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LOCATING THE MANHATTAN HOUSING MARKET:
GIS EVIDENCE FOR 1880-1910

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Working Paper 2020-01

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Abstract

There is a dearth of systematic information about the historical New York City housing market. We present a new sample containing rental price and characteristic data for almost 10,000 Manhattan units which was collected from historical newspapers for the period 1880 to 1910. These units were geolocated to the historical map of Manhattan Island to explore their geographic coverage, using Geographic Information System (GIS) software. We use this new sample to plot the evolution of the location and quality of available Manhattan housing units. This complements existing research on the growth of New York City and the evolution of the ethnic composition of neighborhoods across Census years, as we show information at annual frequency during this time of high growth for the city.

Keywords: Historical GIS; New York City; housing markets; neighborhood change

JEL Codes: N31, N91, R31

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historical GIS maps of Manhattan Island and geocoded the first round of observations. Richard Wright provided excellent GIS assistance on an earlier draft.

Introduction

Housing is a relatively neglected topic within economic history, and the focus of study has often been motivated by data availability—looking at mortgage markets, and the relation between housing and business cycles.¹ Historians have highlighted the role that housing plays in overall wellbeing over time, but have had little data to work with beyond anecdotes and case studies. New York City has featured prominently among such case studies, beginning with the photographs and stories of nineteenth century tenement life from Jacob Riis (1997 and earlier editions). Others have presented details of the lives of the poor, often immigrant, classes (Gabaccia, 1984 and Scherzer, 1992) and have outlined the dynamics of relations between tenants and landlords in America’s biggest rental market (Day, 1999).

Recent advances in computing have facilitated new spatial analyses of historical Census data at an increasingly micro level, to explore such questions as how neighborhood change occurred over time and to quantify the level of residential segregation. See, for example, Logan and Parman’s (2017) use of Census cards to measure the likelihood of having an African-American neighbor as a proxy for segregation and Shertzer et al’s (2016) description of geocoded data at the enumeration district level for 10 cities for each Census from 1900 to 1930. The latter paper provides a summary of available historical GIS work, which includes the NHGIS and Urban Transition HGIS projects, covering a variety of cities. Other spatial contributions include Barr and Tassier (2016) which digitized and geocoded residential and employment locations from historical Manhattan business directories to show how midtown rose as the main business district, without fully replacing activity around Wall Street.

¹ See Snowden et al (2018) for a detailed overview of the economic history literature. Gordon and vanGoethem (2007) also decried the lack of reliable data on the rental mark before 1975 and highlighted some issues with using the CPI data that goes back to 1914.

This paper builds on this growing literature by introducing new geocoded data on the Manhattan rental market for 1880 to 1910 on an annual basis, drawn from newspaper rental advertisements.² We believe that this dataset is ideal for analyzing the historical housing market, as well as population movement and neighborhood change, for the following three reasons. Firstly, the city was mostly a rental market: only 9.63% of household heads reported real estate holdings in 1870³, which decreased to 1.7% owner-occupied dwellings by 1940, such that we capture most of the activity in the housing market that was relevant for the average resident.⁴ Secondly, the historical record suggests that the market was very active, with families moving whenever incomes rose or landlords attempted to raise rents for the following year. An 1875 city directory described how “Of all the civilized people on the face of the earth the inhabitants of New York appear to be the most inclined to move about” (Scherzer 1992: 19). This means that tracking the location of new listings over time can provide insight into population movements across the island. Lastly, we can map housing market activity at the address level, at higher frequency than is possible with Census data, which can be used to shed more light on the timing of neighborhood growth and the evolution of neighborhood composition over time.

We present evidence on both location of units advertised, in five popular newspapers, and their quality, as measured by structural and geographic characteristics, to provide a sense of how the market evolved along these dimensions. This allows us to say more about the timing of the development of new neighborhoods such as the Upper West Side and Morningside Heights, and the characteristics of the units that residents were moving

² We limit ourselves to the rental market here, although newspapers did also have some details about sales transactions.

³ 1% sample of the Population Census from IPUMS.

⁴ 1940 Housing Census figures. Home ownership across outer boroughs was greater and households were moving out of Manhattan to achieve home ownership throughout the latter part of the sample period considered here.

to. This research also complements older studies such as the Exhibit of Congestion of Population in 1908 which mapped population density at the block level from the 1905 State Census for areas below Fourteenth Street, along with details on the commuting patterns of workers traveling downtown for work and industrial location (Pratt, 1968).

The use of newspaper advertisements as a research source of housing information goes back at least to Rees (1961), who built a rental price index for 6 cities with no controls for unit characteristics. For New York City, he chose the New York World because of its working-class target audience, and our sample also uses that paper. Margo (1996) constructed a quality-adjusted index of rents for the New York City area for the period 1830-1860, using newspaper advertisements. His sample contained fewer than 1,000 observations, but was comprehensive enough to estimate the capitalized value of various unit-level characteristics as well as the distance to City Hall. Kholodilin (2016) presented monthly data on asking rents in Berlin, from 1909 to 1917, and explored the determinants of trends during and after World War I and its consequent population and building fluctuations. He was also able to geocode his dataset and relate rentals to the evolution of the transit network.

More generally, advertisements containing asking prices have been used before. Examples include Schulz et al (2014) for labor markets and Raff and Trajtenberg (1997) for automobiles. The advantage of newspaper-created samples is that they are comprised of units presented to the open market for rent, which are more likely to be representative of housing market activity at each snapshot of time and does not limit to the subset that actually rented for an agreed price. This type of data is also easily accessible to anybody affiliated with a research library that subscribes to historical newspaper archives, although collecting these types of datasets is labor-intensive given the need to manually assess

whether each advertisement meets the sample criteria as well as to enter and geocode the data.

The paper thus extends the methodology of existing historical studies by geocoding the sample of rental units obtained from newspaper advertisements. In the following sections we describe the data collection and geocoding processes. We then validate our new dataset by comparing it to housing information from existing research. Finally, we present an application of the dataset to the question of the evolving location of the Manhattan real estate market and document the characteristics of units located in newer neighborhoods, relative to existing ones, focusing on size and monthly rents.

New Housing Dataset

Information on rental prices and characteristics at the unit-level was collected from newspaper advertisements from the following newspapers: New York Herald (NYH), New York Sun (NYS), New York Times (NYT), New York World (NYW) and the Brooklyn Daily Eagle (BDE), the last being used in only a few cases. Each year is represented by data from at least two of the above newspapers. Advertisements were coded where the asking rent and the exact street address of the unit were available. Various additional information was included in the typical advert, such as whether or not the unit was furnished; some measure of unit size such as the number of rooms or number of stories; proximity to public transport; and inclusion of an array of amenities such as electricity, steam heating or fixtures and fittings. Figure 1 shows the distribution of observations according to newspaper source, highlighting that, with the exception of 1885, there is a healthy sample size in each year.

Figure 1 about here

The New York rental market was organized so that, though written leases were uncommon before World War I, the oral terms were quite standard and movement followed the following pattern. Landlords announced to tenants early in the calendar year the new rental price and tenants would decide whether to stay or move, with moves usually taking place around May 1st. Any attempt to change the rent mid-year could be resisted by tenants (Fogelson 2013: 32). This motivated us to collect data for March-May. For 1890 and 1891, we sampled the entire year and did find clustering of rental advertisements in the months of March-April-May. A secondary moving date of October 1st is mentioned by, for example, Fogelson (2013: 21) and motivated collection of September rents when Spring was missing. Rees (1961) also looked at April and September rents, for these reasons.

A variety of different types of apartments and homes are advertised for rent in the various newspapers. There is some geographic variation by source-- the NYT appears to have targeted a wealthier clientele, with a higher proportion of units being located next to Central Park and the more prominent avenues running North-South from the Park to downtown. Large townhouses are advertised alongside smaller apartments or parts of houses to rent. All of the publications carried “rooms for let” or “boarders wanted” type of adverts, targeting those who simply needed 1 room, furnished or unfurnished, in a large house. Figure 2 provides snapshots from the NYT and NYW, demonstrating that only a subset of advertisements contained all the required information and that we sampled a wide variety of rental types as far as possible.

Figure 2 about here

Data from Gentzkow et al (2014), provides information on newspaper circulation, which ranges from 34000 for the NYT in 1880 to almost half a million for the NYW in 1896. These were popular newspapers and were main sources of information on available rentals, and advertised themselves as such. Day (1999: 38) describes how immigrant banks advertised in storefronts and papers, while the Conference on Research in Income and Wealth (1975) describes newspapers and periodicals as a regular part of the average household budget, also suggesting that these are an ideal source for studying the housing market.

We recorded the newspaper price and their advertising fees wherever available, to get a sense of who could afford a newspaper and afford to advertise. The real price of buying a daily copy of each paper declined somewhat over our sample period. The NYT was the most expensive but its price (in 2017 dollars) fell from 96 cents in 1880 to 26 cents in 1910. The NYS cost 48 cents in 1880 and 52 cents in 1910. The price of a line of advertising also declined, most notably in the NYT, where it went from 16 2017 dollars per line in 1880 to 3.86 2017 dollars per line in 1910. The NYH in 1910 charged a bit more, up to \$7.72 per line. This price has implications about the type of units and rooms that were likely to be advertised. The cheapest rooms for rent or rent and board would likely only be advertised when multiple rooms were available, as otherwise an advertisement could not be justified economically. Our strategy of building the sample during the busy moving period makes it more likely that we capture the lowest end of the market. However, we likely do not fully capture the lower tail. We do not observe many advertisements mentioning subletting, for example, even though it was a common practice. A unit that was listed at a particular price and size may in fact have been occupied by two families, thus reducing rents and housing quality, or been let for less than asking price. Further, fashionable and expensive units might not have listed a price

(many simply mention a fair or negotiable rent) or been advertised in newspapers for reasons of privacy or exclusivity, so we may miss the extremes of the market.

As an additional check on our sampling strategy, we performed some comparisons of the average characteristics of units that were advertised with and without prices, and found that those that listed no price were more likely to be houses or rooms with board (as opposed to apartments, which comprise the bulk of the sample).⁵ They were not statistically significantly larger or more likely to be described as “elegant”, but we only collected a limited sample of 285 listings without prices so it is difficult to draw definitive conclusions. We also collected 24 months of rental data from the NYS for 1890 through 1891 and explored whether the characteristics and rents were significantly different across sample and non-sample months. Rents were statistically significantly higher in the sample months, by about 14%, despite the unit size being similar. In fact, most characteristics are similar across the months, notably the location of the units. It appears that the higher rents may have been driven by listing nicer apartments during the prime moving period, when landlords tried to extract the maximum for the property. Either the same units would then be reduced if the landlord failed to rent them by May 1st, or the remaining apartments that had not been renewed or rented were actually of inferior quality or location.

Geocoding

The rental units were geocoded to the historical map of Manhattan using the program ArcGIS. In many cases we were able to find latitude and longitude for units using a macro connected to the current Manhattan streetmap. These were manually checked and any that could not be geocoded initially were located by hand and coordinates identified

⁵ We do not show these results here, but they are available upon request.

using Google maps. This is similar to the manual part of the procedure outlined in Barr and Tassier (2016), Appendix 1, which also describes some of the same challenges to geocoding that we outline below.

The main challenge in completing the geocoding task was in locations where public housing projects (or private developments such as at Stuyvesant Town) or other major new buildings (Penn Station, for example) have been constructed since 1880 which have changed the street map substantially. For cities where the street map remains largely unchanged, this process could be automated to a large extent, as modern-day coordinates derived from the modern map could be used. We began by identifying our addresses on the modern map of Manhattan, and manually corrected the output to account for street name and numbering changes. We began with about 15,000 observations drawn from historical newspapers. This was reduced due to: 1) a lack of rental price information; 2) inability to be geocoded or were actually outside of Manhattan; 3) we oversampled for the years 1890 and 1891 and here keep only data for the usual Spring sample months; 4) we dropped commercial units and 5) we merged to three further datasets, described now, which resulted in the loss of a small number of observations. This left us with 9,962 observations for this paper but this approach can be scaled up by consulting other newspapers, in a greater range of months and gathering the universe of acceptable observations from each issue.

We also constructed a new dataset of transportation times from each of the rental points to City Hall. City Hall was the locus of the traditional central business district of Manhattan. We built an algorithm in Python using the historical timetables of New York City for subway and elevated trains combined with the evolution of stations for each mode of transport over time and the shortest walking distance between units and transit

stops.⁶ The formula calculated the minimum transit time from each unit to City Hall. Transport times fell over time as the subway was built in 1904, elevated railroads electrified from 1902, and transportation options expanded over the full 31-year span (Hood, 1993).

Using the free software QGIS, we added a modern shapefile of Manhattan neighborhood boundaries and aggregated to larger neighborhoods that made sense historically.⁷ This became a convenient way to organize and analyze the data. This standardization was necessary because we merged with Census population data by enumeration districts. Enumeration district boundaries changed over time, so we aggregated both the population and rental data up to the neighborhood level, when we wish to compare the two. Population totals, by country of origin, for each district, were assigned to neighborhoods according to the proportion of district area that fell within each neighborhood boundary. This is similar to the approach in Shertzer et al (2016) which divided cities into hexagonal shapes and calculated population counts for each shape according to its share in that year's district boundary. Incorporating Census population data allows us to understand further the coverage of the rental dataset and to compare the evolution of location as measured in the two datasets, which we discuss more below.

Figure 3 displays the evolution of the Manhattan housing market over 31 years, as mapped using the free software R. There is good overall coverage of the island, with the

⁶ We used Walker (1918) and Fischler (1997) for most details of opening dates for each transit stop/mode, coupled with the map of the entire system as it existed in 1910, from Villarreal et al 2014. Further details came from Taunton (1882). An original timetable from the Interborough Rapid Transit Company provided information on time between each stop.

⁷ Shapefile publicly available from:

https://data.cityofnewyork.us/browse/select_dataset?Dataset-Information_Agency=Department+of+City+Planning+%28DCP%29&nofederate=true&suppressed_facets%5B%5D=domain&utf8=✓

exception of the Lower East Side which was a heavily populated tenement district but which apparently did not advertise its rentals in the typical newspapers. We discuss coverage of this area further in the next section and explore in more depth the changing location of the Manhattan real estate market in the application section, along with what that implied about who was moving to new areas of the island.

Figure 3 about here

Comparison to Existing Information

This section presents information on actual rental prices in New York City gleaned from the secondary literature on housing.⁸ We compare this to observations on asking rents in our newspaper sample in order to validate the dataset, while noting that the secondary literature usually gives no information on unit quality beyond, occasionally, size which makes comparison difficult, and that our larger sample makes more systematic analysis possible.

Dora Costa's dataset on women giving birth in the Lying-In Hospital in New York City lists actual monthly rents paid by their households.⁹ We looked at 28 observations from 1910 and compared them to our sample of asking rents. A number of observations were close enough geographically for direct comparison. For example, 1 of our units was 733 feet from 1 of Costa's observations on West 81st Street. The asking rent in our sample was \$12, while the realized figure was \$8 in Costa's dataset. The same margin was observed for units on East 11th Street that were 976 feet apart. These are most

⁸ All figures given in this section are in nominal, contemporary dollars.

⁹ The dataset was downloaded from Dora L. Costa's website on 8/6/2015: <http://www.econ.ucla.edu/costa/data.html>. It contains exact addresses.

convincing because they contain actual addresses and can be compared to co-located observations.

The Charity Organization Society of the City of New York's tenth volume (1900: 3) details a 4-room apartment on East 12th Street inhabited by 2 Austrian families for a total of 7 people, renting for \$14. On Elizabeth Street 2 Italian families rented 3 rooms for \$6, while another 2 Italian families rented 3 rooms for twice that price. In the newspaper sample are single, furnished rooms listed in 1895 and 1896 on East 12th Street for between \$2.25 and \$4.25 per week. Another single, furnished room was listed in 1900 for \$3. Scaling up to four rooms, the asking prices in our sample are in line with the actual prices given for East 12th Street at similar points in time.¹⁰ We do not observe many advertisements for families to share apartments, while we do record many prices for furnished/unfurnished rooms and boarders. We believe we capture part of the lowest-income market but not the full span.

As shown in Figure 3, our dataset records few observations in the Lower East Side tenement district, where we know a large population resided. The secondary literature commented a lot on this area and provides some more detail. Jacob Riis (1997) cited going rents around 1900 to be \$6 for a rear tenement, \$17 for 4 front rooms in more modern tenements. These do not specify exact locations but probably refer to the Lower East Side tenement district. The newspaper dataset shows single, furnished, front rooms in 1900 had asking rents of \$1.50-4 per week, suggesting that \$6-16 for four rooms was consistent.

¹⁰ There are no observations on Elizabeth Street in the newspaper rental sample. Gabaccia (1984: 74) provided more rents in her in-depth study of Elizabeth Street, around 1905. Two-room apartments cost \$9.50 monthly in a dumbbell tenement. 50% of apartments had 3 rooms, costing \$8-\$15 per month while the 20% with 4 rooms charged about \$20 in a new law tenement.

Anbinder (2001) describes an overcrowded Bayard Street apartment in 1885 where lodgers paid 5 cents per spot to sleep, while a bed at a lodging house at 508 Pearl Street in 1882 cost 12 cents per night and 10 cents for a basement room. The new dataset does list a couple of unfurnished rooms to rent in Pearl Street in 1883 and 1884, and those cost \$0.83-1.42 per night. This is substantially more than Anbinder finds, suggesting that the newspapers do not advertise places such as 508 Pearl Street, an extremely cheap boarding house. Chapin's (1909) study of living standards in New York City cites a 4-room tenement on Essex Street with bathroom for \$18 per month in 1905. The new dataset has few residential listings in this area but it does show an apartment on Bowery Street offered for \$15 in 1901 and nightly hotel room rates on Bowery of 25 cents in 1903. The per room rate for this hotel is greater than for Chapin's tenement, but assuming that it comes furnished and with some hotel amenities, this is not out of line.

The secondary literature thus has more abundant information for those living in tenements, who indeed made up a large share of the city's population. The new, newspaper sample reflects more the changing nature of the New York City housing market and may be more representative of classes above tenement-dwellers. These kinds of comparisons are fairly crude, and as King's *Handbook of New York City* (1892) outlined, apartment rents showed huge variation at this time, depending on a variety of factors such as location, size etc. The direct comparisons suggest that our data is in line with what previous researchers have found, but the newspaper-derived sample may represent a different basket of properties, targeting a slightly wealthier renter, compared to those identified in previous work.

Application: Changing Location of the Manhattan Real Estate Market

This section explores the evolution of Manhattan rentals in terms of dispersion across neighborhoods, identifying the main areas that experienced rental activity, which was due to new development in some cases. We further explore the characteristics of units in terms of mean monthly rents and number of rooms, and we split this at 1904, to acknowledge the key role of the subway in terms of changing the costs of commuting longer distances. This is merely a first step in determining whether the changing commuting capability made substantive differences in the type of housing consumed in New York City and in providing suggestive evidence of which types of people were able to take advantage of this unprecedented mobility within the city.

Figure 4, panels a and b, displays counts of the data according to neighborhood and is split at 1904 to demonstrate the effect of the subway on the location of units advertised in newspapers. Areas with very few observations before 1904 include the northernmost neighborhoods—Washington Heights and Morningside Heights. These grew substantially after 1904, as the cost of traveling to the jobs in lower Manhattan substantially decreased. The figure also demonstrates the main areas that had substantial real estate activity in our sample period—midtown, particularly before 1904, with the upper west side, Harlem and the northernmost neighborhoods predominating later.

Figure 5 shows the evolution of the sample in 5 year bins, for 8 slightly more aggregated neighborhood groups (for ease of exposition). Here, we see that the number of units advertised in midtown peaked by 1890, while the upper west side began its growth in the late 1890s and the northern tip of the island really saw a break in trend after 1900. It seems that the arrival of the subway made a substantive difference mainly for the northernmost neighborhoods, which goes along with our priors about transit costs,

which fell most steeply for those areas at that time, as we will show more concretely below. The earlier expansions of the elevated train network had already made expansion into Harlem and the upper west side possible and desirable for workers and landlords alike.

Figures 4 & 5 about here

Another way to think about the evolving location of the housing market is to calculate some measure of the locus of our sample observations. The mean latitude and longitude of our sample in 1880 is roughly at the location of Trump Tower today in Midtown, which confirms Barr and Tassier's (2016) findings that several industries had moved to midtown by 1880, bringing residents with them. The huge number of observations located in the broad midtown district, shown in Figures 4 and 5, also bears this out. By 1910, the mean latitude and longitude of the sample is placed off Central Park West at West 91st Street, which today houses a large Depression-era apartment block which replaced an 8-story block built in 1902, indicating also the decline in relative importance of midtown as the center of the Manhattan rental market and ascendancy of neighborhoods higher on the island.

Applying this approach more systematically, Figure 6, panels a and b, shows mean latitude and longitude by year, using only observations from the NYT and NYS respectively. Panel a covers 1882-1910, because the NYT was available in almost all years and panel b spans 1880-1899, when the NYS was available. Focusing on one newspaper source at a time ensures greater comparability, as each newspaper was targeted at a slightly different clientele—the NYT even early in the period was advertising slightly nicer units in areas closer to Central Park than other outlets. Panel a maps out part of

Manhattan island, as the locus of observations is lower in the island early in the sample and in the later 1890s and 1900s the locus moves further west and up the island. Panel b begins even further down the island, in the area around Washington Square Park, and units advertised tended to be closer to the Metropolitan Museum of Art, 80 blocks up, as we go towards 1899. This suggests a switch in rental activity from downtown and midtown to areas like Harlem, the upper west side and even further up the island. The figure also provides more information on the timing of these changes, compared to Census data which offers nothing in between 1880 and 1900, and then 1900 and 1910. Figure 6 shows decisive shifts in rental location by the 1890s and again after further transit expansions from 1902 and 1904.

Figure 6 about here

We have thus far only presented data from our new rental sample. However, as mentioned above we also merged the Census population counts by enumeration district to our dataset and aggregated it to the neighborhood level, to ensure comparability with our other figures. Figure 7 depicts population counts per square kilometer across neighborhoods for the available years—1880, 1900 and 1910. Census data thus provides the overall pattern of population movement across the island. After 1880, the lower extremity loses population, while midtown initially gains and by 1910 there is more movement towards the northern extremities. The figure, when compared to the other information we have presented, highlights that the rental dataset can provide more information about the exact timing of these shifts, which is useful in trying to identify their main determinants, given that factors such as transportation improvements happened continually during the 31 years, while the Census data leaves 10 and 20 year gaps. We discuss potential determinants now.

Figure 7 about here

One determinant of residential location that we have focused on throughout this paper is the menu of transit choices. Figure 8a shows isochrones of transit times, in minutes, for the island of Manhattan in 1880 and 1910. The biggest change in transit time comes for the upper part of the island, after 1904. Figure 8b shows rental observation locations in 1880 and 1910 and we observe a geographic shift upwards and westwards. One hour of commuting time is often cited as a sort of maximum that most individuals are willing to spend to get to work. While the 1-hour commuting zone from lower Manhattan extended to Harlem by 1880 (Moehring, 1981), the figure shows that the zone was at least 60 blocks higher on the island by 1910, beyond Washington Heights. This is why we can detect movements in rental activity well before the 1910 Census, which is when we can detect population movement.

Figure 8 about here

A further determinant of residential location choice is the location of available jobs, which interacts with the transit network in that “available” may be defined as “can afford to commute to”. The panels of our Figure 3 could be compared to Figure 3 in Barr and Tassier (2016), who displayed the residential and employment locations of their business directory samples for 1861, 1879, 1892 and 1905-6. The latter shows substantial residential movement towards the upper west side from 1890 on, along with the dispersal of business activity away from the southern tip. So, some workers moved up the island because jobs became less concentrated around the traditional Central Business District centered on Wall Street, and they chose specific parts of the island to relocate to based

on the transit network. Thus, families were able to enjoy a wider range of residential options and maintain their employment options.

Finally, we can use the new dataset to explore who was able to make this decision to commute to work and what type of housing they rented. The secondary literature suggests that higher status male workers predominated among commuters. This is supported by the study on congestion on Manhattan (Pratt, 1968: 119), which showed that hours worked and commuting were inversely related. This makes sense based on hours available to commute, but also suggests that those who could afford to commute (in terms of time and money) were more likely to be clerical and higher status workers, who worked more standard hours.

We could also discern status from characteristics of housing of people living in older and newer areas. On average, if we compare all other neighborhoods to the newer neighborhoods of the upper west side and the northernmost tip, we see that the newer areas tended to offer units with greater number of rooms. But, the upper west side is somewhat different to the other new areas—it was already attracting higher status individuals and was more likely to describe its units as “elegant” and charged higher nominal rents. After the subway opens, it appears that the differences in neighborhoods was diminishing, at least in terms of unit size.

House size is a commonly-used measure of housing quality in the real estate literature. Here, our measure is the number of rooms per unit, and we can look at the distribution of this across time and neighborhoods. Figure 9, panels a and b, show the distribution of units by number of rooms, for three sets of neighborhoods: upper west side, which rose to prominence from the 1890s; northern tip neighborhoods including Washington and

Morningside Heights which rose to prominence from 1900; and all other neighborhoods. Panel a shows the distribution pre-1904 and panel b post-1904. The distributions appear to become more similar after 1904, although Kolmogorov-Smirnov tests rule out that they are drawn from the same populations in both time periods. Panel b suggests that the distributions were converging a bit after 1904—there were more 1-room listings appearing in the newer neighborhoods and the mean number of rooms is very close across the three, between 5.1 and 5.3 rooms. These patterns are consistent with the idea that it was more highly skilled and well-paid members of the working class, on average, who were able to move out of the most congested parts of lower Manhattan and up towards newer, bigger living quarters which could now be reached after work each evening by subway, or electrified rail or some more efficient form of transit. The rental dataset contains a wealth of other characteristics and details which could be explored in future research.

Figure 9 about here

Conclusion

Increasingly accessible spatial analysis software and cheaper computing power can be combined with the traditional tools of the historian, identifying and interpreting historical data sources, to transform our knowledge of living arrangements and standards in the past. This paper presents new data along these lines and thus contributes to the growing literature that allows us to consider the role of space, at a micro level, in history. Though we were able to validate the dataset in general, we identified one weakness-- the lack of coverage of the cheapest types of housing in Manhattan—tenements in the Lower East Side. Further work might investigate German and Yiddish language newspapers as a source that might have advertised more heavily in those areas. It may be, though, that

rents in those areas were so low and rental arrangements so informal that the units, rooms and sublets that predominated might not be easily uncovered and we will have to rely on the secondary literature.

We presented one application, exploring the evolution of the locus of the Manhattan rental market around 1900 and its relationship to the changing landscape of transit opportunities across the island, which we also formalized into an algorithm of transit times to the Central Business District. The methodology could be employed at a larger scale, to collect more or higher frequency data on rentals and expanding to outer boroughs in New York or to other cities. Another avenue of research might be to identify these units in Census records, to match individuals to their places of residence and the likely rent paid for them. Finally, there is scope for new work creating estimates of the quality-adjusted rental price of housing that are comparable across space and time. With our application in this paper we have shown only a small slice of the possibilities for this type of data.

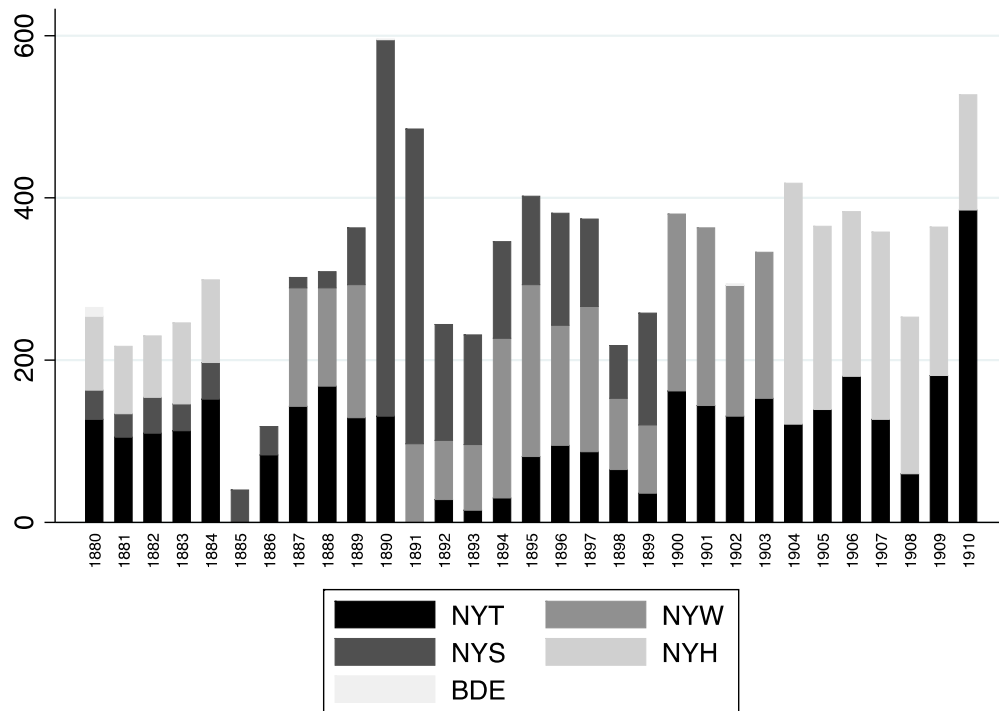
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Figures

Figure 1: Rental Observations by Newspaper Source



Notes: 9,962 observations are presented according to newspaper source and year advertised.

Figure 2: Examples of Rental Advertisements from Newspapers

A. New York Times, March 3, 1880

TO LET—THE ENTIRE DWELLING PART OF
No. 76 6th-av., north-east corner of Waverley-place;
good stand for millinery or dress-making; five rooms;
rent, \$500; possession May 1.

Also, the store and front basement room No. 129
Waverley-place; \$30 per month; no liquor; immediate
possession.

Also, on 10 years' lease, the buildings No. 46 Hudson-
st. and No. 88 Thomas-st.; lot forms an L; rent, \$2,500.

THORNTON M. RODMAN, Real Estate Agent,
No. 696 Broadway, corner 4th-st.

STORE AND BASEMENT TO LET - ON
Broadway, near Bleecker-st., \$2,200; bargain; also,
fine corner store, near A. T. Stewart's, very low.

E. A. CRUIKSHANK & CO., No. 68 Broadway.

TO LET—THE STORE AND DWELLING NO. 8
Bowery; excellent business position; rent, \$2,250;
possession May 1. THORNTON M. RODMAN, Real
Estate Agent, No. 696 Broadway, corner 4th-st.

B. New York World, April 9, 1889

BOARDERS WANTED.

East Side.

MADISON AVE., 135—Second floor: all light rooms;
other large and single rooms; excellent board.

MADISON AVE., 73, near Madison Square—Second-
story handsome large room; good table; reference.

MADISON AVE., 144—With board, desirable sec-
ond floor, en suite or separately; also fourth-floor
square room.

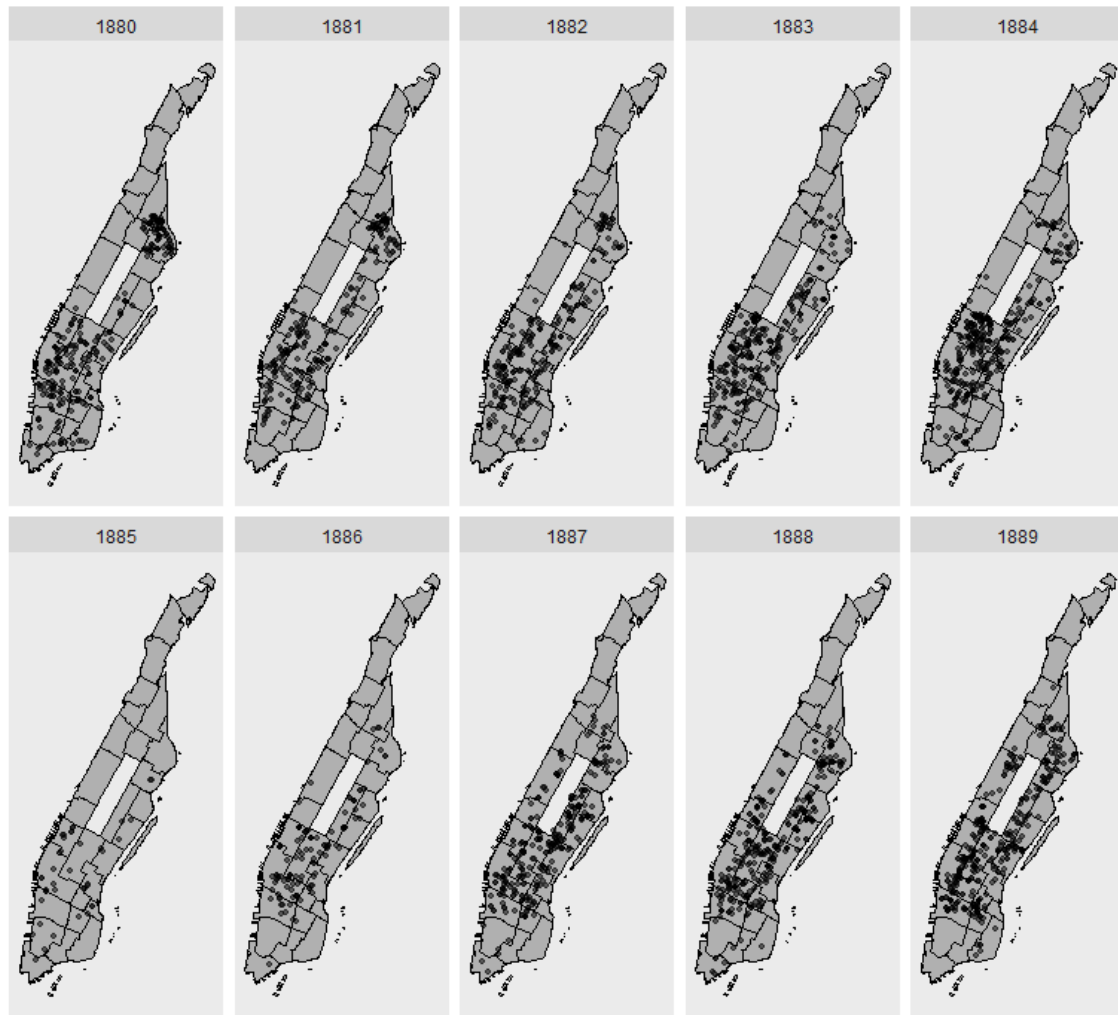
MADISON AVE., 163—Desirable rooms, with large
closets, running water; with board.

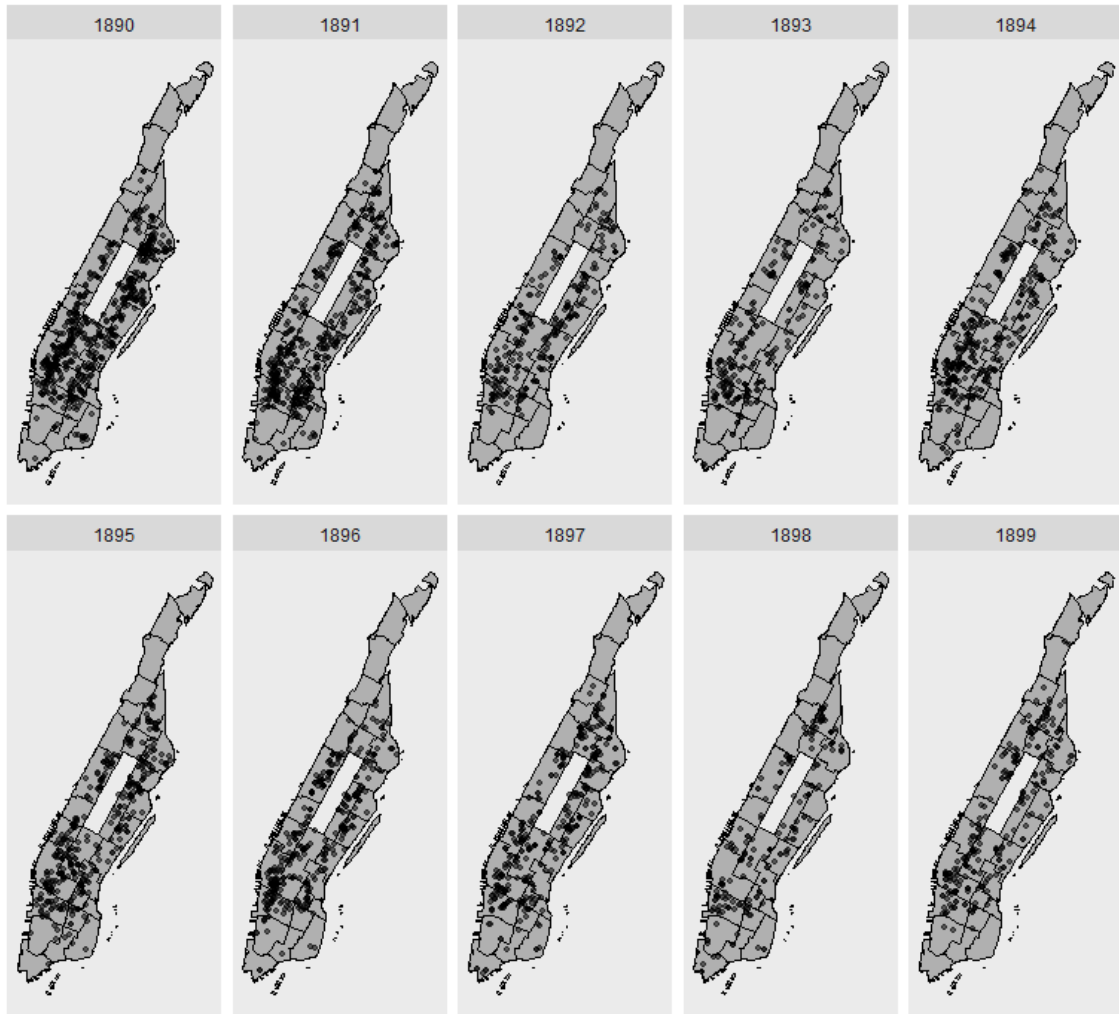
2D AVE., 1590—Parlor and bedroom, with or with-
out board; suitable for a married couple or two single
gentlemen or ladies.

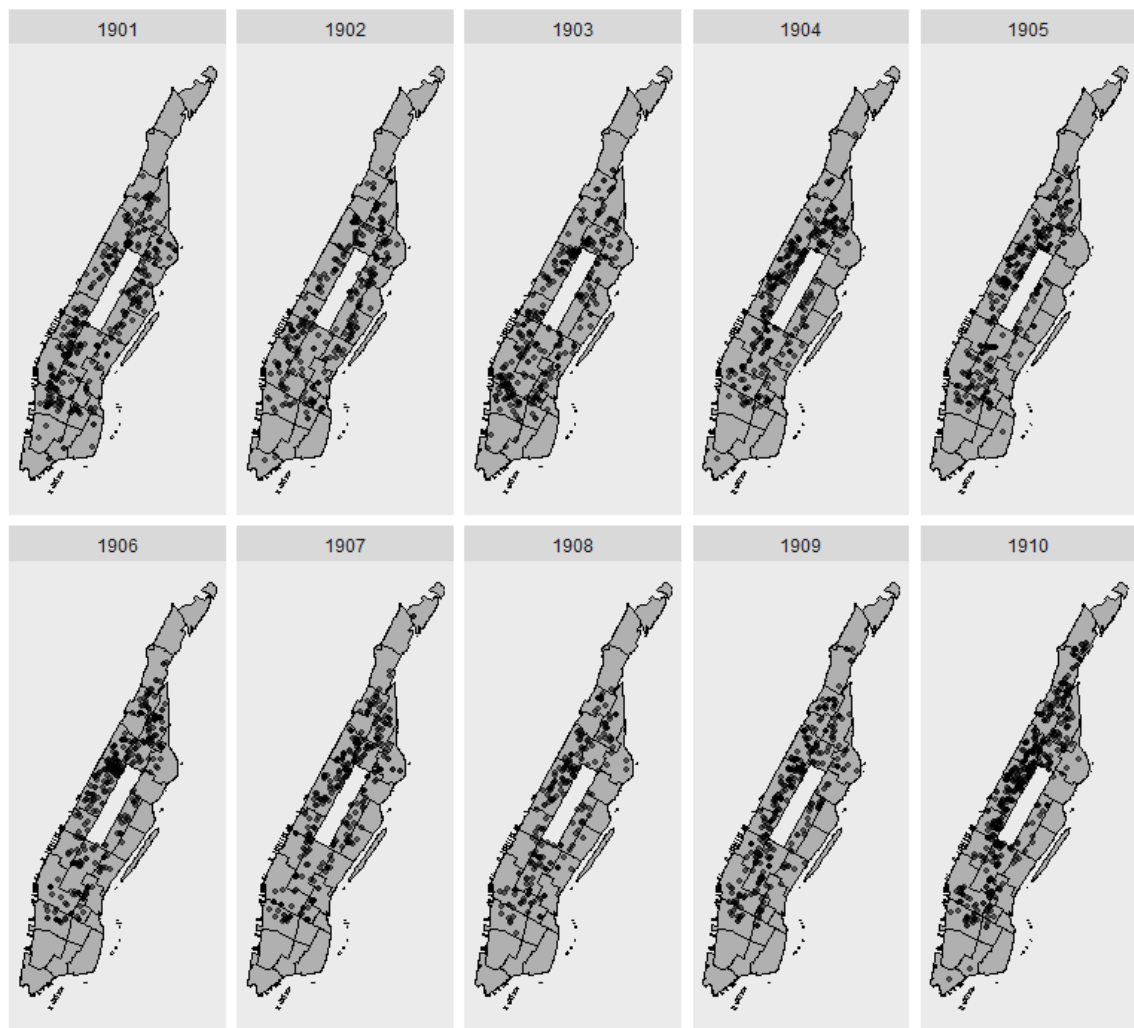
2D AVE., 126—Three connecting rooms, suitable for
3 or 4 gentlemen, with board.

4TH AVE., 10, opposite Cooper Union—Furnished
rooms, good substantial board; English cooking;
\$4.50 upwards.

Figure 3: Geographic Evolution of the Market



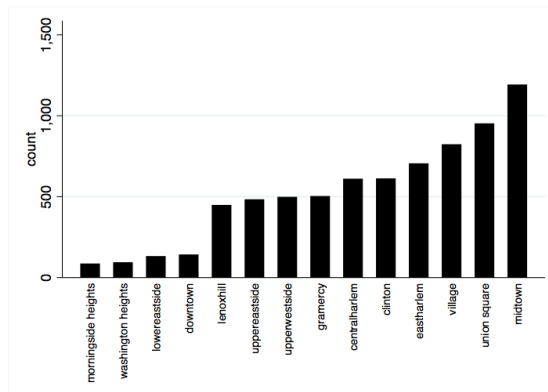




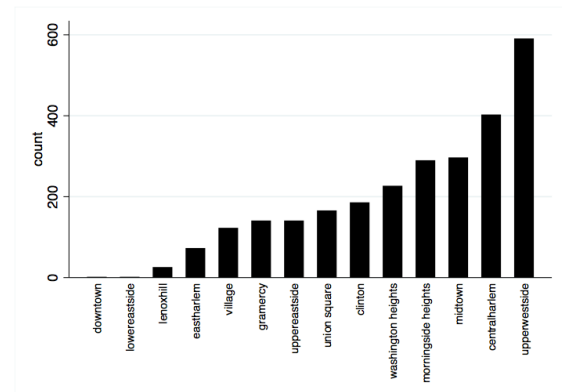
Notes: Each dot is one of the 9,962 observations in the final sample. The boundaries are modern neighborhood definitions from the current city shapefile.

Figure 4: Rents by Neighborhood

a. Pre-1904

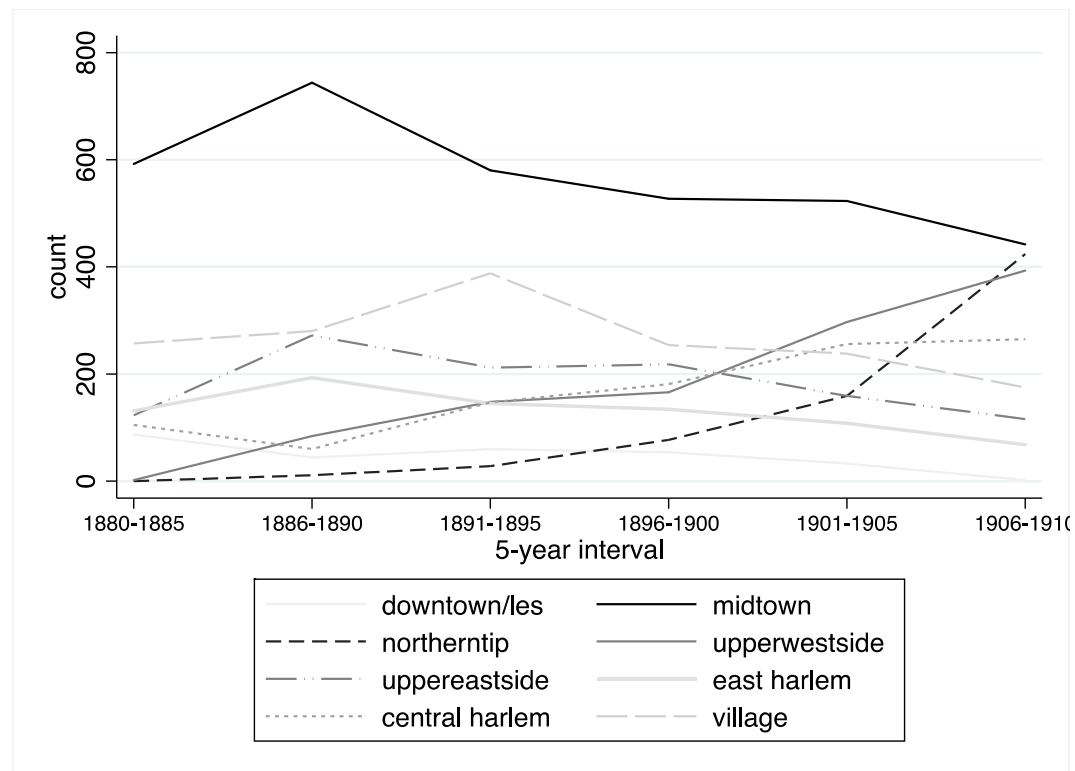


b. Post-1903



Notes: Figure shows the distribution of the 9,962 sample across neighborhoods, split at 1904 which is when the subway opened. The neighborhood shapefile used was the modern one, and we aggregated up those neighborhoods which were small historically.

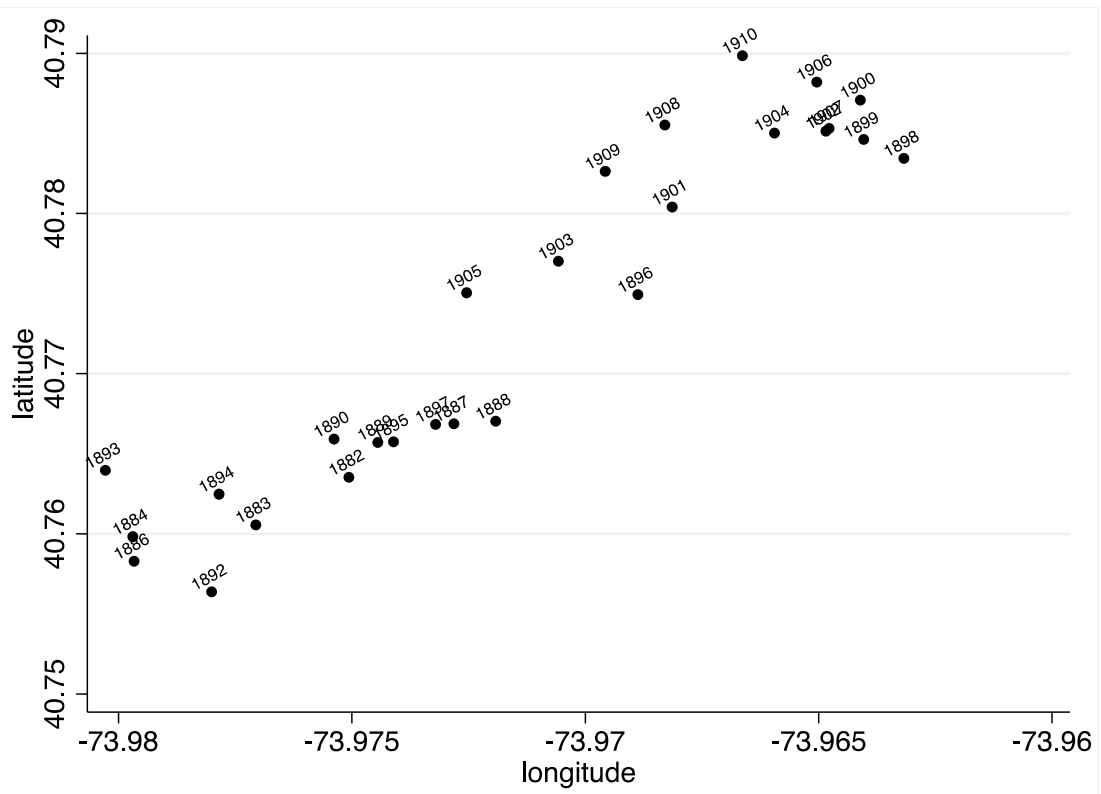
Figure 5: Neighborhood Concentration over Time



Notes: Neighborhoods have been aggregated from the categories displayed in Figure 4, for ease of exposition in this figure.

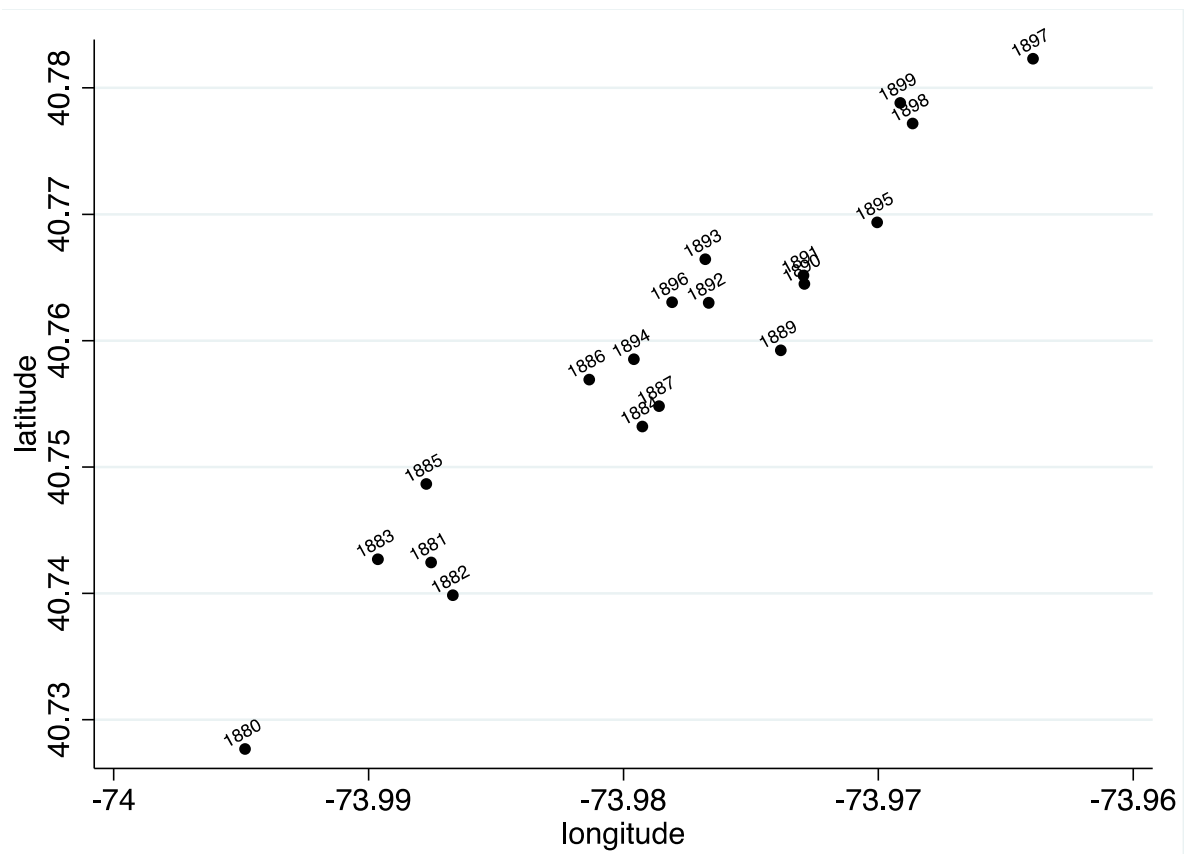
Figure 6: Mean Location

a. NYT 1882-1910



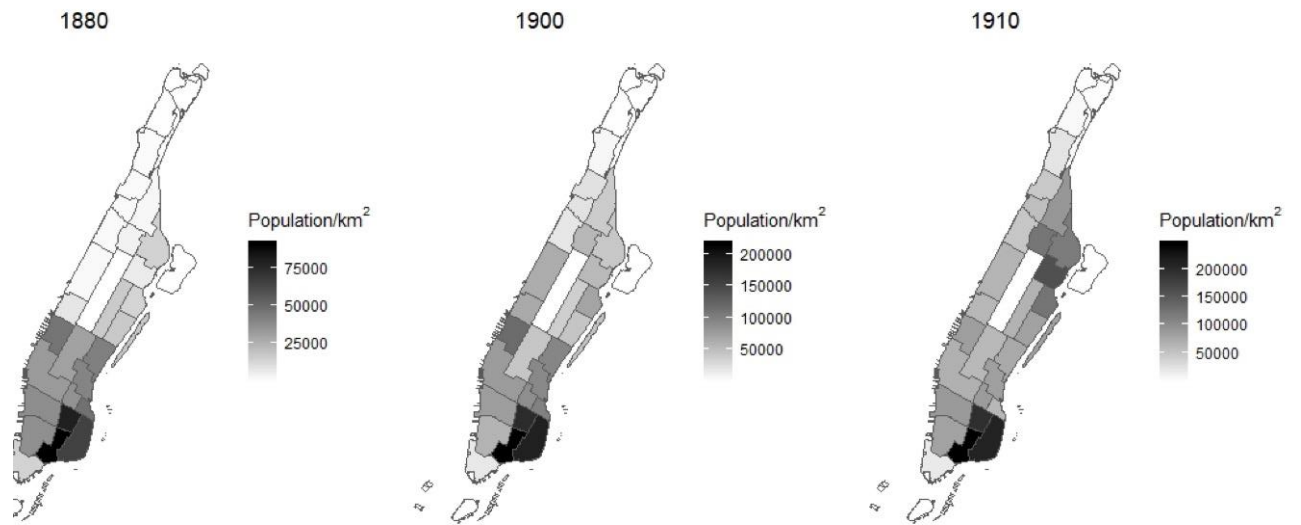
Notes: Panel a uses data from the NYT only, for 1882-1910. It shows mean latitude and longitude across sample years, and the scale ranges from (roughly) 6th Avenue and East 51st Street to Central Park West and West 95th Street. This is based on 3,249 observations.

b. NYS 1880-1899



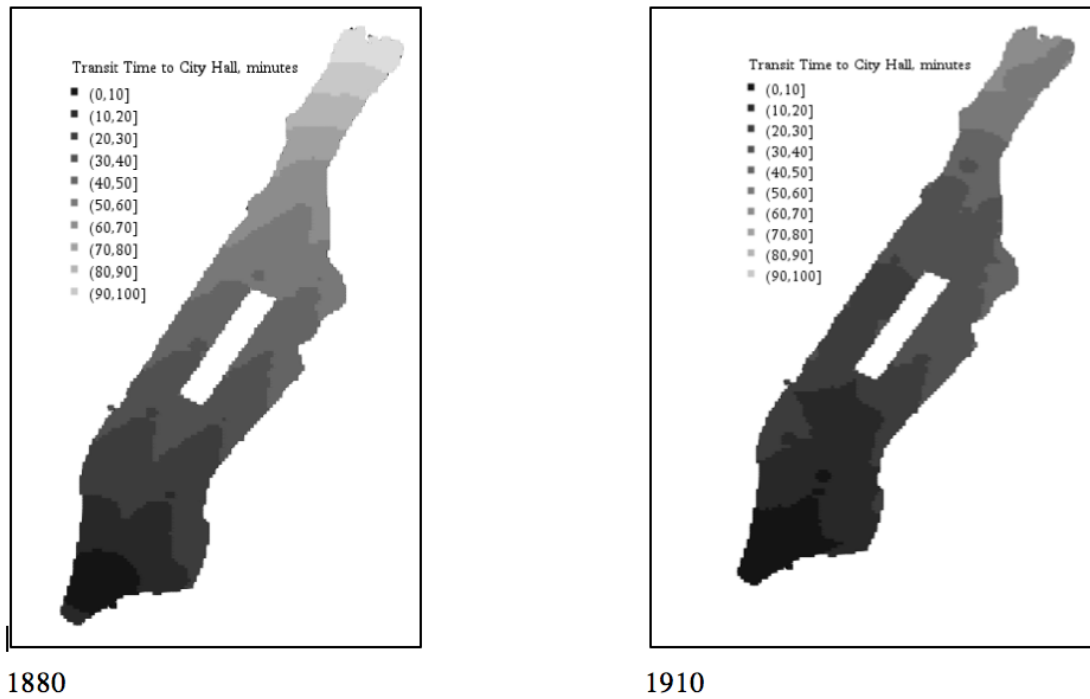
Notes: The NYS panel is based on 2,172 pre-1900 observations. The scale here ranges from about Washington Square Park to the Metropolitan Museum of Art.

Figure 7: Residential Location in Census Data



Notes: Census population per km² by enumeration district aggregated to common neighborhood definitions as described in the text. Each scale in the choropleth map is relative and generated using the Natural Breaks (Jenks) method.

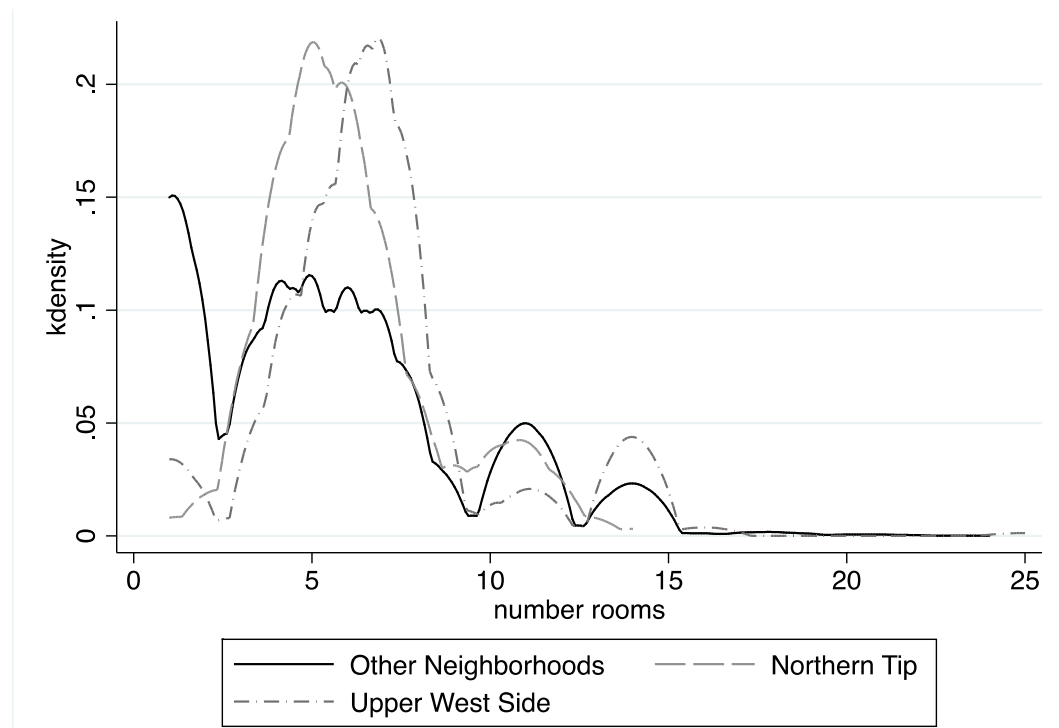
Figure 8 a & b: Isochrones of Transit Times



Notes: Data above constructed using historical sources and algorithm created in Python to code available historical transport timetables and their change over time.

Figure 9: Distribution of Size by Neighborhoods

a. Pre-1904



b. Post-1904

