Iterative Two-Stage Demographic Sorting in L.A.

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The income distribution of the population of Los Angeles appears chaotic and resists explanation by most standard models. By analyzing the many frequent economic growth and decline phases underwent by Los Angeles, we show that the current distribution is a natural outcome given those fluctuations. We solidify that conclusion by developing a theoretical framework which models city dynamics.

In attempt to shed light on the nature of Los Angeles' demographic distribution, this paper will make the following arguments: (i) Over the last century, L.A.'s demand for labor went through rapid expansion and contraction cycles perpetuated by defense spending and policy (ii) The entertainment industry at west Hollywood was largely immune to these fluctuations and therefore it functions as a traditional business center (iii) The downtown area after the decentralization of industry became a very valuable location for lower income job seekers since it's location minimizes expected transportation costs (iv) Discontinuities in the levels of income along the districts in between are a natural result of the rapid economic cycles.

I. Historic Perspective on the Los Angeles' Economy

The history of L.A. over the last century has been heavily shaped by government policy. After its initial industrial boom due to the discovery of oil, every major industrial boom it had -aside from early film and entertainment- could be traced back to federal policy decisions. More specifically, these booms manifested as the supply of armament, equipment, technology, housing and services demanded by the national defense policy and its consequences. Moreover, this supply was always heavily subsidized on a federal level from the defense budget and a variety of social programs. The intent of this section is to demonstrate this relationship as well as the pattern each investment goes through. The recurring theme is that the government, in response to a sudden external event, would increase spending suddenly and decrease it abruptly after the event is resolved. As a result, demand for labor witnessed frequent cyclic shocks in both directions. Lastly, it is essential to note the discontinuation of the extensive electric rail transportation network in favor of modern multi-lane highways and it's consequences on labor supply.

Putting all those factors together we can reconstruct a timeline of the major events in the last century and use that timeline to identify the cyclic trend. Due to the importance of transportation costs, we will split the time line into two epochs, one predating the 1950s while the electric rail was still in place and

another after the 1950s after its discontinuation. Starting from the year 1900, we can summarize L.A.'s timeline as follows:

- First Epoch (1900-1955):
    1) On 1911, Nestor Motion Picture Company was founded in Hollywood. Moreover, Ford Motor Company opened its' first plant [4].
    2) On 1917, The Emergency Fleet Corporation (EFC) was established to meet US naval industrial demand in World War I[7].
    3) During the 1920s, after the war, L.A. experienced a housing boom[2].
    4) (1929-1939) The great depression.
    5) During WWII (1939-1945), industry was revitalized with shipbuilding, aerospace and other war supporting efforts[10].
- Second Epoch (1955-Present):
    1) (1955) By this time, the majority of the Pacific Electric rail network had been discontinued.
    2) (1956) The initiation of the interstate highway project[1].
    3) (1957-1970) Increase in military and rocketry industries as a response to the Vietnam War, the Sputnik Crisis and the perceived gap in missile technology against the USSR which lead to the establishment of L.A. as Aerospace Industry center[3].
    4) By the 1970s, suburbanization became wide spread, segregation of communities started becoming very prevalent and due to the decentralization of industry the downtown area started having increasing lower median household incomes[9].
    5) During the 1970s up to 1980, the city faced a period of stagnation, rapid loss of industry, civil riots and increased crime rates as well as reduced output per capita.
    6) From 1983-1989 L.A. witnessed an economic expansion due to Reagan era defense policy of outspending the USSR and information technology advancements [6].
    7) The early 1990s was marked by a period of economic contraction, a banking crisis and civil unrest manifested in the "race riots" of 1992[6].

II. The Cyclic Boom-Bust Pattern and Transportation Costs

In the timeline set up above we can see a clear repeated pattern of economic expansion propelled by government defense spending, followed by a period of stagnation and higher unemployment. During the second epoch, public cheap transportation was replaced with reliance on personal cars, most industries were

decentralized and the population was growing rapidly. This established the downtown area, due to its location as a central hub on the intersection of several major highways as the place with the cheapest expected transportation costs for those who seeked industrial jobs or those who faced job insecurity. In addition, the volume of traffic and the tendency of lower income migrants to target central areas (due to cheaper transportation costs), created conditions which made the Hollywood area as well some coastal and port areas into higher income demographic centers. Red-lining and other discriminatory practices further increased the cost of relocating from district to district. If we look at modern day real estate prices, we would see first many discontinuities in rent and sale price per square foot along Los Angeles' map. Furthermore, central downtown while having one of the lowest income residents, maintains much higher real estate prices (sometimes up to double the price of neighboring regions). [11].

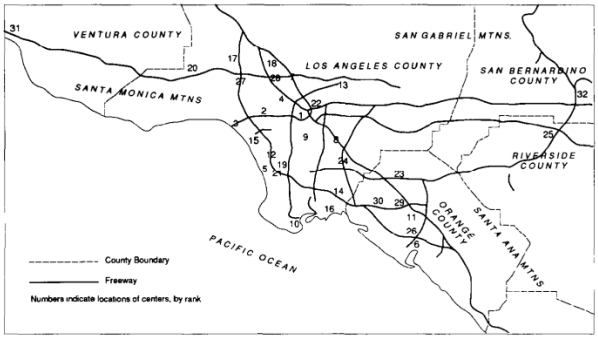
III. Fluctuating Spatial Labor Demand

L.A. employment spatial distribution in the 1980s was dispersed over many centers while being generally influenced by the pull of the central area [5]. Giuliano et al, identified a *core* of several high employment density centers. It formed an arc along the 10th interstate highway. The *core* contains the region from Downtown LA through Hollywood up to the coast. Employment patterns seemed to *fit the notion of a dense center surrounded by areas of gradually declining.* Furthermore, Downtown Los Angeles contained 31 percent of all jobs in the studied centers. In total the the 32 centers cover a wide range of employment from specialized manufacturing to services and entertainment (Figure 1). High employment centers had a high concentration of the population while having relatively low employment-population ratios. *The average employment population ratio for all centers is 1.55, less than four times the average for the entire region. Clearly there is a great deal of intermixing of population and employment, even within well defined employment concentrations.* A more recent analysis on the distribution of employment in the periods of 1997-2014 demonstrated that over that period, center boundaries where fluctuating with entirely new centers emerging and some old ones vanishing[8] (Figure 2).

IV. Spatial Discontinuities in Rent and Income

Empirical results discussed in the previous section showed that labor demand tends to co-exist with high density residential areas in Los Angeles. Those results also showed that labor demand in a given spatial point is highly unstable overtime. Now, we will show the instability of demand for real estate over space in the current time. Using Trulia's mapping service, we created figures (3-8). In figures 3, 4, 5 we show the median rent price of Los Angeles, New York and Chicago respectively. In figures 6, 7, 8 we show the price per square foot for the same three cities. We chose NYC and Chicago as accompanying examples to highlight the

Figure 1. Major employment centers in L.A. in 1980[5]

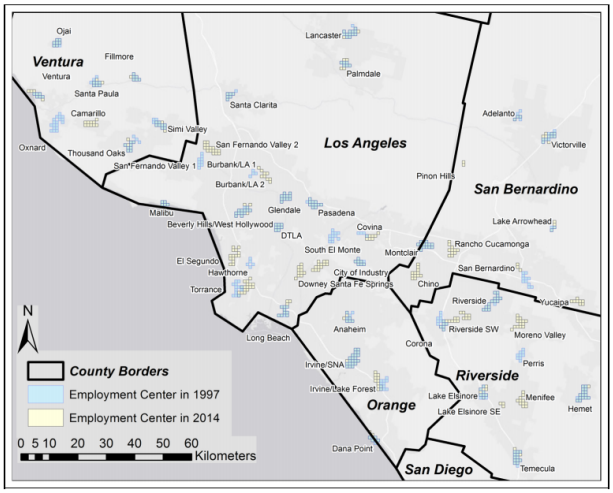


pathology this distribution in Los Angeles. Since all three cities have comparable levels of ethnic segregation (figure 9), the comparison will aid ruling out possible alternative explanations based on Ethnic sorting either by preference or historic immoral means as a possible explanation for the discontinuities observed in Los Angeles. The distribution of rent prices in NYC and Chicago are largely characterized by peaking in the center and then gradually dropping with distance. The exceptions to that rule are almost always another high value peak with low radius. On the other hand, Los Angeles has a peak in the Central Downtown but gradual decline cannot be observed unless you follow a northern trajectory through the arc formed by the *core* described earlier. Furthermore, most anomalies manifest as a low peak, cheap land surrounded by expensive land in contrast to the reverse pattern observed in the other two cities. Furthermore, the prices do not seem to be direct consequences of community preferences sorting. For example, the peak near Korea Town encompasses around 50 percent of its area in conjunction with significant land to its east along the highway. In Chinatown and majority African American regions in Southern Los Angeles, we can observe the low peak anomaly discussed earlier, suggesting lower demand for the internal regions.

V. The Modelling Challenge

Given the employment distribution structure and it's change overtime, the fact that those changes were consistently happening due to the boom-bust cycle described earlier and the current income and rent distribution. Our aim is to understand the structure and formation of rent and income distribution. First of all we have to note that West Hollywood behaves like a classic business district which fits the monocentric model. Given the presence of the combination of stable employment and residential districts. Median income tends to drop smoothly in its local vicinity. Only when observing regions close enough to Central Downtown that the standard distance based models start to fail[8]. However, if the original CBD -the downtown area- underwent a typical suburbanization story, we should

FIGURE 2. LOS ANGELES REGION EMPLOYMENT CENTRES, 1997 TO 2014.[8]



still see continuous changes in income and rent prices, a similar story to New York. If the SBD -West Hollywood- was a point from which wealth decreases with distance from and CBD held an inverse property, we would not observe any discontinuous in wealth levels between adjacent districts. Even if we additionally accounted for the high value of the beach area, it would just add a third "line" where higher levels of wealth concentrate and decrease with distance. Each of these centers would act as a smaller local peak composed on top of the distribution, but this would not account for the frequent anomalous local minima and discontinuities observed in the map.

VI. Modelling sorting given Boom-Bust Cycles

In our modeling attempt we will take the start of the second epoch (1950s) as the initial conditions. This is a crucial time period as it marks a transportation cost shock with the construction of highways and discontinuation of most Pacific Electric Railways. Additionally, during the second period, booms and busts happened more frequently over-shorter time span, like the Reagan Era "golden age" of the 1980s. Faster and more frequent lower the probability of reaching the current state's long run equilibrium. Given the conditions, we are attempting to model the dynamics of transitioning between arbitrary partial local equilibria as conditions change.

To abstract transportation costs and district segregation we will model the city with a line bounded by $(-L, L)$ where the origin represents central downtown. The line is partitioned in uniform unit length segments each representing a district. For the sake of model simplicity we will omit the effects of the SBD of Hollywood as well as the high value beach area. We start a time period $t = 0$,

then for every time period let $J_t(x) \mapsto (0, \inf)$ be the amount of job concentration in segment $x \in \{-L, ... -3, -2, 1, 0, 1, 2, 3, ..., L\}$. Then the utility of an average person living in district x at time t would be $U_t(x) = \sum_{y=-L}^{y=L} \frac{J_t(y)}{||x-y||+1} + Q_t(x)$ and $Q_t(x)$ represents the current quality of the district, we will elaborate more on how Q_t behaves later. In other words, utility is increased for every job discounting transportation costs. Each time period, we receive a signal $\theta(t) \in \{\theta_L, \theta_H\}$, where $\theta_L < \theta_H$ representing a low and a high state respectively. This signal informs the distribution of jobs as follows $J_t(x) \sim (N(\theta(t), \sigma))^2$.

We posit that quality is proportional to the wealth of the inhabitants of the district and disproportional to concentration (i.e. the number of its inhabitants), quality also changes smoothly over time since the impact of the arrival or departure of wealth does not instantly get resolved. We also assume that quality is a normal good. Assuming L.A. had M citizens numbered from 1 to M, then we can denote their district choice at time t with $C_t(i) \to \{-L, -3, -2, -1, 0, 1, 2, 3, L\}$. Therefore quality can be approximated with

$$Q_t(x) = \gamma Q_{t-1}(x) + \frac{\sum W_t(i) \ \forall \ 1 \leq i \leq M \ s.t. \ C_t(i) = x}{N_t(x)}$$

Here $N_t(x)$ is the number of the inhabitants of district x and $0 < \gamma < 1$. This measure of equality takes into account dis-economies of scale for most residential amenities such as schools and policing as well as the residents willingness to pay for local public goods. It follows that the rent $r_t(x, Q_t(x))$ will have the following two relationships: $\frac{\delta r_t}{\delta |x|} > 0$ and $\frac{\delta r_t}{\delta Q_t} > 0$ but these 2 relationships are not sufficient guarantee continuity since we can't make any definitive statement about $\frac{\delta Q_t}{\delta |x|}$.

Even without factoring in that higher quality districts are prone to having more jobs and reality or intentional segregation practices, we can see that rapid boom-bust cycles are bound to create local discontinuities. For example, suppose that at time t^* districts near x^* became more attractive and suppose that $Q_t^*(x^*) < Q_t^*(x^* + 1)$. Then wealthier individuals would to more frequently move to $x^* + 1$. Moreover, during economic contractions, lower wealth individuals in $x^* + 1$ if they choose to remain in the area will choose to move to x^* since quality is a normal good as well. Given constant economic ups and downs, as x increases, quality becomes more and more dependent on the history of the district as opposed to location and transportation costs to jobs, since those costs will vary. When $x \to 0$, the fluctuations don't have the same level of impact since $x = 0$, the downtown area, is where transportation costs to jobs are minimized in expectation.

The model described above is an evolving dynamic system which cannot be solved in closed form. However, it shows the tendency for the emergence of neighboring district with divergent qualities in the short term. When follows

a cyclic pattern of $\theta(t) = \theta_H, \theta(t+1) = \theta_L, \theta(t+2) = \theta_H, \theta(t+1) = \theta_{L+4}...$, whenever $\theta(t) = \theta_H$ and we reach a state where $Q_t^*(x^*) < Q_t^*(x^*+1)$ holds, because of the sorting described above $Q_{(t^*+1)}(x^*) < Q_{(t)^*}(x^*)$, but $\theta(t+1) = \theta_L$ and since everyone is less wealthy, more often than not $Q_{(t^*+2)}(x^*) < Q_{(t^*+1)}(x^*)$ will hold, unless jobs keep showing up near x^*, but if they did there will exist another region on which the logic of this statement holds.

VII. The Full Picture

The modelling exercise above shows that constant fluctuations is expected lead discontinuities. Extending the logic, we can see how Los Angeles' anomalies of frequent cheaper districts surrounded by more expensive one can emerge. If the quality of some place has been historically low, the districts near it will be chosen and will never get a chance to revive. One crucial element which this model omits is negative externalities due to lack of some local public goods like policing. There exists a certain cap on how much the quality difference between two adjacent districts can be. However, some of the most extreme discontinuities we observe in Los Angeles are in the rental price between southern and western borders of Downtown Los Angeles where interstate highways draw a significant barrier. This alludes to a more general version of this model where the severity of externalities between pairs of districts is considered. As long as local district borders are strong enough to sustain quality differences between adjacent districts and lower to middle income industries fluctuate the self-reinforcing cycle will continue to generate such discontinuities. If Southern LA's manufacturing vanished during one of the busts, as it's quality degrades, the probability of industry returning there gets lower and lower. Even if it's location is more efficient in terms of transportation, adjacent districts will be chosen. In a case where it's location is the optimal position, firms will opt to set up in it's periphery making it a local price minima.

This model also sheds light on the rationality of higher willingness to pay of lower income individuals to live near central Downtown, where the difference in rent is compensated by minimizing the expected transpiration cost as opposed to their current transportation cost. As industries shift their location, this strategy minimizes the risk of getting stuck with a high transportation cost or having to relocate abruptly.

VIII. Future Work

As we developed a theoretical framework capable of handling the impact of economic fluctuations on wealth distribution, we made a strong and naive assumption about the distribution of $J_t(x)$. It is likely the case the distribution will depend on quality and other region specific goods. We call upon future economists to look into understanding the true distribution of J_t using historical data and then estimate empirically the validity of the local discontinuities result.

REFERENCES

"The Cracks are Showing". The Economist, june 2008.

Michael Brocker and Christopher Hanes. The 1920s american real estate boom and the downturn of the great depression: Evidence from city cross-sections. In *Housing and Mortgage Markets in Historical Perspective*, pages 161–201. University of Chicago Press, 2014.

Dwayne A. Day. Blue skies on the west coast: a history of the aerospace industry in southern california, 2007.

James J Flink. *The automobile age*. mit Press, 1990.

Genevieve Giuliano and Kenneth A Small. Subcenters in the los angeles region. *Regional science and urban economics*, 21(2):163–182, 1991.

George Hanc. *History of the eighties: lessons for the future, an examination of the banking crises of the 1980s and early 1990s*, volume 1. Federal deposit insurance corporation, 1997.

Edward Nash Hurley. *The bridge to France*. JB Lippincott Philadelphia, PA, 1927.

Kevin Kane, John R Hipp, and Jae Hong Kim. Los angeles employment concentration in the 21st century. *Urban Studies*, 55(4):844–869, 2018.

Douglas S Massey and Nancy A Denton. Suburbanization and segregation in us metropolitan areas. *American Journal of Sociology*, 94(3):592–626, 1988.

Dana T Parker. *Building Victory: Aircraft Manufacturing in the Los Angeles Area in World War II*. DT Parker, 2013.

trulia. Los angeles real estate market overview, 2018.

Figure 3. Map of rent prices in L.A. districts

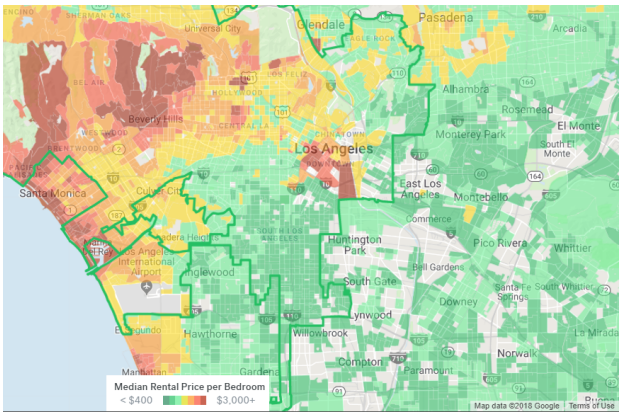


Figure 4. Map of rent prices in NYC districts

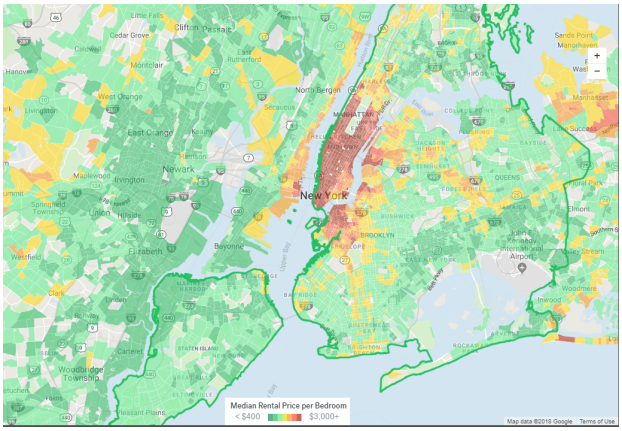


Figure 5. Map of rent prices in Chicago districts

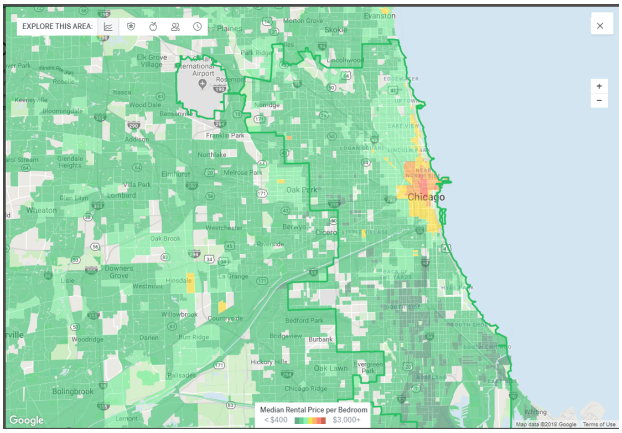


Figure 6. Price Per Square Foot in L.A.

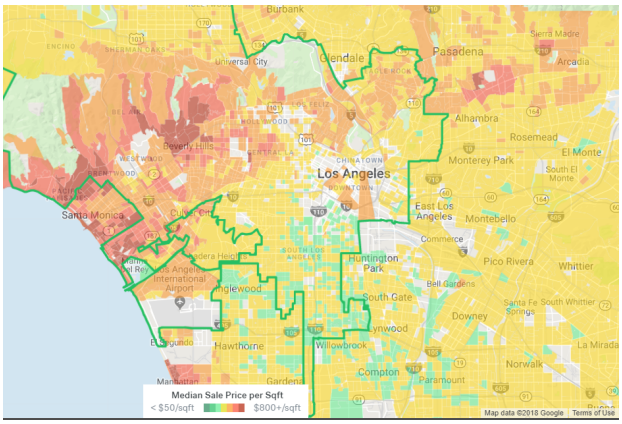


Figure 7. Price Per Square Foot in NYC

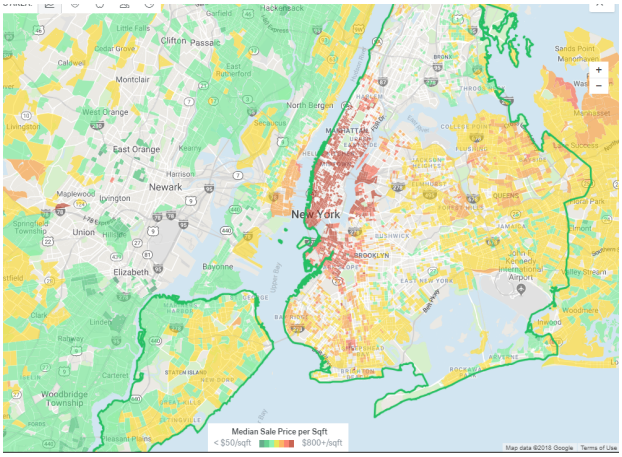


Figure 8. Price Per Square Foot in Chicago

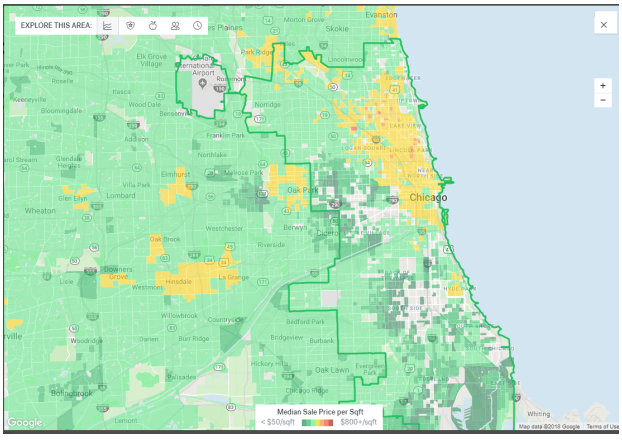


FIGURE 9.

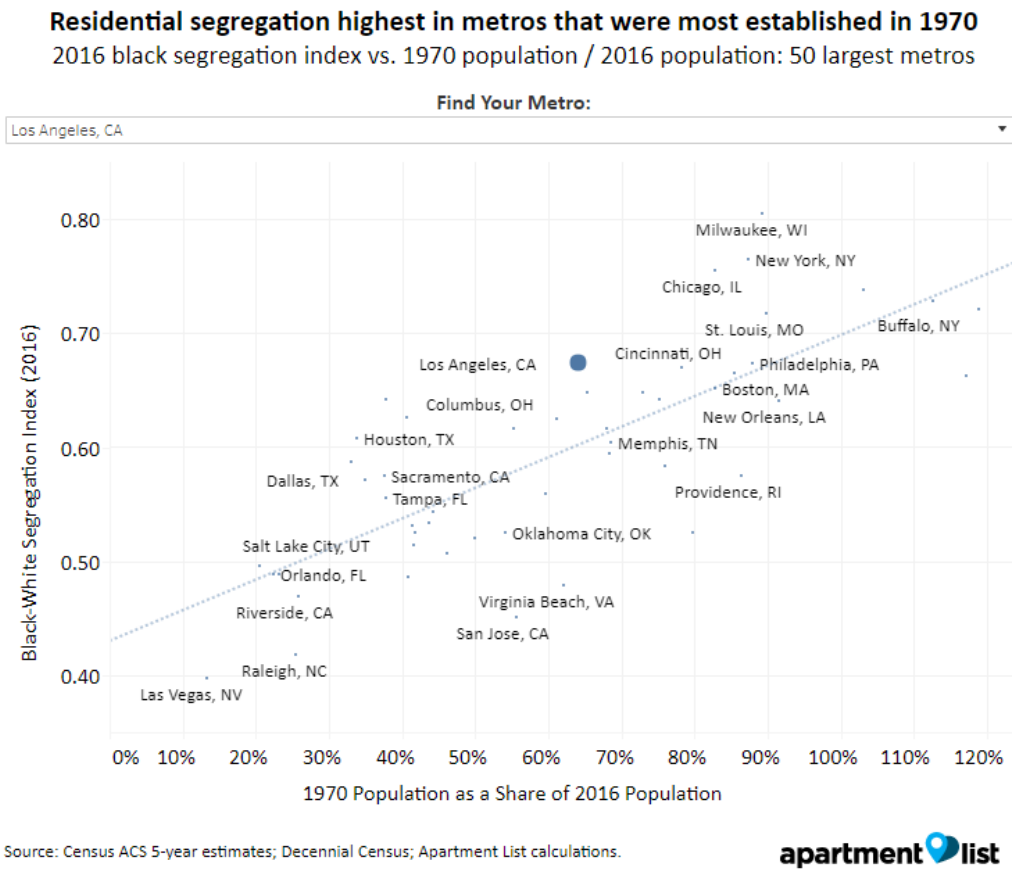

Residential segregation highest in metros that were most established in 1970
2016 black segregation index vs. 1970 population / 2016 population: 50 largest metros
Find Your Metro:
Los Angeles, CA
Black-White Segregation Index (2016)
0.80
0.70
0.60
0.50
0.40
Milwaukee, WI
New York, NY
Chicago, IL
St. Louis, MO
Buffalo, NY
Cincinnati, OH
Los Angeles, CA
Philadelphia, PA
Boston, MA
Columbus, OH
New Orleans, LA
Houston, TX
Memphis, TN
Dallas, TX
Sacramento, CA
Tampa, FL
Providence, RI
Oklahoma City, OK
Salt Lake City, UT
Orlando, FL
Virginia Beach, VA
Riverside, CA
San Jose, CA
Raleigh, NC
Las Vegas, NV
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 110% 120%
1970 Population as a Share of 2016 Population
Source: Census ACS 5-year estimates; Decennial Census; Apartment List calculations.
apartment list

Figure 10. MEdian Household Income, Los Angeles, Census Data 2000-2018, city-data.com