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Locating the Manhattan housing market: GIS evidence for 1880–1910

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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 10,715 Manhattan units which was collected from historical newspapers for the period 1880–1910. 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 and the development of new neighborhoods. 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; commuting; transit; housing rents

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, for example.¹ Historians and social reformers have highlighted the role that housing plays in overall wellbeing over time, beginning perhaps with the photographs and stories of nineteenth century Manhattan tenement life from Jacob Riis (1997). Others have presented details of the lives of the poor, often immigrant, classes (Gabaccia 1984; Scherzer 1992); have outlined the dynamics of relations between tenants and landlords in America's biggest rental market (Day 1999); and described the evolution of the housing stock, such as the conversion of apartments to tenements during recession periods (Blackmar 1989).

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, Walsh, and Logan'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.

This paper builds on this literature by introducing new annual geocoded data on the Manhattan rental market for 1880 to 1910, drawn from newspaper advertisements—information on rental prices and characteristics are not available in substantial quantities from any other source, including the Census.² We believe that this dataset is ideal for analyzing the historical housing market, complementing the existing work on population and business movements and neighborhood change, for the following three reasons.

First, the city was mostly a rental market: only 9.63% of household heads reported real estate holdings in 1870,³ 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 More generally, the urban US was dominated by renters before the 1930s, when the federal government began to intervene in the market and incentivize home ownership. New York City

was often an innovator in regulation of housing, being an early mover in zoning and tenement laws for example, so that it was a very important city within the national housing market. Census data (using the IPUMS 1% sample) provides information on home ownership in 1900 and 1910 and suggests that New York City was in line with cities in other Middle Atlantic states and with cities with large immigrant populations in New England, with home ownership rates below 40%, much below the US frontier. New York City was considerably larger than other cities, so, while it was similar to other US cities on Census demographic characteristics, it did experience much more population turnover and inflows and its overcrowded tenement areas are most similar to other large cities such as Philadelphia, Boston and Chicago.

Second, 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). Riis (1998, 133) says that this was also true of tenement-dwellers—3 months after the 1900 tenement census, for example, he estimated that one third had moved. 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 and determinants of neighborhood growth and 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 to. This research complements 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 source of housing information goes back at least to Rees (1961), who built a rental price index for 6 cities. 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. Kholodolin (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 also geocoded the data and related rentals to the evolution of the transit network.

More generally, advertisements containing asking prices have been used before. Examples include Schulz, Maas, and van Leeuwen (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 studies by geocoding the sample of rental units. In the following sections we describe the data collection and geocoding processes. We discuss the geographic coverage of our dataset and provide a sense of which parts of the housing market we capture. Finally, we present an application of the dataset to the question of the evolving location of the Manhattan real estate market and document some characteristics of units located in newer neighborhoods, relative to existing ones, focusing especially on transit time and unit size. The richness of our data allows us to test the hypothesis of Hood (1993) that it was the subway that facilitated development of the Upper West Side west of Broadway, and we show evidence in favor.

New housing dataset

Information on rental prices and characteristics at the unit-level was collected from advertisements from the following newspapers: New York Herald (NYH), New

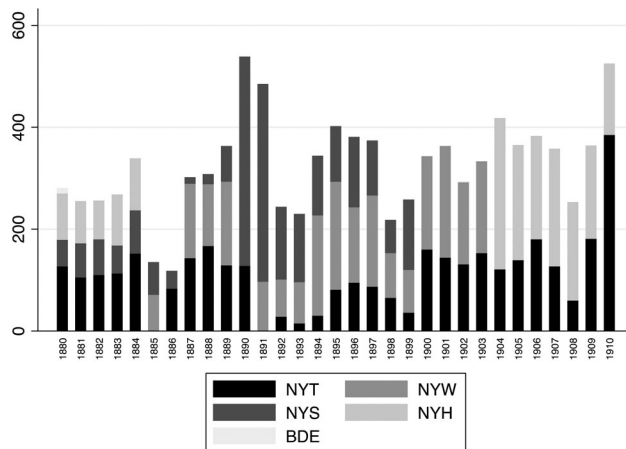


Figure 1. Rental observations by newspaper source.

Notes: 10,715 observations are presented according to newspaper source and year advertised.

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 unit characteristics were 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 an array of amenities such as electricity, steam heating or fixtures and fittings. We also coded the presence of phrases such as “elegant” and “all improvements.” Figure 1 shows the distribution of observations according to newspaper source, highlighting that there is a healthy sample size in each year.

The target was 150 observations from each newspaper source per year. In most years there were many more listings than we have recorded in our sample, and usually there were many more usable listings (i.e., that had both asking price and location). We sampled across housing types (houses, apartments, boarding, furnished rooms to let) and parts of the city (this was straightforward as listings were often arranged by East and West side, and a northern designation, such as above 125th Street). Newspapers for our earliest years were the least legible and this reduced somewhat the sample size collected. Future research might count the number of advertisements in each issue and time period to get a sense of market activity, but this was beyond the scope of this project and would be more challenging than in the case of, for example, job postings, which tended to be a more standard length and

occupy a more consistent and uniform portion of the papers.

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 (Blackmar 1989, 213). 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 that April was indeed the modal month for 1891 and March the modal month for 1890. 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. We discuss further checks below on the representativeness of the sampling strategy.

A variety of different types of apartments and homes were advertised in the 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 to ensure that the sample is as representative as possible.

Data from Gentzkow, Shapiro, and Sinkinson (2014), provides information on newspaper circulation, which ranges from 34,000 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—they frequently stated the thousands of advertisements they had run in previous years, encouraging more people to advertise their rentals with them. Day (1999, 38) describes how immigrant banks advertised in papers, while the Conference on Research in Income and Wealth (1975) describes newspapers and periodicals as a regular part of the

A. New York Times, March 3, 1880

TO LET—THE ENTIRE DWELLING PART OF
I 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
S 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
I 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., 155—Second floor; all light rooms;
 other large and single rooms; excellent board.

MADISON AVE., 78, near Madison Square—Second-
 story handsome large room; good table; references.

MADISON AVE., 144—With board, desirable pec-
 onid 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 2. Examples of rental advertisements from newspapers.

A. New York Times, March 3, 1880

B. New York World, April 9, 1889

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 paper and to advertise. The real price

Table 1. Summary statistics by rental price availability.

	NYT Limited Years with Prices	Sample without Prices	Difference
House	24.3	16.8	7.5***
Board	3.8	21.5	-17.7***
Apartment	62.7	43.5	19.2***
Rooms	5.4	5.2	0.2
Decorated	9.6	8.5	1.1
Elegant	9.2	13.4	-4.2***
Improvements	18.7	17.6	1.1
Furnished	15.4	32.6	-17.2***
Heating	24.4	13.6	10.8***
Transport	10.4	4.2	6.2***
Latitude	40.77317	40.75933	.0138***
Longitude	-73.97113	-73.97818	.007***
Mean location	Terrace Drive in Central Park, at around 71st Street	Rockefeller Plaza (West 51st St & 5th Avenue)	
Obs	1822	506	

Notes: The first column uses observations with prices drawn from the NYT for the years 1884, 1886–1889, 1892–1899, 1901, 1904–1907. Column 2 uses observations listed without prices, for the same years. The statistics report the percentage of each sample that indicated each characteristic in the advertisement. Column 3 shows the difference between the means.

*Indicates significance at the 10% level;

**At 5%;

***At 1%.

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 per line in 1880 to \$3.86 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 full extent of the market. However, we likely do not fully capture the lower tail. We do not observe many advertisements for sublet or shared living arrangements, for example, even though the historical literature suggests that these were common practices.⁵ 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. A unit in our dataset that was listed at a particular price and size may in fact have been occupied by two families, thus reducing rents and housing quality. Additionally, units may have been let for less than asking price. 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. This is a common problem for historical data on housing rents, even using other data sources such as tax records (see, for example, discussions in McCants 2007 and Alfani and Ryckbosch 2016).⁶

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. We collected data on 506 rental listings that provided all of the desired information except for price, for the years 1884, 1886–1889, 1892–1899, 1901, 1904–1907.⁷ These were mostly drawn from the NYT so Table 1 presents summary statistics from this sample without prices and listings from the NYT with prices, for the same years. The table shows that the unit mix is very different for listings with and without prices—the share of apartments is almost 20 points lower when no prices are provided. This accounts for many of the differences in average characteristics across the two groups—while the means are similar in terms of number of rooms, and likelihood of mentioning “all improvements” or “decorated”, they are statistically significantly different from each other for all other characteristics in the table. Finally, the mean location of listings with prices is about 20 blocks north of listings without prices, which likely reflects the concentration of rooms for board in the latter group. We take this as further indication that using newspapers as a source of rental data is very informative about the apartment sector within Manhattan, but much less representative of those living in houses, at the high end of the market, as well as those at the other extreme, living in modest boarding houses closer to the southern tip of the island. The next section addresses these issues in more detail.

We also collected 24 months of data from the NYS for 1890 and 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 and location being similar.⁸ 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. In this paper we have tried to capture the main moves in the rental market, so we believe that focusing on the May 1 and October 1 moving dates makes sense, but we acknowledge that the ensuing sample may not be representative for all purposes.

Geocoding

Rentals were geocoded to the historical map of Manhattan⁹ using the program ArcGIS. The first step was to run the addresses through an automated geocoding macro which used a modern Manhattan map from bing.com/maps. In many cases this provided the correct historical location because the map had not changed in that location. We then identified likely problems with the geocoding, such as where the geocoder located an observation in Manhattan, Kansas instead of New York City. These were easily identified and corrected. More difficult were the observations where the map has changed substantially—this manifested itself in many addresses falsely clustering at particular edges of the island, which were also relatively easy to identify and manually correct. Changes were commonly the result of new public housing projects (or private developments such as Stuyvesant Town) or other major new buildings (Penn Station, for example). In effect we manually checked the geocoding of all observations.

The correction procedure involved mapping the coordinates from the automated geocoder and moving the observation to where we believe the historical address stood, and taking the coordinates manually from maps.google.com.¹⁰ We coded all location information from the original advertisements—cross-streets and landmarks, for example— and used this for manual geocoding and cross-checks. We also gained knowledge over time about street name changes, such as the 1888 creation of Park Avenue from the former

4th Avenue, above Grand Central. To give some specific examples of manual geocoding, 323 West 32nd Street is an address in the dataset. Today that address doesn't exist because of the building of Penn Station and the USPS building adjacent to it. Automated geocoding locates this address at approximately 156 West 32nd Street, so that we had to find the true coordinates manually, based on where we believe number 323 stood. Similarly, 170 West 59th Street is located too far west using automated geocoding. After 1896 part of West 59th became Central Park South and so this address had to be manually coded. The process outlined above was very time-consuming and we anticipate that the final dataset mislocates only a small fraction of rental observations, by small margins.

We began with 15,056 observations drawn from historical newspapers. This was reduced due to: 1) being outside the sample months because of oversampling in 1890 and 1891 (−1611); 2) not being residential listings (−780); 3) inability to be geocoded or were actually outside of Manhattan (−177); and 4) a lack of rental price information or observations where the periodicity of rent was not clear and so no monthly rent could be calculated (−1773). This left us with 10,715 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. Geocoding at scale is a challenge, based on our experience in this project, but might be easier for cities whose maps have changed less and perhaps only a subset might be geocoded via automated methods.¹¹

We constructed a new dataset of transportation times from each of the rental points to City Hall and to Grand Central Station. City Hall was the locus of the traditional central business district (CBD) of Manhattan, while Grand Central, located in midtown, became a CBD during this period (Barr and Tassier 2016). 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.¹² The formula calculated the minimum transit time from each unit to City Hall or to Grand Central Station in every sample year.

Using the free software QGIS, we added a modern shapefile of Manhattan neighborhood boundaries and aggregated to larger neighborhoods that existed historically.¹³ This was 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, in order to compare the two. Population totals 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, Walsh, and Logan (2016) which divided cities into hexagonal shapes and calculated population counts for each shape according to its share in that year's district boundary.

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 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.

Coverage of cheap housing

As mentioned above, Figure 3 shows that the newspaper sample does not offer extensive coverage of the Lower East Side, which was dominated by tenements. Comparison to Census densities at the neighborhood level, as shown in Figure 4, illustrates that population counts per square kilometer were in fact highest in these areas. This is a shortcoming of the newspaper sample, although it does have the advantage of being available on an annual basis, thus providing more temporal information than the three Census snapshots of 1880, 1900 and 1910.¹⁴ Figure 4 also portrays population movement over the long run, from the lower extremity of the island, toward midtown and, by 1910, the northern extremities, which we explore further in our application.

The Lower East Side and similar areas were characterized by overcrowding and relatively cheap housing, populated mostly by recent immigrants. Housing supply was tight in this neighborhood, with more rear dwellings appearing on lots and multiple families and boarders sharing each apartment. Boarding houses for single men, renting single rooms or in dorm style, also abounded here. The absence of this area in our sample suggests the presence of an informal market for rentals in areas dominated by the working classes. Here, we discuss what can be gleaned from the secondary literature about how large this more informal sector was and what prices looked like there.¹⁵

Manhattan grew considerably during the sample period, reaching its peak in 1910 at 2.33 million residents (Revell 2003, 106). This was facilitated not only

by development of new neighborhoods on the Upper West Side and northern part of the island, but also by overcrowding in tenement districts. In fact, western and northern development exacerbated crowding in areas like the Lower East Side, as such areas had been home to many in chancy towns, even into the 1890s (Ballon 2012, 99).

Some data exists on the size of the tenement population. The 1900 tenement house census found that 1,585,000 people lived in Manhattan tenements and also noted overcrowding even in the presence of vacant units (DeForest and Veiller 1903, 194). That was an increase from 1891 when there were 1,225,421 tenement residents and 1893, when the figure stood at 1,332,773 (Costa and Fogel 2015). It is worth noting that all buildings classed as tenements may not have been impoverished and decrepit, as suggested by the discrepancy between the 1893 figure given above and the estimate of Manhattan slum dwellers from Wright (1970), which was only 360,000 in 1893. The 1900 Tenement House Report showed the increased tenement population across almost all wards since the previous comprehensive investigation of 1864, as the total population increased by almost 230% and the number of families per house increased by over half a family (DeForest and Veiller 1903, 217). In 1910 768,360 people lived below 14th Street, where most tenements were found (Laidlaw 1932). The 1901 tenement house law made it more expensive to build housing for the poor and encouraged the building of higher status apartments,¹⁶ but the evidence also suggests that tenement house quality did in fact improve, although increased overcrowding may have resulted in no actual improvement in living conditions for individual families (Jackson 1976, 136).

The secondary literature provides some detail on rental prices in tenements, to supplement our lack of data from newspaper sources. Jackson (1976, 76) describes how families in the mid-1880s paid \$8 per month for 2 rooms in a downtown slum. Riis (1997) cited going rents around 1900 to be \$6 for a rear tenement, and \$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 tenement house department presented figures for 1902–3 on the distribution of monthly rents per room across 38,732 Manhattan tenement houses (Costa and Fogel 2015). The data show a wide range from a low of \$1.50 to a cluster of highs that were in the \$8.00 plus range. Few tenements had prices lower than \$3 and the modal price range was \$3.45–\$3.50.

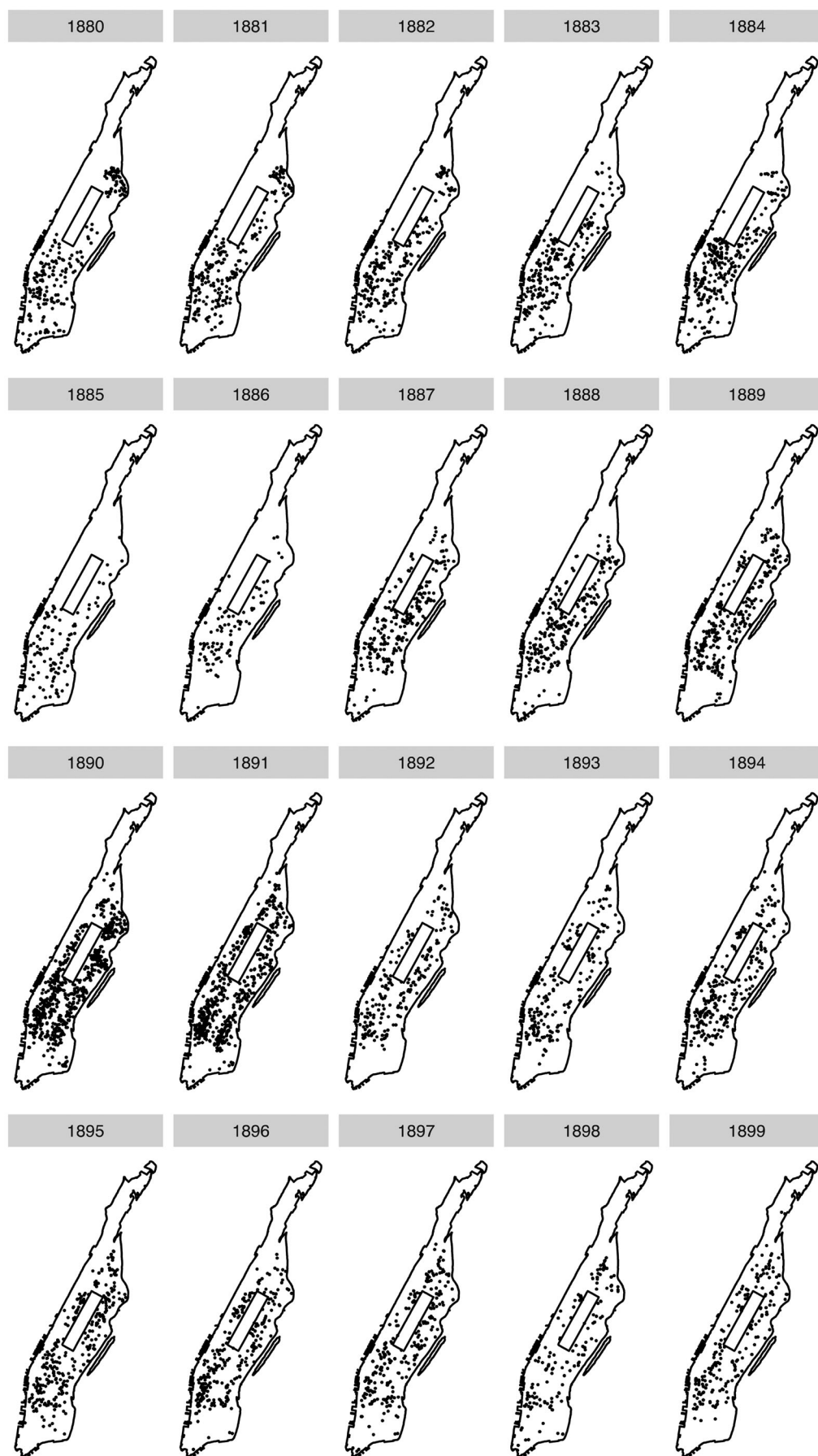


Figure 3. Geographic evolution of the market.
 Notes: Each dot is one of the 10,715 observations in the final sample.

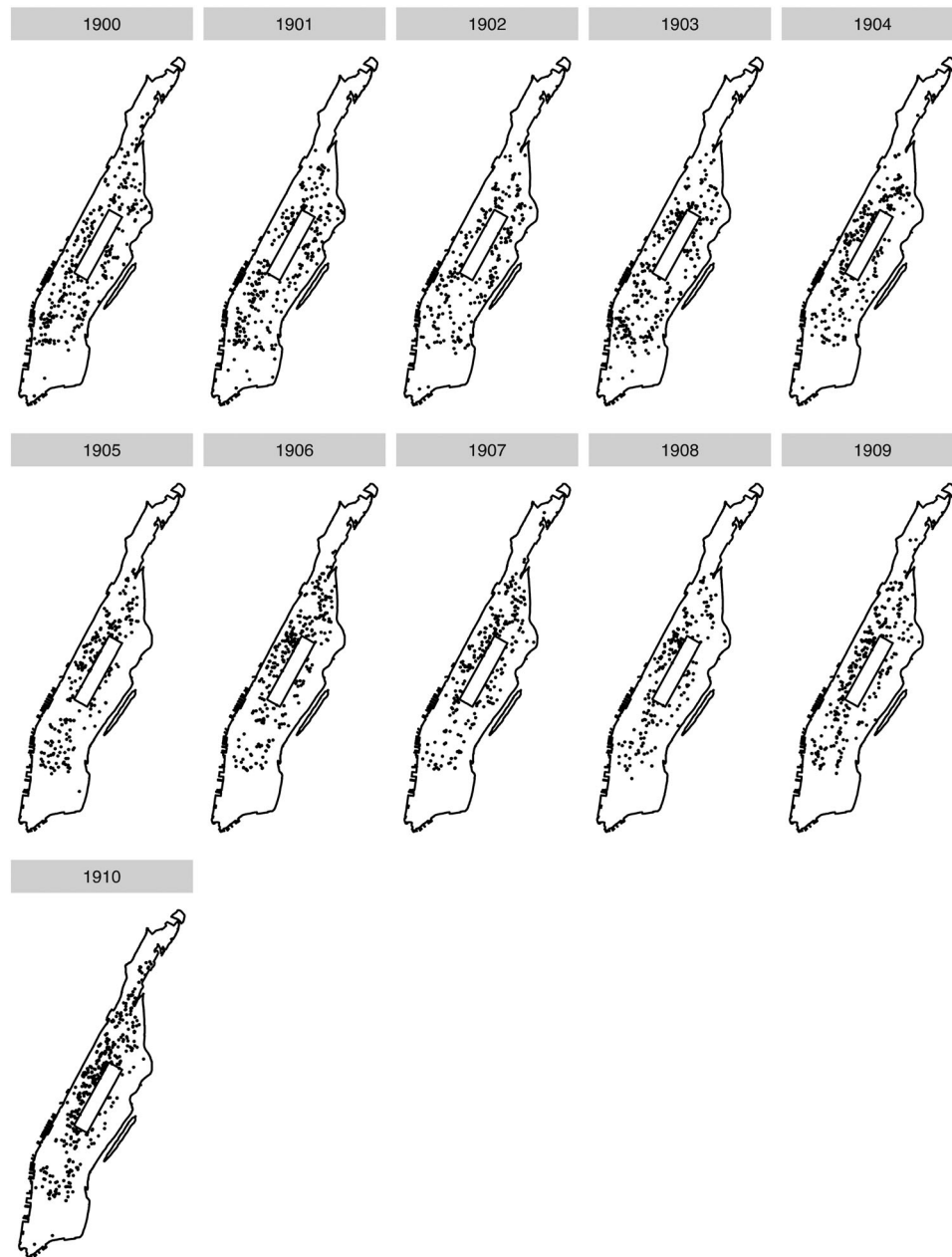


Figure 3. Continued.

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. Gabaccia (1984, 74) in her in-depth study of Elizabeth Street, around 1905, quoted two-room apartments in a dumbbell tenement which cost \$9.50 monthly. 50% of apartments had 3 rooms, costing \$8–\$15 per month while the 20% with 4 rooms charged about \$20 in a new law (post-1901) tenement. At the end of our period, tenement rents after the bust of 1907 were said to be back to the pre-boom level of \$1.50 per room, per month (Jackson 1976, 153). Before rents reached equilibrium, the tenement apartment vacancy

rate reached 7.5% in 1909, as families were still recovering from the recession and couldn't yet afford them.

Looking at the market for board and simple lodging, our analysis above of the advertisements without prices suggested that our final sample does not fully capture that market, perhaps especially at the lowest end. Here are some figures in the literature to provide a richer picture of that part of the distribution. 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

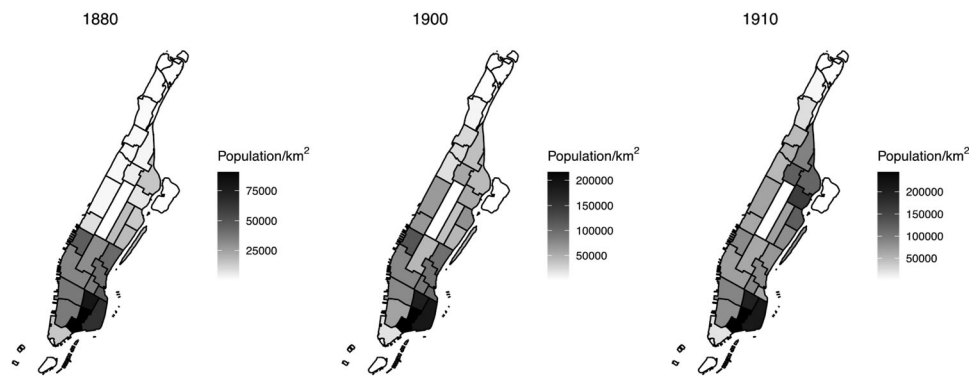
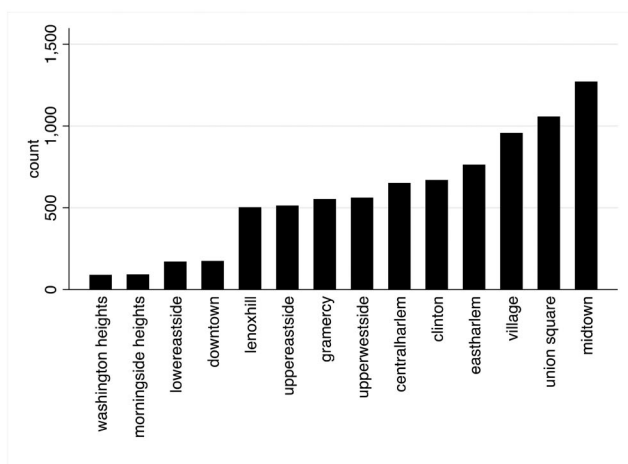


Figure 4. Residential location in census data.

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.

a. Pre-1904



b. Post-1903

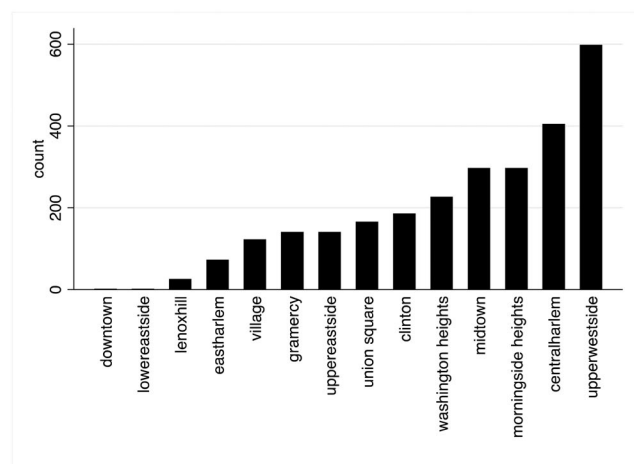


Figure 5. Rental observations by neighborhood.

Notes: Figure shows the distribution of the 10,715 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.

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.

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 apartment classes above tenement-dwellers.¹⁷

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 increased rental activity, which was due to new development in some cases.¹⁸ We focus on transit and commuting as a key cause of this switch in rental activity, in line with descriptions in the existing literature. We use the fine geographic and temporal levels of our data to provide tests of hypotheses from the literature and place our analysis within the context of other discussions about the changing location of business activity on the island. Finally, we investigate some key characteristics of units across these new and existing residential neighborhoods, to assess who participated in this era of enhanced intra-urban mobility.

The starting point in 1880 was an island that was well developed up to 100th Street on the East side and only to 59th Street on the West side (Jackson 1976, 77). The ensuing thirty years saw improvements in the streetcar and elevated train networks and the landmark event of the subway, whose construction began

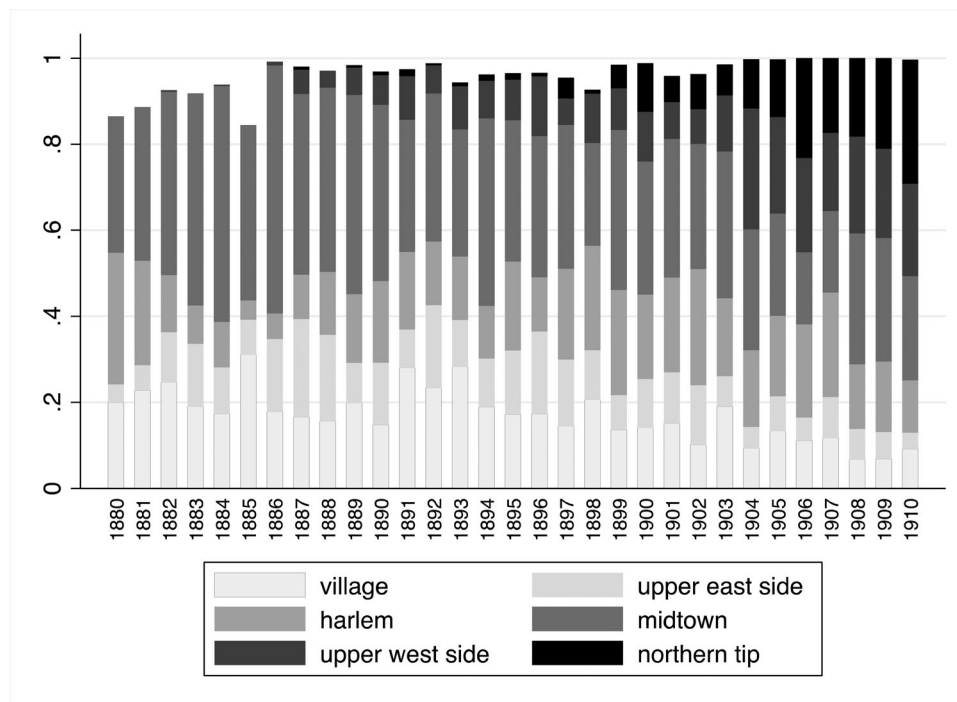


Figure 6. Neighborhood concentration over time.

Notes: Neighborhoods have been aggregated from the categories displayed in Figure 5, for ease of exposition in this figure. The downtown and Lower East Side neighborhoods have been omitted, because they are only a significant share in the early 1880s and this accounts for why each bar does not sum to 1, at least before 1904.

in 1900 and was completed in 1904. As Revell (2003, 105) put it: “Although Manhattan had emerged as a commuter city before the opening of the first subway in 1904, even the best combination of street cars, elevated railways, ferries, and bridges still made getting to the central business district a chore.”¹⁹ The subway revolutionized transit because trains could travel up to 3 times faster than steam-powered elevated trains and 6 times as fast as electric streetcars (Hood 1993, 5). Many times since 1880 business people had called for the building of a subway and some routes gained traction in certain periods before fading. New York City was thus late to the subway era, held back by corruption and the huge investment required and so it was only anticipated from about 1899 when a final plan and route were approved.

Figure 5, 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, coinciding with the reduction in transit times driven by the subway. 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. If we focus on neighborhood-years that had at least ten observations, the Upper West Side had the most observations of any area in each year from 1904 onwards, and it appeared in the top three most numerous areas for the first time in 1896. Washington Heights appears among this limited sample only in 1900, and Morningside Heights in 1897. These slices of the data are also suggestive of the key role of the transit network in the development of these areas and the spurt in rental advertisements was followed by a 265% increase in the population living above 125th Street, just above Morningside Park, from 1904 to 1919 (Hood 1993, 113).

Figure 6 explores further the timing of relocation of the rental market, for 6 slightly more aggregated neighborhood groups (for ease of exposition). Here, we see that the midtown share dominated the Manhattan rental market throughout the 1880s and 1890s, consistent with previous work by Barr and Tassier (2016) showing that several industries had moved to midtown by the 1880s, bringing residents and, particularly, office workers with them. From the late 1880s, the Upper West Side starts a slow and steady rise among the rankings while, for areas north of West 110th Street, that rise began only around



Figure 7. 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 locations range from (roughly) the Rockefeller Center to Central Park West and West 93rd Street. This is based on 3,248 observations. Each point is labeled with the corresponding year of the data.

7b. NYS 1880-1899.

Notes: The NYS panel is based on 2,841 pre-1900 observations. The locations range from about Washington Square Park to the 79th Street Traverse in Central Park. Each point is labeled with the corresponding year of the data.

1900. This chart suggests that the arrival of the subway made a substantive difference mainly for the northernmost neighborhoods, where transit costs should have fallen most steeply, as we show more concretely in the panels of [Figure 8](#) below. The earlier expansions of the elevated train network made expansion into Harlem and the Upper West Side possible even without the subway. However, we investigate in [Figures 9](#) and [10](#) below whether all areas of the Upper West Side were affected at the same time, and our transit model will allow us to explore some predictions of the existing historical literature.

We can look at the mean latitude and longitude of our sample to explore the changing locus of the rental market. In 1880 the mean rental was located in midtown, roughly at today's Trump Tower, which follows from [Figures 5](#) and [6](#). 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 7](#), 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 shows that the locus of observations is lower in the island early in the sample and in the later 1890s and 1900s 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 toward 1899. [Figure 7](#)

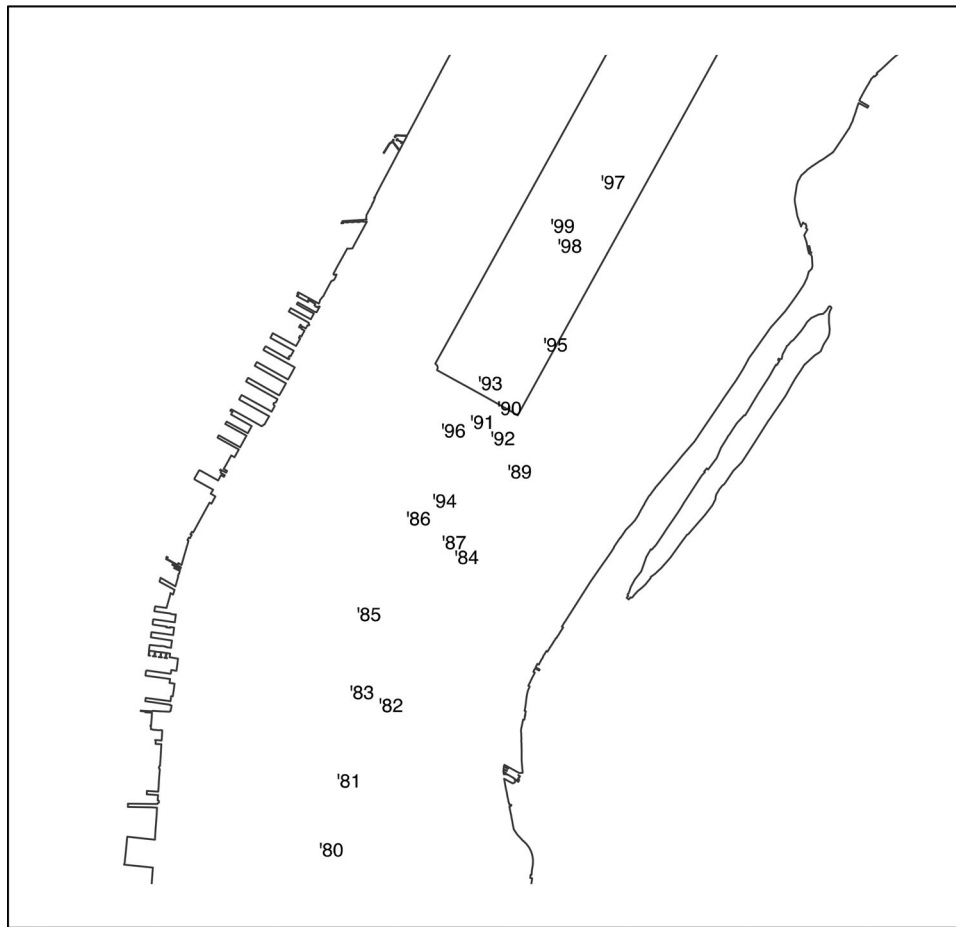


Figure 7. Continued.

shows decisive shifts in rental location by the 1890s and again after further transit expansions from 1902 and 1904. Panel a suggests a distinct break around 1898 where rental observations are found further north than the cluster for most of the 1880s and 1890s, which is quite consistent with the timing of the announcement of the final subway route. Panel b shows that, using NYS observations, a shift is discernible even in the late 1880s, when the elevated railroad expansion was being completed.

Figures 5-7 show the broad trends in location of the Manhattan housing market. We can use the secondary literature to provide more detailed information about residential movements which we can then test using our more detailed data. For example, Hood (1993) makes the case very clearly of how important transit was in the development of particular areas of the Upper West Side. Elevated railroad service started that development but limited it to Central Park West and Amsterdam Avenue, with little building closer to the Hudson River before 1900.²⁰ Post-subway, Broadway in particular got a boost, with 9 stations between 59th and 110th Streets which led to building

of many 10–14 floor apartment buildings, with the ground floor used for retail. Avenues toward the Hudson, such as Riverside Drive, really only developed systematically after 1904, in this assessment. We now test whether this was true.

We focus on transit as a driver of location trends. Previous work has documented the era's transit innovations, with Moehring (1976, 489) showing that even around 1870 it took 2 hours and 40 minutes to reach Lower Manhattan from Harlem, by streetcar, in the pre-electrified age. Over the next 40 years, elevated service expanded and electrified and the first subway lines opened, improving the regularity, comfort and affordability of commuting longer distances. Residences moved northwards and westwards following these developments, and transit and residential choices interacted with the upward movement of business activity (Moehring 1976, 480-482; Barr and Tassier 2016).

Figure 8a shows isochrones of transit times (a common proxy for commuting costs) to City Hall, in minutes, for the years 1880, 1900 and 1905. This shows that there was little reduction in transit time

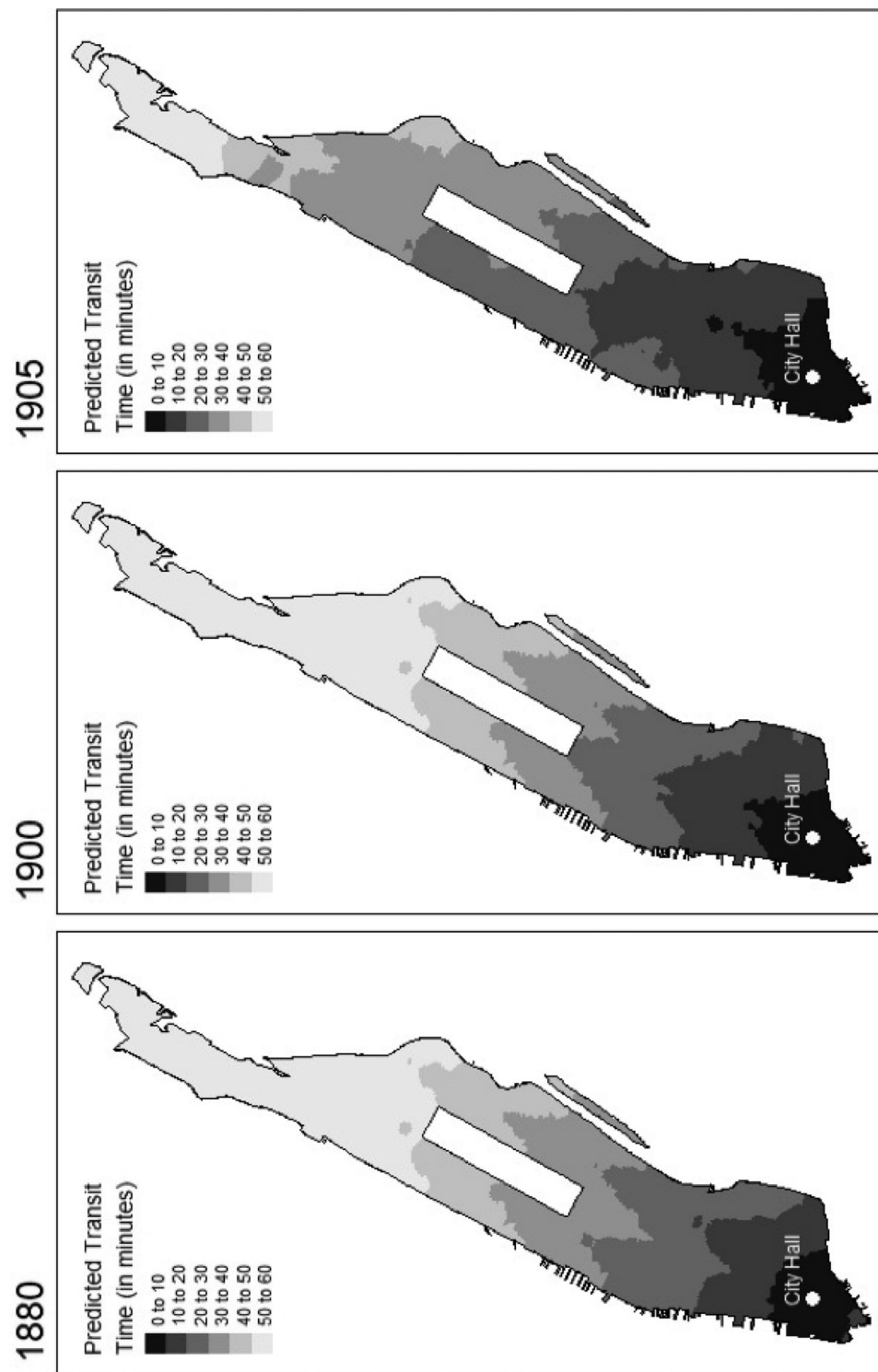


Figure 8. a. Isochrones of transit times to city hall. b. Isochrones of transit times to grand central station.

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

before 1900 for areas such as the Upper West Side and north of West 110th Street, while the 20 years after 1880 certainly brought midtown closer to jobs downtown. The northern extent of the 20–30-minute isochrone to City Hall was 59th Street in 1900, which

is just at Central Park at the beginning of the Upper West Side, so it is unsurprising that most workers could not afford to move into that neighborhood until further improvements reduced the travel time. [Figure 8b](#) further illustrates the advantageous location of

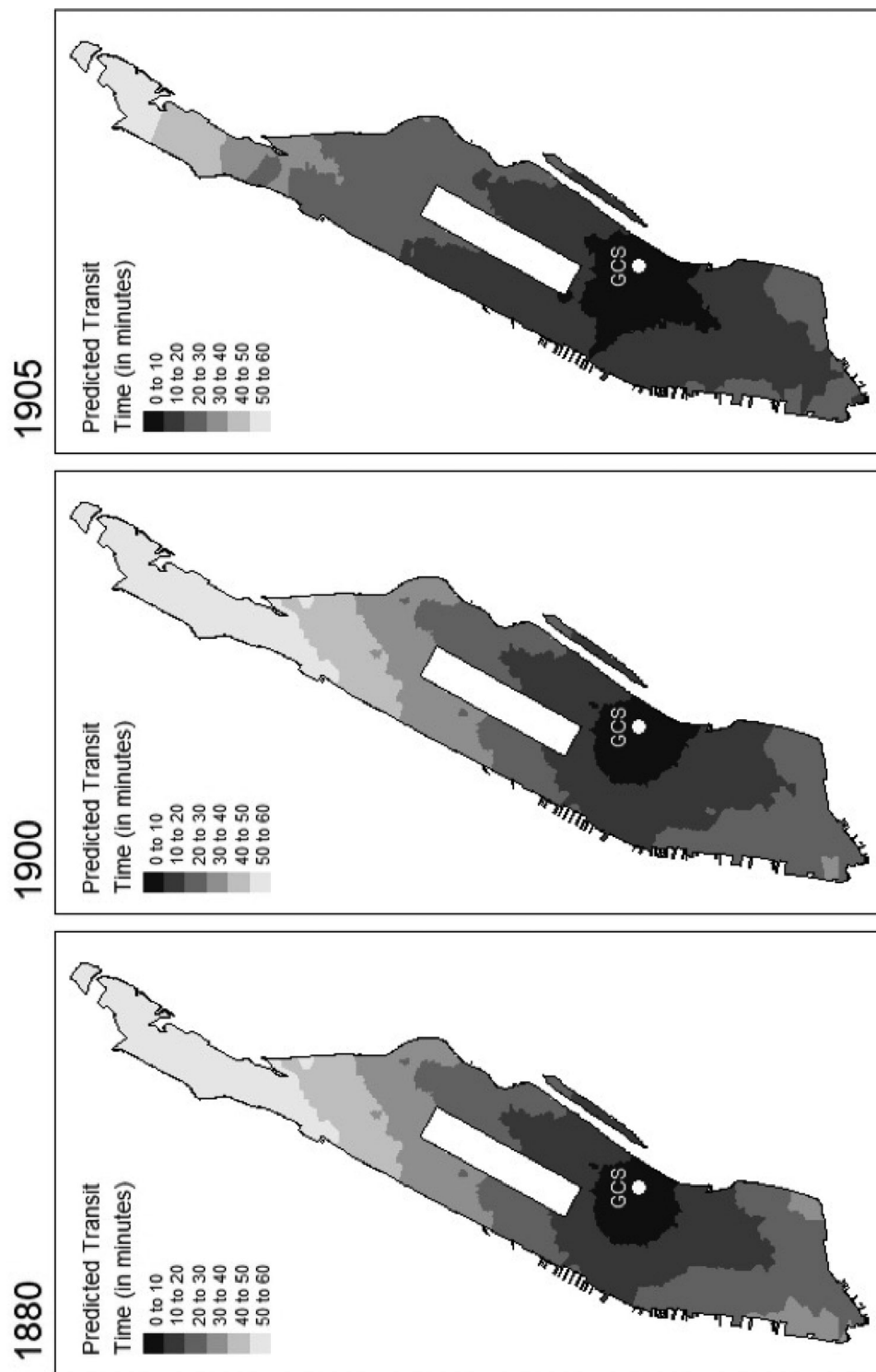


Figure 8. Continued.

midtown in terms of connection to the secondary, rising business district centered around Grand Central Station. A commuter from the average unit in our sample took 35.6 minutes to reach City Hall in 1880, a barely smaller 34 minutes in 1900 but only 24.6 minutes in 1905, a few months after the subway

opened. The northward expansion of the 20–30 minute isochrone for City Hall was 20 blocks between 1900 and 1905, while relative to the midtown CBD it was 31 blocks, up to about West 152nd Street.

Drilling down within the Upper West Side neighborhood in our dataset, we can evaluate Hood's

assertion that areas west of Amsterdam Avenue (this is 10th Avenue below Central Park) did not see much development before the advent of the subway. We do this in a number of ways. Crudely, we can see that

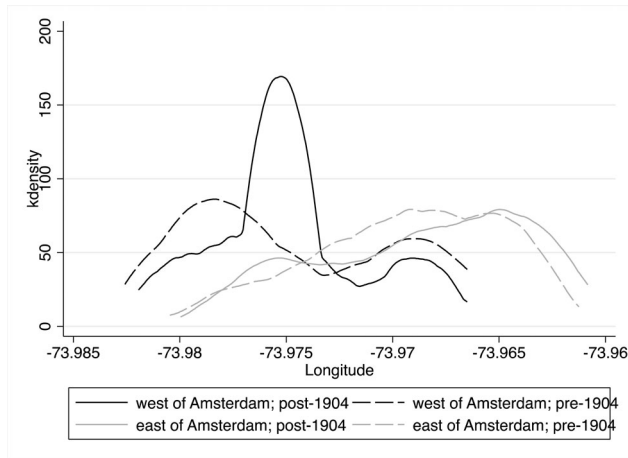


Figure 9. Distribution of longitude across sectors and years.
Notes: Data drawn from the newspaper sample, split by sector within the Upper West Side neighborhood and across pre- and post-subway time periods (1,160 observations total).

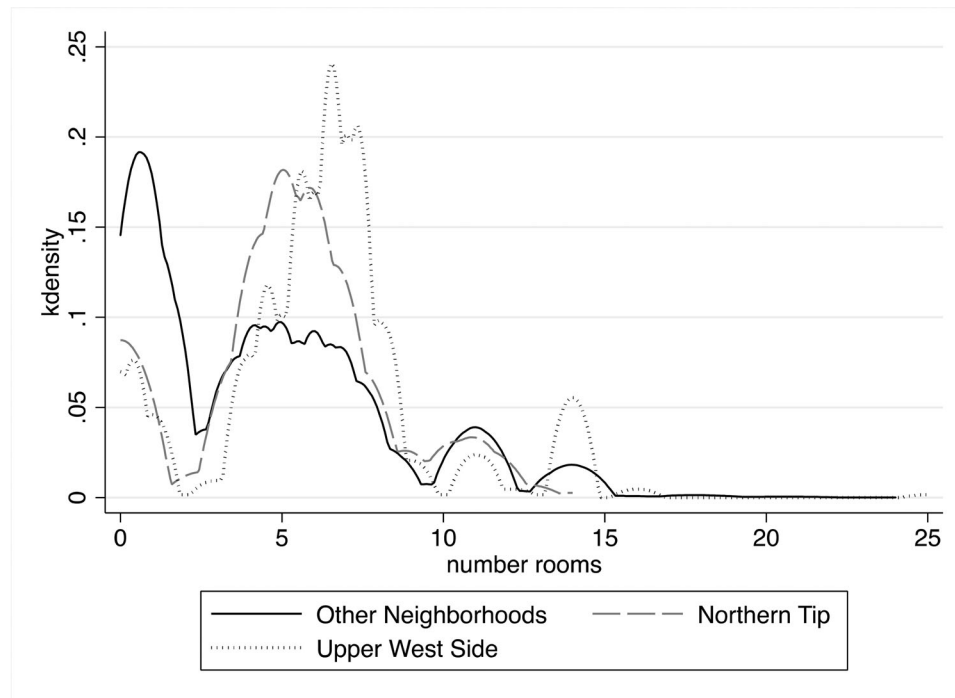
21% of rental observations on the Upper West Side pre-1904 were west of Amsterdam Avenue, and this figure increases to 46% post-subway. The mean location of observations in the western section was Broadway and West 90th Street before 1904 and had moved further toward the Hudson River to West 92nd and West End Avenue post-1904. In contrast, observations in the eastern section did not see a mean change in location, as the transit options remained quite similar in that area. Looking across the distribution more fully, Figure 9 shows the kdensity of longitude of our observations, pre- and post-1904 and west and east of Amsterdam Avenue. Being close to the axis on this graph means closer to the river. We see little change in the distribution on the east side, but a clear break around the subway introduction on the west. The large mass in the solid black line is centered on West 95th & Riverside Drive, while its modal location pre-subway had been at West 78th and Amsterdam Avenue. These line up with the panels in Figure 8, and this is especially clear from looking at 8b, where we see in 1900 that the 10-20 minutes



Figure 10. Local indicators of spatial association for upper west side.

Notes: Same underlying data as Figure 9. Anselin's (1995) LISA method, as described in text. Only observations significant at the 5% level are shown. A queen's case (8 sides) was used to construct the spatial weights matrix to determine a point's neighbors.

a. Pre-1904



b. Post-1904

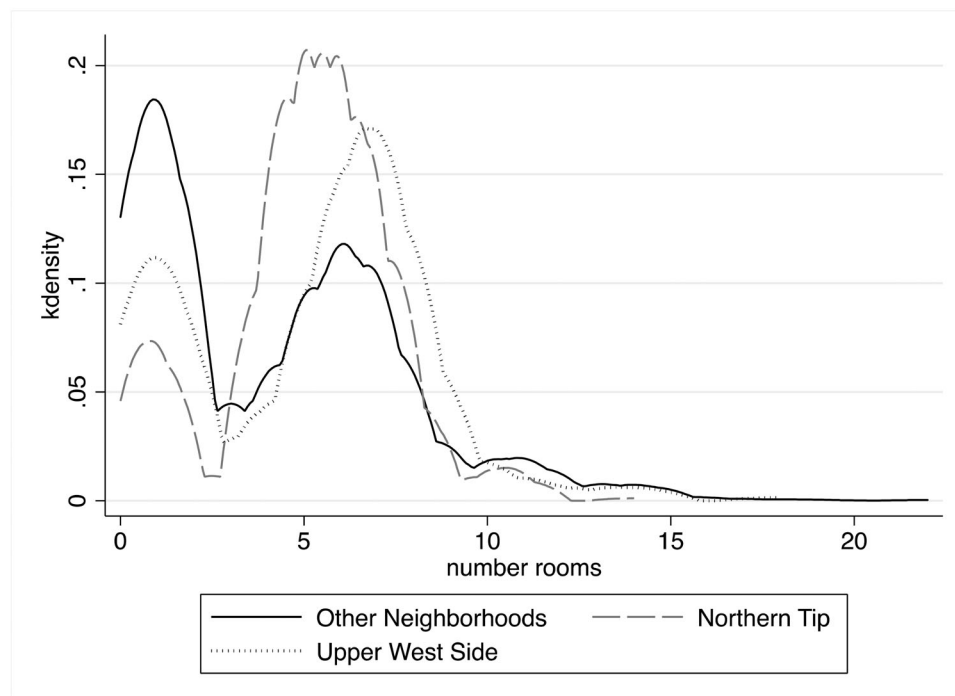


Figure 11. Distribution of size by neighborhoods.

a. Pre-1904.

b. Post-1904.

Notes: Panel a contains 8,031 observations and panel b contains 2,684 observations.

isochrones from Grand Central touches the part of the Upper West Side east of Amsterdam Avenue but that by 1905 the entire neighborhood belongs to that isochrone.

Looking at this with another approach, [Figure 10](#) uses Anselin's (1995) local indicators of spatial association methodology to inform us of where the "hotspots" for each time period tend to be located. In

brief, this analysis searches for datapoints that are similar to each other both temporally, given the year of the observation, and spatially, clustering them without *a priori* categorization. The map shows in grey observations that are in the dataset pre-1904 and which display clusters low in the Upper West Side and toward the Park, as Hood had predicted. The post-1904 hotspots in black tend to cluster around Broadway and toward Riverside Drive.

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 existing literature suggests that higher status, higher-earning 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 professional workers, who worked more standard hours. Data from Pratt's Appendix suggests that 47% of male workers whose jobs were located below 14th Street in Manhattan spent under 60 minutes commuting, while about a quarter spent under 40 minutes commuting, via various means.²¹ As jobs shifted north and other areas became better connected, this also allowed workers to move further away and still reduce commute times. Hood (1993, 180) described pre-World War I subway riders as being exclusively from the upper-middle class and this didn't change until after the dual contracts of 1913.

We can 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 newer areas offered larger units. 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 opened, 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 11, panels a and b, shows the distribution of units by number of rooms, for three sets of neighborhoods: Upper West Side; northern tip neighborhoods including Washington and Morningside

Heights; and all other neighborhoods. Panel a shows the distribution pre-1904 and panel b post-1904. The tails of each distribution are very long because there are some larger houses listed for rent, especially in the earlier years. The most frequent number of rooms in each period for the “other” neighborhoods is 1, driven by observations that advertise a single room to let with or without board. The main clusters within the northern tip and Upper West Side are for larger apartments or smaller houses, around 5 rooms. Again, the earlier period has more density at around 11 and 15 rooms, which is because houses and floors to let were more common features of that period.

The size distributions across neighborhoods 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 more 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 toward 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.

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. A more rigorous comparison of existing Census data at the enumeration district level and samples drawn from newspapers may also be useful in determining the representativeness of the latter datasets.

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 formalized into an algorithm of transit times to the CBDs around City Hall and Grand Central Station. 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.²² The availability of subscription services such as newspapers.com, with an expanding range of historical newspapers, means that an ever-growing set of data could be gleaned, similar to the sample presented here. 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.²³ 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 a small slice of the possibilities for this type of data.

Notes

1. See Snowden, Fetter, and Rose (2018) for a detailed overview of the economic history literature. Gordon and vanGoethem (2007) also decried the lack of reliable data on the rental market before 1975 and highlighted some issues with using the CPI data that goes back to 1914.
2. We limit ourselves to the rental market here, although newspapers did also have some details about sales transactions and listings.
3. 1% sample of the Population Census from IPUMS. The other homeownership rates quoted also come from the 1% IPUMS (Ruggles et al 2020). Earlier in the nineteenth century property owning had been more common, but the trend shifted towards renting for most of the century (Blackmar 1989, Appendix tables).
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.
5. Day (1999, 15) describes people renting whole buildings and undertaking to find tenants for individual units as a common practice.
6. Gray (2020) provides more discussion of coverage across the income distribution of other historical housing datasets.
7. We did not initially collect any observations without an asking price, but added this later in the data collection process to investigate sample selection issues.
8. Results available upon request.
9. This map is from Villarreal et al (2014), with thanks.
10. Our procedure is similar to that used by Barr and Tassier (2016), outlined in their Appendix 1, which also describes some of the same challenges to geocoding that we mention here.
11. In other work, Gray is exploring the use of machine learning to improve the success rate of the automated approach and this appears to work well.
12. 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.
13. 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=✓
14. We computed the correlation between neighborhood population size and the number of observations in our dataset and found them to range from .4 for 1910 to .7 for 1880, suggesting that our dataset does draw observations from neighborhoods in the “right” proportions.
15. All figures given in this section are in nominal, contemporary dollars.
16. Although 4,134 new law tenements had been built on Manhattan by the end of 1909 (Costa and Fogel 2015).
17. We acknowledge that for the sample to be representative of apartments then there must have been no systematic bias in the way we sampled advertisements across locations and over time and that the newspapers must have been used by all types of landlords. We believe these assumptions to be broadly satisfied in this setting.
18. For example, Hood (1993, 17) sketched out the stimulus to residential building in upper Manhattan and the Bronx that followed the subway opening of 1904.
19. Further evidence of pre-subway commuting comes from the 1890 Census which showed that New Yorkers averaged 300 mass transit trips per year (Hood 1993, 55).
20. Hood’s (1993) discussion is consistent with Plunz (1990, 57) who says that the Upper West Side urbanized between 1885 and 1895.
21. In Pratt’s (1968) study, female workers were more likely to walk to work and to spend less time commuting, similar to today.
22. Such a cross-city project is being undertaken, with funding from the National Science Foundation (Award 1918554), by Co-PIs Allison Shertzer and Rowena

Gray and collaborator Ronan C. Lyons. The aim is to build a house price and rental index for the U.S. with enough detail within each city to be useful for urban economists and economic historians.

23. Allen and Van Riper (2020) located residents of the first public housing units in New York City in the 1940 Census and used the data to evaluate the success and values of the new program.

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Sincerely,

Dr Sylvester

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