.007	0.023^{***}
	(0.001)	(0.005)	(0.006)
Additional controls		Year fixed effects	
R^2	0.013	0.003	0.024
Adj. R^2	0.013	0.001	0.022
Num. obs.	13439	581	541

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table 3: Explaining Metropolitan Growth in the Long-Run: Shocks vs. Fundamentals

This table presents a regression of the change in a metropolitan area's ranking between 1970 and 2010 on shocks and fundamentals. The shocks are (i) billion dollar storms according to NOAA's database of significant storm events, (ii) protests with damage to property. The fundamentals are black-white spatial segregation, education, housing supply elasticity, industrial composition, industrial diversification.

	Dependent variable: Change in metropolitan area population ranking, 1970–2010										
Fundamentals											
Black-white dissimilarity	−44.41**										−47.15**
	(15.89)										(17.35)
% College		175.58***									87.64
		(52.66)									(64.11)
Housing supply elasticity			9.79								9.36*
			(5.33)								(4.58)
Industrial composition											
% Mining & oil				0.06							0.12
				(0.25)							(0.27)
% Construction				8.45***							5.44**
				(1.53)							(2.09)
% Manufacturing				0.33							−0.91
				(1.19)							(1.80)
% Utilities				1.22							1.58
				(2.45)							(3.19)
% Finance/RE				6.42**							3.71
				(2.11)							(2.59)
% Retail				1.33							3.30*
				(1.02)							(1.41)
Industrial specialization											
HHI Q2					−5.95						−4.70
					(6.31)						(6.30)
HHI Q3					−12.02*						−6.26
					(6.08)						(7.56)
HHI Q4					−42.33***						−34.25**
					(8.36)						(11.82)
Shocks											
A riot with damage to property						−2.54	−9.40				−9.60
						(7.02)	(10.43)				(6.67)
Nbr of riots with damage to property							4.18				
							(4.70)				
Nbr of b$ storms								−0.02			
								(2.69)			
Property damages									−0.02		
									(0.81)		
Any b$ storm										−1.89	2.48
										(10.79)	(10.37)
R^2	0.03	0.04	0.07	0.29	0.10	0.09	0.09	0.00	0.00	0.00	0.35
Num. obs.	306	306	306	306	306	306	306	306	306	306	306

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Sources: NOAA's Storm Events Database, Ethnic Collective Action in Contemporary Urban United States, 1954-1992 (ICPSR 34341), County Business Patterns, the National Historical Geographic Information System tract level Census file of 1970.

Table 4: After a Shock: Population Changes in the San Francisco Bay Area After the 1989 Loma Prieta Earthquake

These six regressions present the regression of decennial log population change (upper panel) and population rank (lower panel) on the share of a tract in an earthquake liquefaction area.

	Δ Census Tract log Population		
	1990–1980	2000–1990	2010–2000
(Intercept)	0.29^{***}	0.16^{***}	0.10^{***}
	(0.02)	(0.01)	(0.02)
% in liquefaction area	-0.12^{**}	-0.01	-0.01
	(0.04)	(0.03)	(0.04)
R^2	0.01	0.01	0.01
Adj. R^2	0.01	0.01	0.01
Num. obs.	1,791	1,791	1,791
	Δ Census Tract Population Rank		
	1990–1980	2000–1990	2010–2000
(Intercept)	7.81	-1.26	1.86
	(7.64)	(6.61)	(9.20)
% in liquefaction area	-35.90^{*}	5.81	-8.57
	(18.01)	(15.59)	(21.69)
R^2	0.01	0.01	0.01
Adj. R^2	0.01	0.01	0.01
Num. obs.	1,791	1,791	1,791

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Source: California Department of Conservation's regulatory liquefaction maps. Neighborhood Change Database with 2010 Census Tract Boundaries.