Crabgrass Frontier Revisited in New York :
Through the Lens of 21st-century Data

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Abstract

Jackson's famous *Crabgrass Frontier: The Suburbanization of the United States* (1985) argues that when American cities suburbanized in the early nineteenth century, the richest households moved from the core to the periphery, the poorest stayed in the core, and the households that moved to the periphery were richer than those who were there before them. I study the gradual process of prewar suburbanization in America's biggest city, New York City, between 1870 and 1940. During this time there were huge transportation infrastructure improvements at both intra- and inter-city level, and there was gradual suburbanization, just as in Jackson (1985). I construct a historical longitudinal database that follows individuals to analyze how the migration patterns differ across workers with different income (skills). Rich people on average did not leave the core and poor people on average did not stay. New suburbanites to the city periphery were not richer than the people who already lived at the periphery. Jackson's fundamental claim about the growth of high income at the edge relative to the center still holds true for my study period. However, I show the mechanism behind this change and show that this relative change in income growth at the edge did not result from a simple shuffling of rich and poor. Up until the Great Depression, flows of migrants from and to outside

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the metropolitan area were the dominant force in changing average income. Richer people from outside NYC metropolitan area migrated to the periphery and poorer people from outside NYC metropolitan migrated to the core. The people from the city core who left the metropolitan area were far richer than the people from the periphery who left the metropolitan area. Furthermore, people who stayed at the periphery got richer as the metropolis grew. Many readers have interpreted *Crabgrass Frontier* as the story of America's suburbanization always and everywhere, and so my finding that two of the major propositions in that book and the mechanism behind income growth at the edge do not apply to 1870-1940 New York has implications beyond local history.

JEL: N71, N72, N91, N92, O18, R3, R4, R12

1 Introduction: Crabgrass Frontier Revisited

> *"Our property seems to me the most beautiful in the world. It is so close to Babylon that we enjoy all the advantages of the city, and yet when we come home we are away from all the noise and dust."*[1]

Jackson (1985)'s *Crabgrass Frontier: The Suburbanization of the United States* remains one of the most influential books ever written on urban history and on American cities. One of the main ideas in the book is that the rich began the flight from the city first — something that the middle classes eventually emulated as city tax rates skyrocketed and those on the lower end of the economic stratum moved into the city.

Jackson (1985) found that suburbanization, a phenomenon that started no later than the early 19th century, was accompanied by enormous growth in metropolitan size and rapid population growth on the periphery, an absolute loss of population at the center, and an increase in the average journey to work, and a rise in the socioeconomic status of suburban residents.

However, Jackson did not have the benefit of the datasets and quantitative analysis techniques that we have now. In particular, he could not follow individuals. He could observe, for instance, that suburbs gained population and that the central parts of cities lost population, but he did not know whether any individual moved from the city to the suburb. With only periodic snapshots of aggregates and no guarantee that anyone in any snapshot is in any other, we cannot begin to think how events affected individuals. While formal welfare analysis is beyond the scope of the current paper, the longitudinal analysis that I perform here is a necessary prologue to any such work.

My study period (1870-1940) occurs after Jackson's study (i.e. 1815-1875) and before the major introduction of highways in the US (Baum-Snow (2007)). I concentrate on New York City. I investigate three of the major conclusions of *Crabgrass Frontier:*

1. That the relative population of more suburban areas increased
2. That the richest people were the ones who led the movement from the center of the city to the periphery, and poor people stayed in the center of the city

[1] Jackson (1985) cites the letter in cuneiform on a clay tablet, which was a letter to the King of Persia in 539 B.C.. Jackson (1985) argues Boston, Philadelphia, and New York established suburbs well before the Revolutionary War, and this letter represents the first extant expression of the suburban ideal.

3. That the people who moved from the center to the periphery were richer than the people living in the periphery

I investigate each of these propositions in turn. Notice that second and third propositions are explicitly longitudinal statements that repeated cross-section data cannot examine.

To bring Jackson's work to the 21st century, I create a micro longitudinal database of individuals by linking US demographic census records. These new datasets provide a very high level of geographic resolution and help shed light on the evolution of neighborhoods over a long time horizon as transportation infrastructure was developed. I link individual-level US demographic census records from 1870 to 1940 (every decade, except for 1890 as the 1890 population census was lost due to fire), to track individuals' residential locations in relation to transit infrastructure-driven transit access change. I decompose how neighborhood changes were driven by out-migration and in-migration of individuals with different socioeconomic characteristics, along with the incumbents' income increase when intra-city transit infrastructure improved market access.

Through the above approach, I "let the data speak" about the process of suburbanization in the biggest city in America. Regarding Jackson's three points, I find

1. Yes, population decentralized

2. No, the people who stayed in the center of the city were richer than the ones who left the city center

3. No, the people who moved to the periphery were poorer than the people already living there

4. Relatedly, richer people from outside NYC metropolitan area migrated to the periphery and poorer people from outside NYC metropolitan area migrated to the core; the people from the city core who left the NYC metropolitan area were far richer than the people from the periphery who left the metropolitan area; furthermore, people who stayed at the periphery got richer as the metropolis grew.

Jackson's fundamental claim about the growth of high income at the edge relative to the center still holds true for my study period. However, I show the mechanism behind this change and show that this relative change in income growth at the edge did not result from a simple shuffling of rich and poor.

Up until the Great Depression, flows of migrants from and to outside the metropolitan area were the dominant force in changing average income. Richer people from outside NYC metropolitan area migrated to the periphery and poorer people from outside NYC metropolitan migrated to the core. The people from the city core who left the metropolitan area were far richer than the people from the periphery who left the metropolitan area. Furthermore, people who stayed at the periphery got richer as the metropolis grew.

To be sure, I am studying only one city for one period, and it is a period outside Jackson's explicit study period. But the city is America's largest, and the period encompasses New York's greatest growth and most dramatic change. Many readers have interpreted *Crabgrass Frontier* as the story of America's suburbanization always and everywhere, and so my finding that two of the major propositions in that book and the mechanism behind income growth at the edge do not apply to 1870-1940 New York has implications beyond local history.

Several research projects explain the central city population decline. For example, Baum-Snow (2007) demonstrates that the construction of new limited-access highways caused central city population decline. Boustan (2010) focuses on sorting where white households left central cities due to racial preferences. Relative to the aforementioned papers, I use a panel data of individuals that enables me to decompose the relative magnitudes of the flows among entrants, leavers and stayers and its associated income differences.

This paper also relates to the large reduced-form empirical literature on transport infrastructure, including Banerjee et al. (2012), Baum-Snow (2007), Donaldson (2010), Donaldson and Hornbeck (2013), Faber (2013), Duranton et al. (2013), Michaels (2008). This paper also contributes to the literature on the internal structure of the city, through a quantitative analysis of economic geography. While there has been extensive development of economic geography in the past few decades (Fujita and Ogawa (1982), and Lucas and Rossi-Hansberg (2002)), there is growing empirical literature. Especially, the structural estimation approach has been implemented in studying the allocation of economic activity, including Ahlfeldt et al. (2012), Allen and Arkolakis (2013), Allen et al. (2015), Heblich et al. (2018), Monte et al. (2015), and Tsivanidis (2018). Especially, Heblich et al. (2018) use the invention of steam railways in the 19th century London to document the role of separating the workplace and residence in supporting concentrations of economic activity. Tsivanidis (2018) evaluates the effect of the world's largest Bus Rapid Transit in Bogota, Colombia and show the gains of improving transit in cities may differ across skill groups.

The remainder of the paper is structured as follows. Section 2 discusses the data and methodology. Section 3 discusses the relevant background of the study. Section 4 discusses the findings of revisiting some propositions of *Crabgrass Frontier* in New York during the study period. Finally, Section 5 concludes.

2 Data and Methodology

2.1 New Population Data on Suburbanization in the US: 1870-1940

I use restricted-access IPUMS complete count individual-level US Federal Demographic Census records (Ruggles et al. (2019)) from 1870 to 1940 to analyze skill-based internal migration in relation to transit infrastructure. These individual-level census records provide rich socioeconomic and demographic information such as occupation, industry, race, and family characteristics along with the residential location. However, complete-count population censuses only exist in cross-sectional format and they do not have a time-invariant individual identifier(s). As following the same individuals over time is essential, I use a "machine learning" approach to follow the same individuals over time. I summarize the record linking criteria and procedure in Subsection 2.2, and details on individual-level record linking are available in the Appendix.

2.1.1 Neighborhood changes from repeated cross-sectional data

In this paper, I use the 1950 Census Bureau occupational classification system (henceforth, OCC1950)-based occupational measures of income and education to enhance comparability across the years. Ruggles et al. (2019) coded occupation-based values according to the 1950 classification. Throughout the analysis, I use OCC1950-based occupational income score (variable called "OCCSCORE") as measures of occupational standing. OCCSCORE is a constructed 2-digit numeric variable that assigns occupational income scores to each occupation in all years of pre-1950 US census which represents the median total income (in hundred of 1950 dollars) of all persons with that particular occupation in 1950.[2]

This approach of using OCC1950-based OCCSCORE controls for inflation and is widely used in the literature to measure individuals' skills. OCC1950 is divided into 10 social classes and 269 occupational groups and has been the US standard for occupational coding due to its strength in comparability across years. However, it has potential shortcomings of not reflecting the relative wage changes, and relative wages may be different across locations. Despite these potential shortcomings, this approach allows me to document neighborhood changes in terms of residents' skills over time (the US Federal demographic census records asked neither one's income nor educational attainment until 1940).

Regarding sources of neighborhood changes, for neighborhoods to change in terms of composition of residents, at least one of three things must hold true (Ellen and O'Regan (2011)) — 1. new entrants to the neighborhood must have different socioeconomic characteristics than the neighborhood average **(selective entry)**; 2. households exiting the neighborhood must have different socioeconomic characteristics than the average (**selective exit**); 3. those remaining in the neighborhood must experience the socioeconomic changes (**incumbent changes**). I can follow all three groups as I seek to match every individual appearing in the US Demographic census records from 1870 to 1940 (every decade, except for 1890 as original 1890 Census records were lost due to fire). The above approach of following all three groups over time requires a longitudinal individual-database and in the following section, I provide more detail about record-linking process.

2.1.2 New longitudinal database and dynamic neighborhood changes

I analyze the longitudinal data of individuals and document how different income groups migrated differently.[3] The longitudinal tracking of individuals is essential to revisit the

[2]Detailed description of "OCCSCORE" and "OCC1950" are available here: `https://usa.ipums.org/usa-action/variables/OCCSCORE#codes_section`, `https://usa.ipums.org/usa-action/variables/OCC1950#description_section`

[3]I create longitudinal database by linking individual demographic census records for both males and females. For female records, however, due to last name change traditions during the study period, I use the marital status information of female records at between two census periods and link only females where the marital status had *not* changed (i.e. single in both periods, married in both periods, or some other cases where last name changes do not typically happen such as married in earlier period and widowed in the later period). For 1870 census records, as the marital status information is not available, I did not link female records between 1870 and 1880.

Crabgrass Frontier propositions for the following reason: suppose one observes a city or neighborhood at two different times, one can observe only how the aggregates changed. Given any sequence of aggregates, there are a huge number of different individual sequences that can produce them, and those different collections of individual sequences have different welfare interpretations. For instance, if one observes only that average income in a city rises between 1870 and 1880, it is unclear whether the people who lived in that city in 1870 stayed there and prospered, or the people who lived there in 1870 suffered and fled the city only to be replaced by richer people who were also losing income but from a higher starting point.

Jackson (1985) argues that when transit infrastructure improved, the rich left the older areas, whereas the poor stayed in the older areas. Therefore, in order for me to revisit these propositions, I need longitudinal data of individuals with different skills (or incomes). To do this, I follow everyone in the US census records (not a sample) during the study period including people who entered, people who left, and people who stayed in neighborhoods in the city between two adjacent censuses. I classify them into "entrants", "leavers" and "stayers" based on their residential location-based migration-status at the neighborhood level. For every neighborhood in the city, "entrants" denote people who lived somewhere other than the particular neighborhood in the earlier period and then migrate into the particular neighborhood in the later period. "Stayers" denote the group of people who live in the same particular neighborhood in the city, whereas "leavers" denote the ones who lived in that particular neighborhood in the earlier period, and no longer live in that neighborhood in the later period. Details of the census record linking are available in the Appendix.

2.2 Record Linking

I implement a supervised discriminative machine learning approach to link historical records without time-invariant individual identifier(s). The essence of this approach is that I use training data (as "teaching-material") to train the algorithm on how to identify the potential matches based on certain discrepancies in the data.[4] I exploit the complete transcription

[4]For example, Heinrich Engelhard Steinweg, the founder of prominent piano manufacturing company, *Steinway & Sons*, anglicized his names into "Henry E. Steinway." Therefore, in linking his records across censuses, string comparison measures called Jaro-Winkler distance of his first (Heinrich vs. Henry), middle (Engelhard vs E.) and last name (Steinweg vs Steinway) would show name discrepancies) even if his birth

of decennial federal census records from 1870 to 1940 except for 1890 (which was lost due to fire), and create a linked-individual longitudinal database across different census years.

Similar efforts of linking records using machine learning methods have been made by Goeken et al. (2011) who built the IPUMS linked individual samples using 1% samples of the 1850 to 1930 US population censuses and 1880 complete count census[5], and Feigenbaum (2015) who linked historical records of children in the 1915 Iowa State Census to their adult-selves in the 1940 Federal Census. Relative to the mentioned work, this project is far more extensive in the scope of matching as it links complete-count census records of the study period (i.e. 1870 to 1940). I create a training dataset which contain both "true" and "false" matches and their characteristics (e.g. some observations with "true" as an outcome would have same/very similar characteristics in terms of age, first and last name, parents' and his/her birthplaces whereas observations with "false" as an outcome would have quite different characteristics in terms of the above mentioned characteristics). In this case, the outcome is whether the matched records are "true" or "false" match, given the observed characteristics. By taking this training data, I build a prediction model, or learner, which will enable us to predict the outcome for new, unseen objects. A well-designed learner armed with a solid training dataset should accurately predict outcomes for new unseen objects.

I implement a supervised learning problem in the sense that the presence of outcome variable ("true" or "false" links) guides the learning process—in other words, the end-goal is to use the inputs to predict the output values. To summarize this process, I extract subsets of possible matches for each record and create training data in order to tune a matching algorithm so that the matching algorithm matches individual records by minimizing both false positives and false negatives while reflecting inherent noises in historical records. I explored various models for model selection, and I ultimately chose the random forest classification as it is *more conservative* in matching records and the number of unique matches are significantly higher than the standard Support Vector Machine model.

Also, I develop a record linking algorithm and methodology that links women's census records over time. Linking women's records is very rare because women's last name

year and birthplace may be the same across different records

[5] IPUMS Linked representative samples, 1850-1930 can be downloaded at the following link: https://usa.ipums.org/usa/linked_data_samples.shtml

changed upon marriage in this period. Also relative to other traditional record linking methods where potential non-unique candidate matches are eliminated, I implement various ways to save more matches by including time-invariant family information.

2.3 Geographic Information Harmonization

The primary geographic units of the analysis are "Neighborhood Tabulation Areas" (hereafter, NTAs), each with at least 15,000 people in 2010 (there are 195 NTAs (neighborhoods) within the city). As datasets used in the analyses have different spatial units and/or the boundaries of the spatial unit constantly change, I create spatial crosswalks from historical spatial locations from various data sources (e.g. "enumeration district" in US census records) to NTAs so that NTAs can be a time-invariant, consistent geographic unit of analyses, and all datasets used in the analyses are harmonized and geolinked to NTAs.

An Enumeration District is a historical version of "census tract" where the historical US census enumerators recorded as administrative division smaller than counties (and wards which were extensively used in existing literature). As individual-level US Federal Demographic Census provides ED number, I can now aggregate the individual-level information to the neighborhood or similar geographic levels within the city. As GIS software enables researchers to know where these geographic units are in space, historical GIS effort of georeferencing ED images from microfilms and creating Geographic Information System (hereafter, GIS)-compatible shapefiles must be made to execute the analyses during the study period (i.e. 1870 to 1940).

This digitization effort has benefited from existing projects called the Urban Transition NHGIS (Logan et al, 2011) and Shertzer et al. (2016). I complement the existing sources by pushing time horizon and geographic scope—1880 Enumeration District boundary files of Manhattan and Brooklyn were obtained from the Urban Transition Historical GIS project; Shertzer et al. (2016) shared with me Manhattan and Brooklyn ED boundary files from 1900 to 1930. However, as Shertzer et al. (2016) mainly focus on studying the ten US largest cities, they did not digitize the relatively unpopulated areas of the Bronx, Queens, and Richmond. Therefore, I use the microfilm scan images of New York City Enumeration District maps of 1880-1940 and created historical GIS files for the remaining regions across time. For boroughs that microfilm scan images were not available in each period such as Queens county in 1900, Richmond County and Bronx county in 1910, I use detailed street and building information of residential addresses from the individual-level census records to locate which ED corresponds to each neighborhood. Stephen P. Morse's website has resources for ED finding tools for 1900 to 1940 censuses https://stevemorse.org/census/unified.html, and I mainly reference this website to check the conversion between different census years, and old street names and ED boundaries.

A major difficulty in making use of ED-level analysis using the above-mentioned boundary files is that the ED boundaries change considerably across time, making it extremely challenging to form consistent neighborhoods. Shertzer et al. (2016), for example, approach this problem by harmonizing ED data to temporally invariant geographically defined areas that they treat as "synthetic neighborhoods" to study neighborhood change. I approach this problem by taking the Neighborhood Tabulation Areas (called "NTAs") created by Department of City Planning in New York City.[6] I use ED shapefiles to create spatial crosswalks from ED boundaries to NTA neighborhoods over the study period. For every ED and every NTA, I aggregate the variables by aggregating the complete-count US Demographic census. Examples of such are total population, age, mean family size, occupation-based earning and education measures, marital status, and race.

2.4 Transit Network

I have collected various subway and elevated railway datasets, including the data on each station in the existing New York transit system. The year each station has opened was determined to estimate the subway opening, network, and station effects. Based on the compiled dataset, and evolution of subway and the elevated train network every decade (1870 to 1940) is documented. I use this transit network evolution, and I classify each neighborhood in the city as "transit hubs" as the core and "transit spokes" as the periphery of the city. "Transit hubs" are locations where transit infrastructures are extremely concentrated such as Downtown Manhattan and Midtown Manhattan, whereas "transit spokes" are locations where transit connections exit with low density but connected to transit hubs.

[6] Description and related GIS software-compatible files of Neighborhood Tabulation Areas is available here: https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-nynta.page

2.5 Geographic Definition

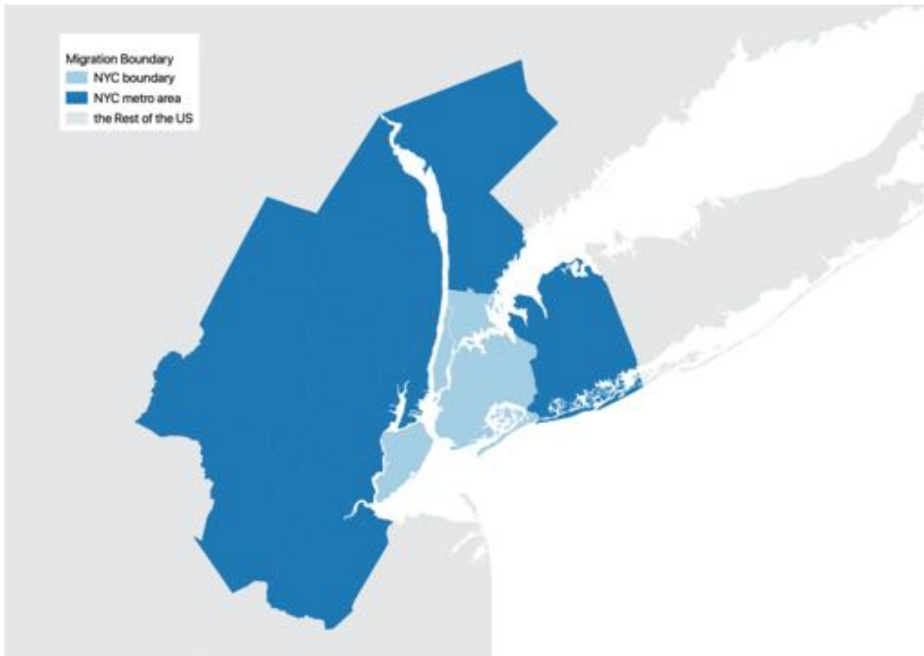
There are essential boundary definitions in Section 4.2, 4.3, and the decomposition analyses in Section 4.4. Here is the definition of the metropolitan area (or metro area), and how I define the core and the periphery of the city. Figure 1a shows geographic boundary of NYC, NYC metro area, and the rest of the country. A metro area, or metropolitan area, is a region consisting of a large urban core together with surrounding communities that have a high degree of economic and social integration with the urban core and I follow the IPUMS-definition, and delineation of the metro area of New York City.[7] IPUMS-delineation of the metro area of the city applies the 1950 Office of Management and Budget standards to historical statistics (Ruggles et al. (2019)). This approach yields time-varying delineations of regions with high degree of economic and social integration with the urban core which is ideal for my study (i.e. Suffolk County, New York was not part of NYC metro area till 1920, however, as the economic integration between Suffolk county and NYC increased, Suffolk county became a part of NYC metro area since 1930). As in Figure 1a, I define 5 boroughs of New York City as the city (in Light blue), NYC metro area (in Dark blue), and the rest of the United States (in Light gray) by following IPUMS delineations of NYC metro areas.

Figure 1b shows the core and the periphery of the city. I define the core and the periphery neighborhoods in the city based on the intra- and inter-railway transit network over time (as in Section 2.4), and therefore the delineation of what makes up the core (in Pink) and the periphery (in Emerald green) of the city changes over time depending on the transit infrastructure at that time. The city is the union of core, periphery and the rest — transit hubs are the core of the city where the transit infrastructure is extremely well connected, whereas transit spokes make up the periphery of the city with low intensity of transit network, and the rest of the city (in Light gray) are areas with no direct transit access.

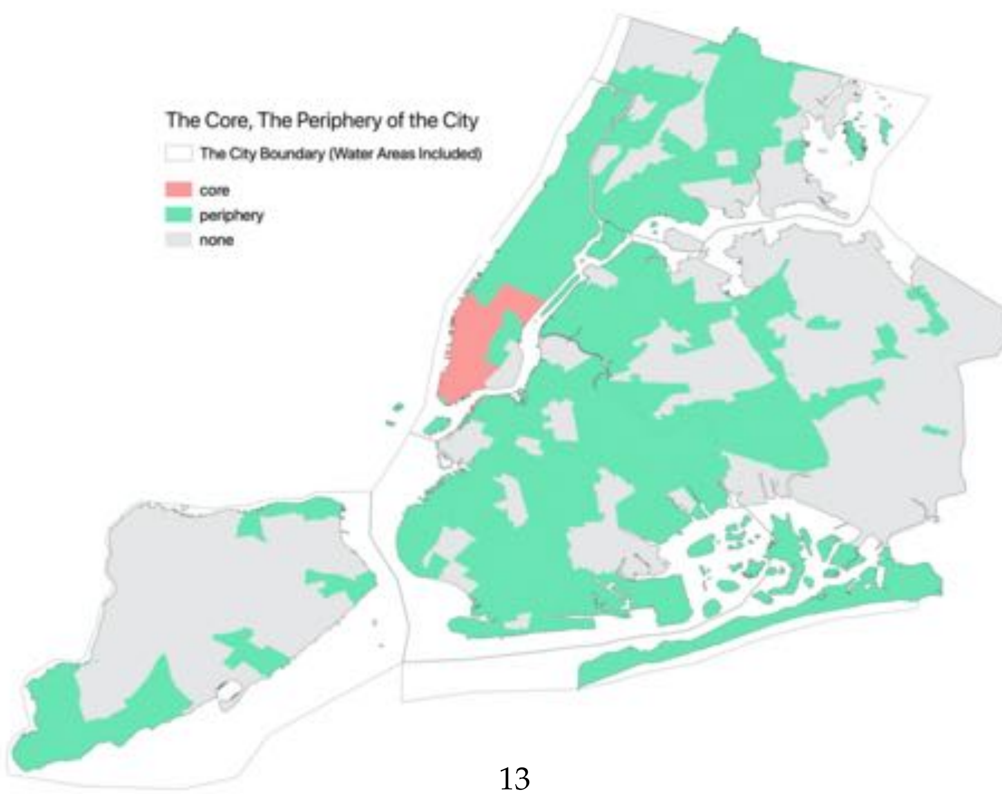
[7] Description of a metropolitan area and definition is available here: https://usa.ipums.org/usa-action/variables/METAREA#description_section

Figure 1: Geographic Boundary Definition

(a) Geographic Boundary of NYC Metro Area



(b) Geographic Boundary of the Core and the Periphery of the City



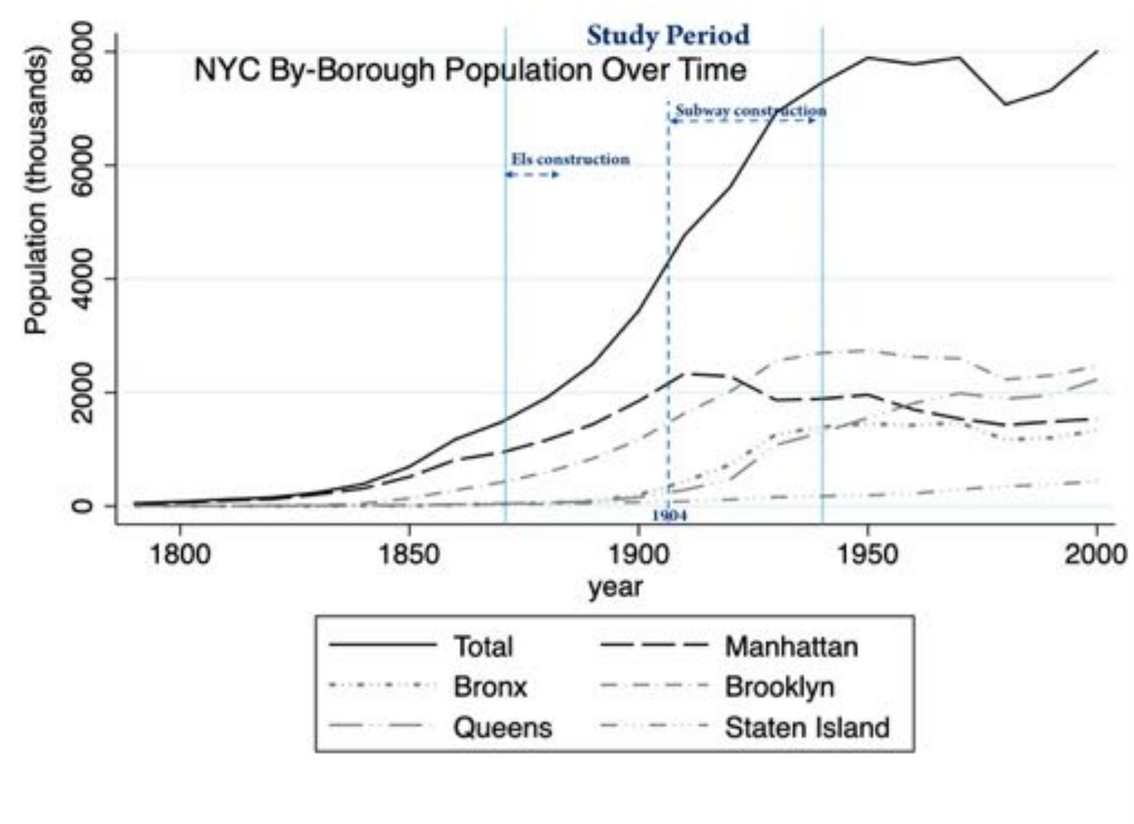
3 New York City Background: 1870-1940

3.1 Population Growth

New York City was the largest city in the country at the beginning of the study period. Over the study period (1870-1940), the total population of the city increased from 1.48 million to 7.5 million.[8] During the study period, the total population in NYC (5 boroughs) experienced an astonishing growth with its peak population growth rate being 39% over a decade. However, beginning in the early twentieth century, Manhattan experienced the dramatic population loss when all outer boroughs were gaining population at an unprecedented rate (for example, between 1920 and 1930, Manhattan lost 18% of its population when the population in Queens and Bronx grew by 130% and 73% respectively).

[8] In 1898, through the consolidation of NYC, outer boroughs (Brooklyn, Bronx, Queens, and Staten Island) were incorporated into New York City. For my analysis, I always define the city as 5 boroughs throughout the study period.

Figure 2: Population Trend Over Time by Borough

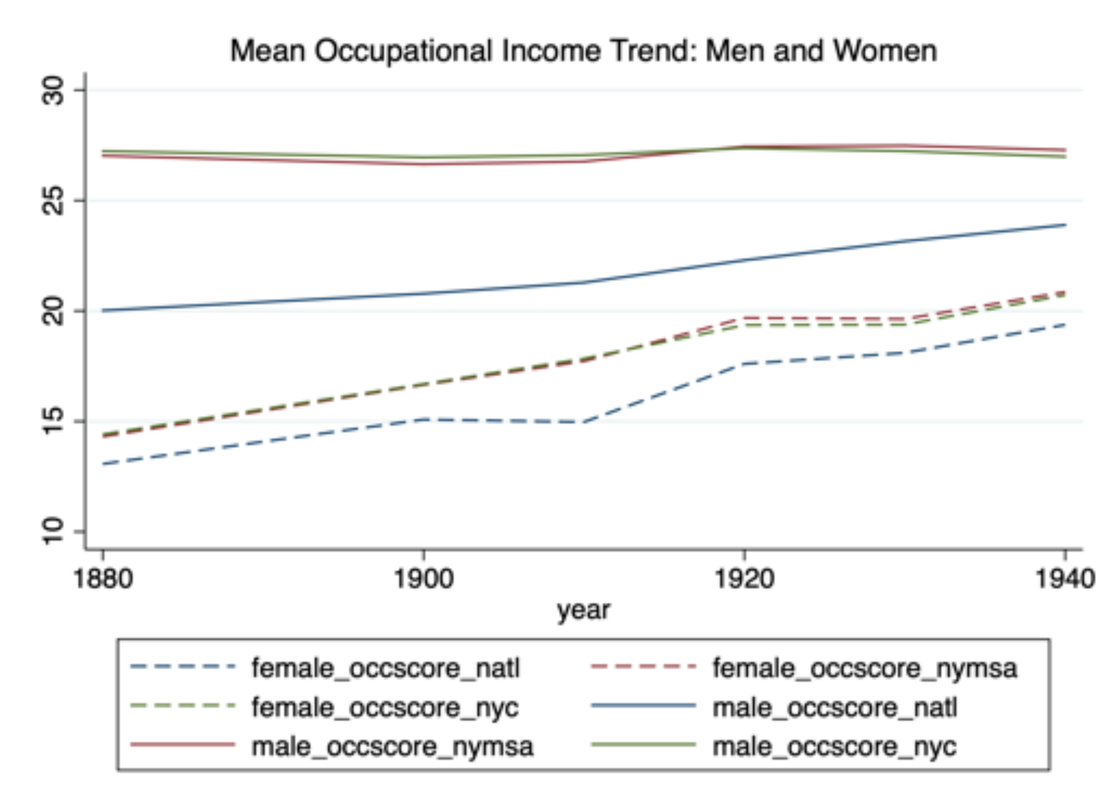


3.2 Income and Occupation Trends in NYC

NYC was growing in skill during the study period, as well as in population, and this growth in skill was occurring among almost all demographic groups. This aggregate skill growth matters for my analysis because it implies that *growth in skill in one neighborhood did not have to come at the expense of a reduction in skill in others*; the tide was rising and so no boat was forced to sink. However, skill growth in NYC was nowhere near as fast as population growth, and in some decades faltered slightly. New York was more skilled than the rest of the nation during the study period, but its advantage was eroding.

Figure 3 shows mean occupational income trend of all men and women aged between 16-60 with occupation over time at the varying geographic scope. Solid lines indicate men, whereas dotted lines indicate women; in terms of geography, the national average is in Blue, NYC's metro area average is in Red[9], and NYC average is in Green. Data reveal that men in NYC and NYC metro area had significantly higher mean occupational income than the rest of the country, but converged to the rest of the country over the 60 years. A similar pattern was observed for women but at a much smaller magnitude.

Figure 3: Mean Occupational Income Trend: Men and Women



Source: US complete-count census records. All observations are aged between 16-60 with reported occupations.

[9] A metro area is a region consisting of a large urban core together with surrounding communities that have a high degree of economic and social integration with the urban core. Since 1950, the Bureau of the Budget (later renamed the Office of Management and Budget, or OMB), has produced and continually updated standard delineations of metropolitan areas for the U.S. as a set of cities or towns. To delineate metro areas in pre-1950 samples (which is the case of all US census data that I use for the analysis), the general approach (used first by the creators of the 1940 PUMS and then by IPUMS for earlier samples) is to apply the 1950 OMB standards to historical statistics. This approach of applying the 1950 OMB standards to pre-1950 samples has merits as it reflects the evolution of population and economic integration between surrounding areas and the urban core over time.

4 Testing the Specific Propositions of Crabgrass Frontier

4.1 Did Population Grow in More Suburban Areas?

As the distance from the center increases (measured by the distance from the Battery which is the southern tip of Manhattan), the population density was declining during the study period. Table 1 and Figure 4 show that the population density gradient was negative and flattening. With the NTAs (neighborhoods in the city) as the units of observation, I regress log of population density as a function of the distance from the Battery to centroids of NTAs in the city. Regression results show that population gradient is negative and statistically significant, but starting from the peak of subway construction in the 1910s, the population density gradient was flattening significantly. The population density decreased as it gets further away from the center of the city. However, due to the transit infrastructure improvement, the population grew in more suburban areas and therefore the density gradient was flattening.[10]

The population grew in more suburban areas and Figure 7 shows this pattern over the study period. In 1880, only the center of the city and its adjacent areas were populated and areas further away from the center were largely unpopulated ("white shade" areas in Figure 7 indicates unpopulated areas, whereas the darker shades of the color red, the higher population density). However, starting from 1900, areas away from the center became populated and toward the end of the study period, in 1940, all neighborhoods in NYC became populated. Similar patterns are observed in Figure 6: in the beginning of study period (in 1880), only the areas close to the center were populated and areas further away from the center were largely unpopulated. Over time, areas relatively closer from the center became populated, and the slope of bivariate plots became flatter which imply that the population density declines less as the distance from the center increases. To the very end of study period (in 1940), basically all areas in the city became populated.[11]

The population density in places close to the center ("transit-hub") such as downtown

[10] This is consistent with the land use theory developed by Alonso (1964), Muth (1964), Mills (1967) which predicts that faster commuting times push up the demand for space in suburbs relative to central cities.

[11] In Figure 6, for $\ln(population\ density)$ (y-axis), I take the natural log of the total population in each NTA divided by the size of each NTA. With regards to the distance from center (x-axis), I measure the distance from the Battery, the southern tip of Manhattan in NYC, to centroids of each NTA in the city (measured in *kilometer*). I assign the value of $\ln(population\ density)$ to be nil for unpopulated NTAs with population of 0.

and midtown Manhattan experienced dramatic losses, whereas "transit-spoke" neighborhoods such as upper Manhattan and Bronx, and Brooklyn were extensively gaining population.[12] As in Figure 8, population density dramatically decreased in the center whereas the population increased substantially in surrounding areas of the city center. During the 1910s and 1920s, subway construction was at its peak through the Dual Contract period, and most neighborhoods in upper Manhattan, Brooklyn, and Bronx were experiencing a huge improvement in commuting transit access.[13]

Table 1: Population Density (with zeros)

	1870	1880	1900	1910	1920	1930	1940
Dist Battery	-0.0463***	-0.0984***	-0.0975***	-0.0898***	-0.0775***	-0.0467***	-0.0411***
	(0.00831)	(0.00831)	(0.00883)	(0.00852)	(0.00853)	(0.00614)	(0.00609)
Constant	3.167***	6.488***	8.260***	8.794***	8.736***	8.456***	8.348***
	(0.417)	(0.417)	(0.443)	(0.428)	(0.428)	(0.308)	(0.306)
N	195	195	195	195	195	195	195
R^2	0.139	0.421	0.387	0.365	0.300	0.230	0.191

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Dependent variable: $\ln(population\,density)$ normalized by the size of each NTA (measured in $kilometer^2$). Indepedent variable: distance from the Battery, the southern tip of Manhattan in NYC, to centroids of each NTA in the city (measured in *kilometer*). Here, when I take natural log of population density, I assign the value log(population density) to be nil for unpopulated NTAs with population of 0. 1870 (the first column) coefficient is less reliable as the availability of geographic information is extremely limited that identifying and harmonizing one's residential location at NTA level was more challenging than other years.

[12] In the Appendix, I map the Transit Access changes by decade drive by the elevated and subway construction by every decade during the study period. At the same geographic and time scale, I also map the new construction of residential-land use construction and commercial-land use construction by decade. Figures show that in places near the center ("transit-hub"), land became more dedicated for commercial use; whereas places far from the center but connected to the center ("transit-spoke"), land became more dedicated for residential use.

[13] Finally, in the 1920s, subfigure 8d shows that the huge population decline in upper east Manhattan and Harlem during this period. Harlem was predominantly occupied by Jewish and Italian in the 19th century. However, in the 1920s and 1930s, during the Great Migration, African-American residents arrived in large numbers and Harlem became the focus of the "Harlem Renaissance" and predominantly an African-American community.

Table 2: Population Density (without zeros)

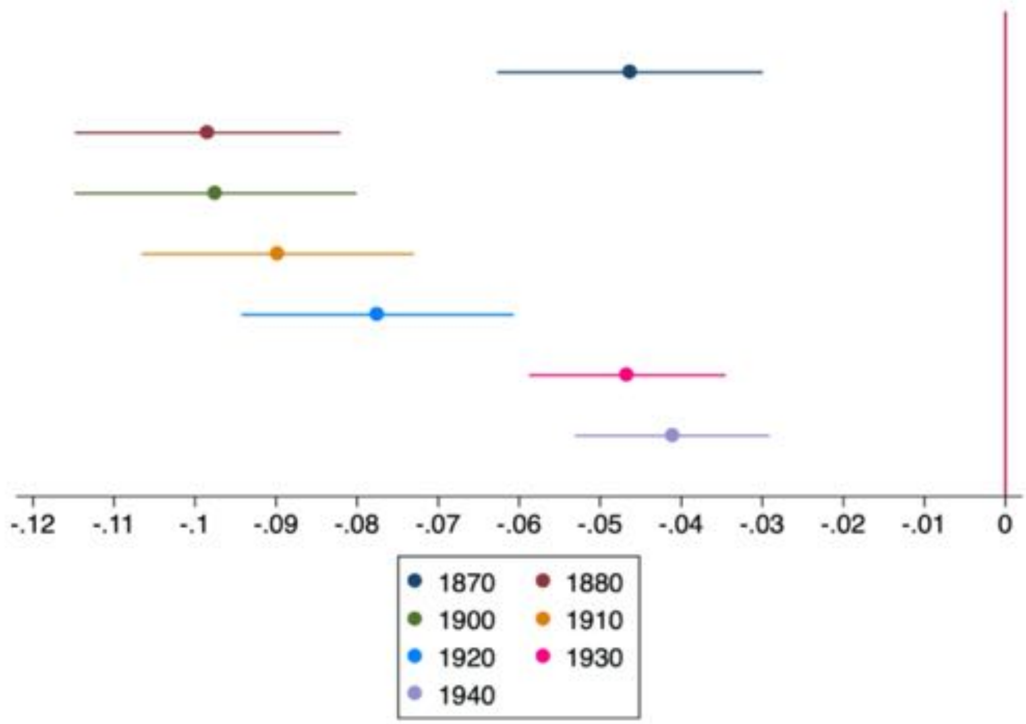
	1870	1880	1900	1910	1920	1930	1940
Dist Battery	-0.0691***	-0.0603***	-0.0630***	-0.0602***	-0.0569***	-0.0465***	-0.0361***
	(0.0151)	(0.00783)	(0.00631)	(0.00610)	(0.00633)	(0.00595)	(0.00542)
Constant	8.571***	8.107***	8.316***	8.523***	8.597***	8.480***	8.239***
	(0.581)	(0.264)	(0.281)	(0.284)	(0.303)	(0.299)	(0.270)
N	32	60	127	152	165	194	191
R^2	0.412	0.505	0.444	0.394	0.332	0.241	0.190

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Dependent variable: $\ln(population\,density)$ normalized by the size of each NTA (measured in $kilometer^2$). Indepedent variable: distance from the Battery, the southern tip of Manhattan in NYC, to centroids of each NTA in the city (measured in *kilometer*). Here, when I take natural log of population density, I excluded unpopulated NTAs with population of 0. 1870 (the first column) coefficient is less reliable as the availability of geographic information is extremely limited that identifying and harmonizing one's residential location at NTA level was more challenging than other years.

Figure 4: Population Density Result Coefficients and Confidence Intervals (with zeros)



Note: When I take natural log of population density, I assign the value log(population density) to be nil for unpopulated NTAs with population of 0.

Figure 5: Population Density Result Coefficients and Confidence Intervals (without zeros)

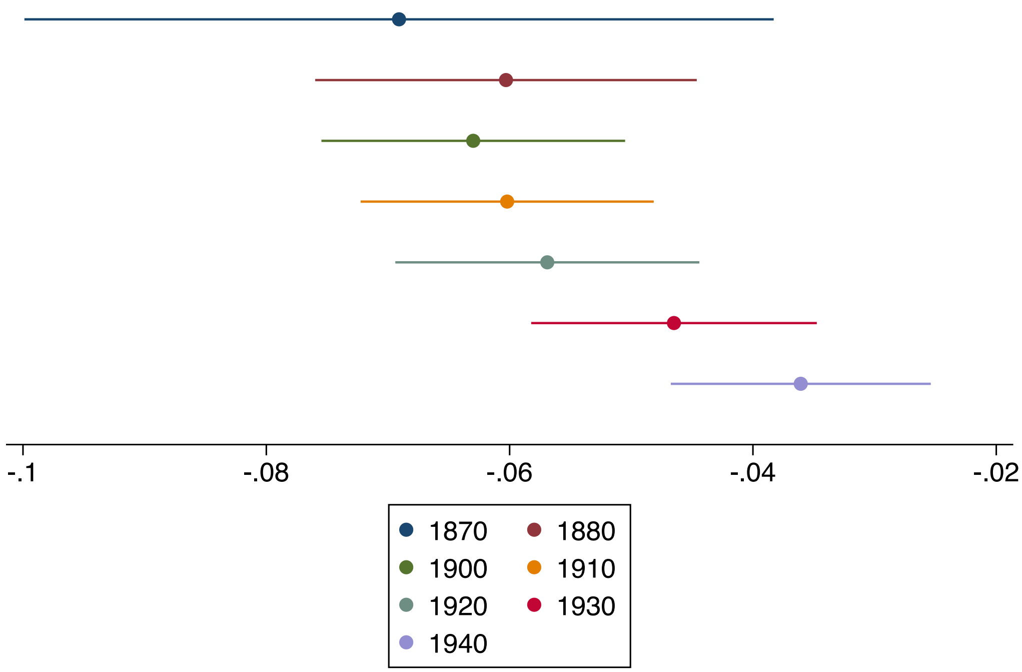
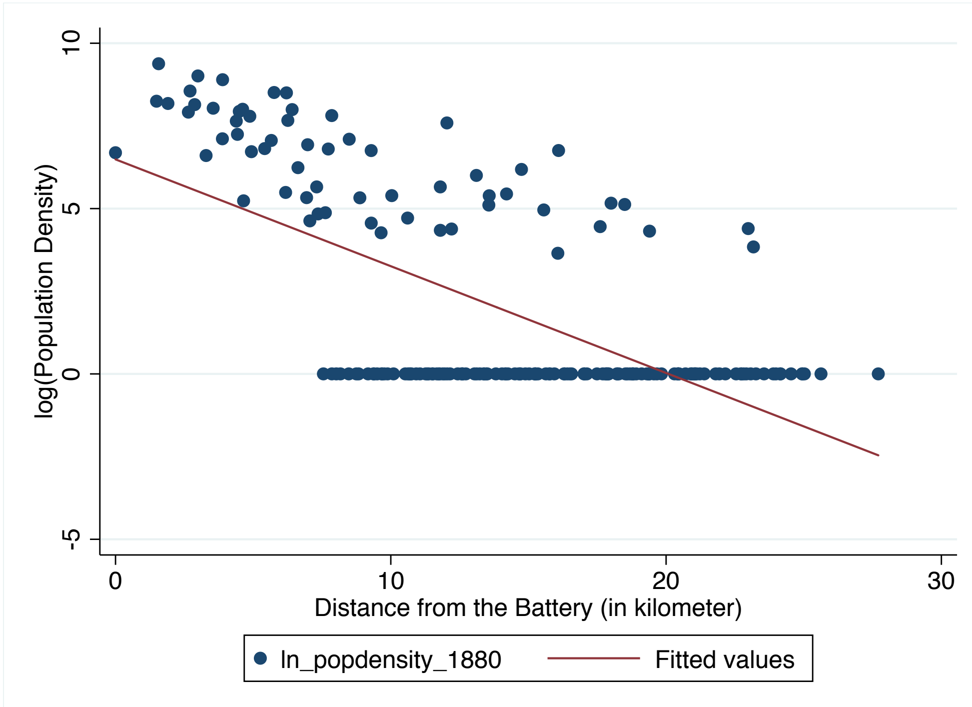


Figure 6: ln(*Population Density*) Against Distance From Center

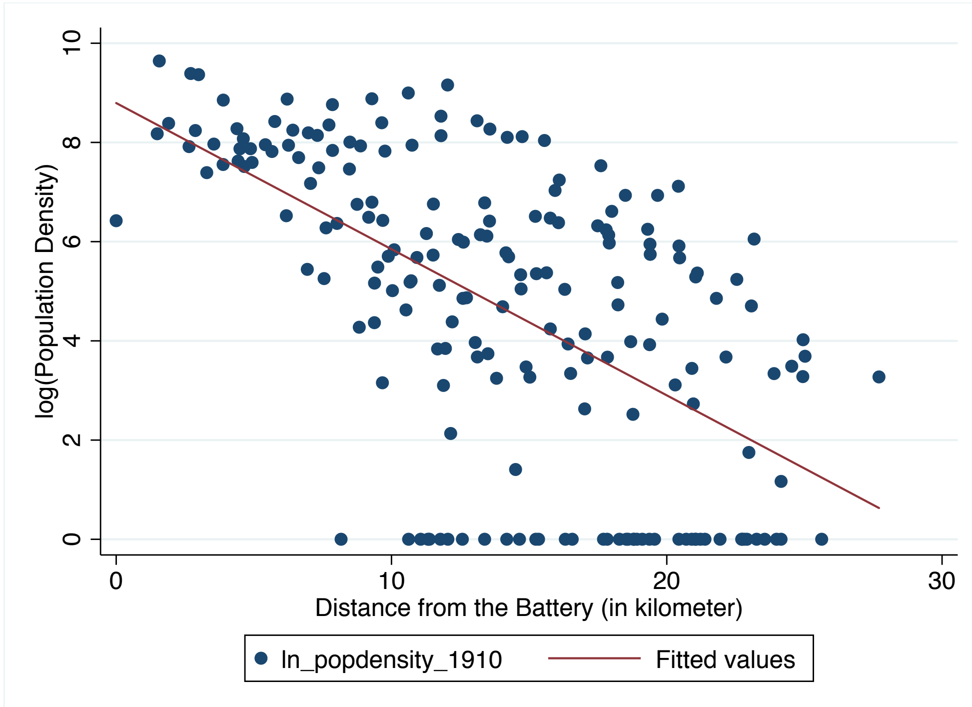
(a) 1880



(b) 1900

Figure 6: ln(*Population Density*) Against Distance From Center

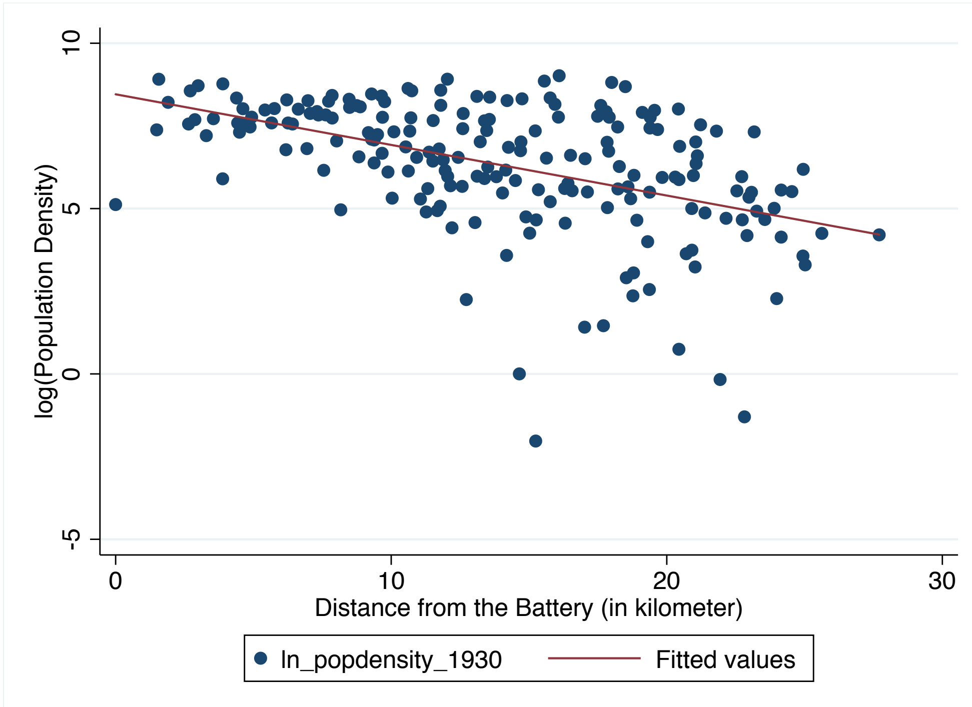
(c) 1910



(d) 1920

Figure 6: ln(*Population Density*) Against Distance From Center

(e) 1930



(f) 1940

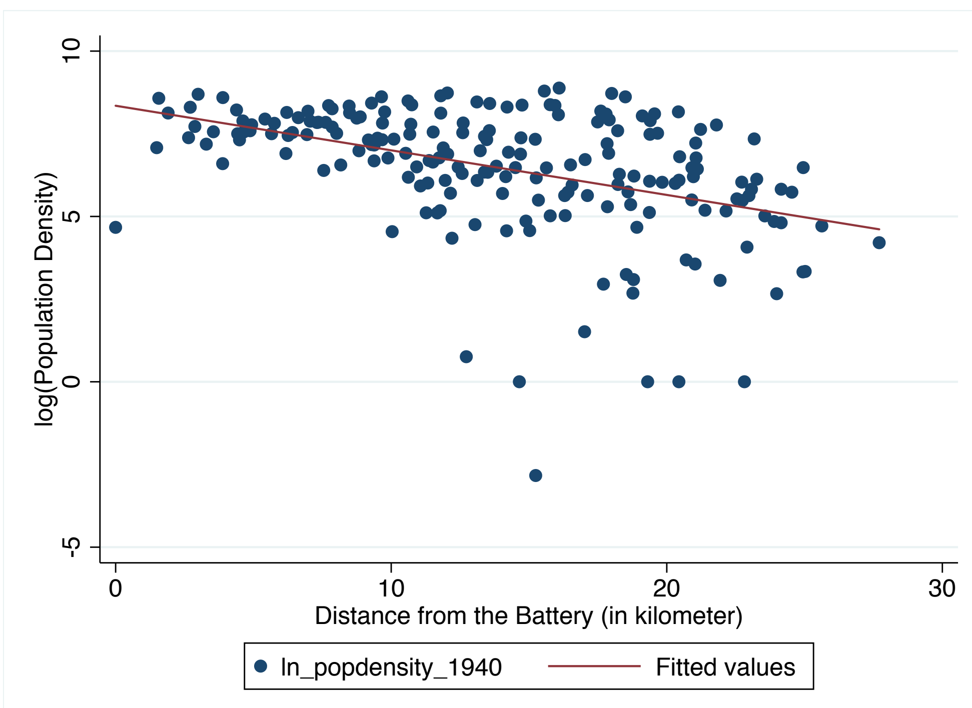
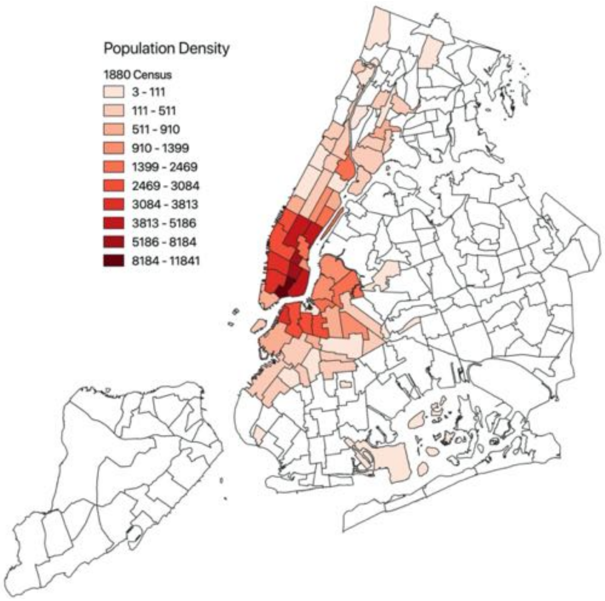
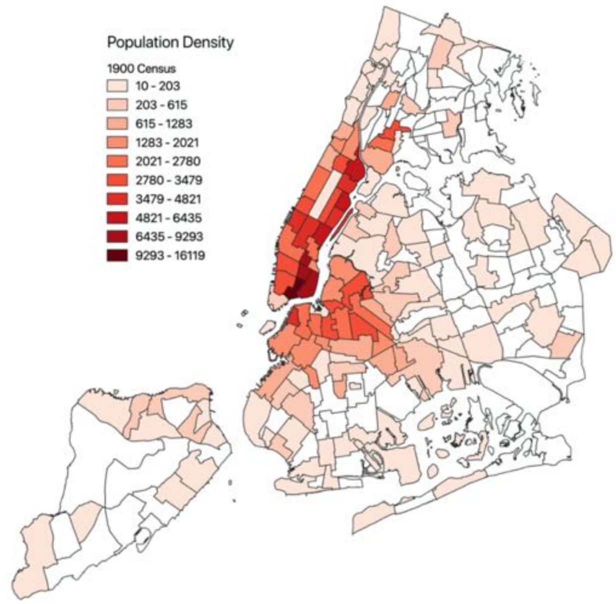


Figure 7: Population Density

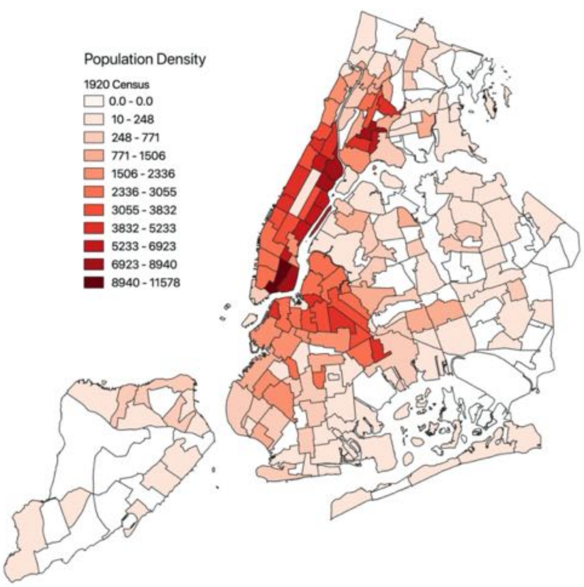
(a) 1880 Population Density



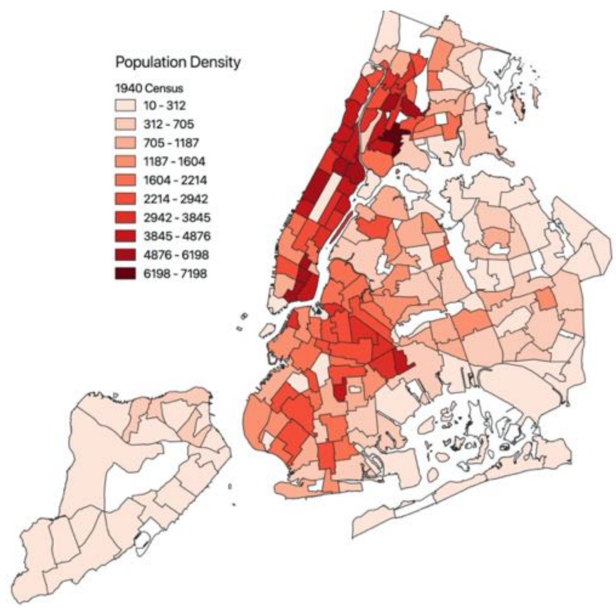
(b) 1900 Population Density



(c) 1920 Population Density



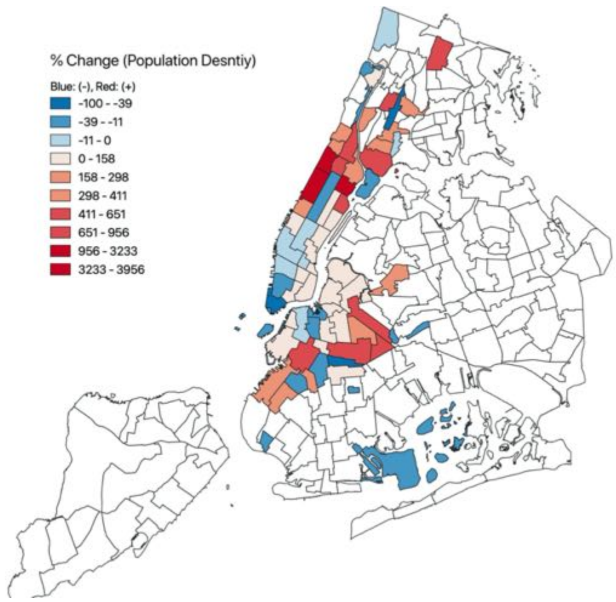
(d) 1940 Population Density



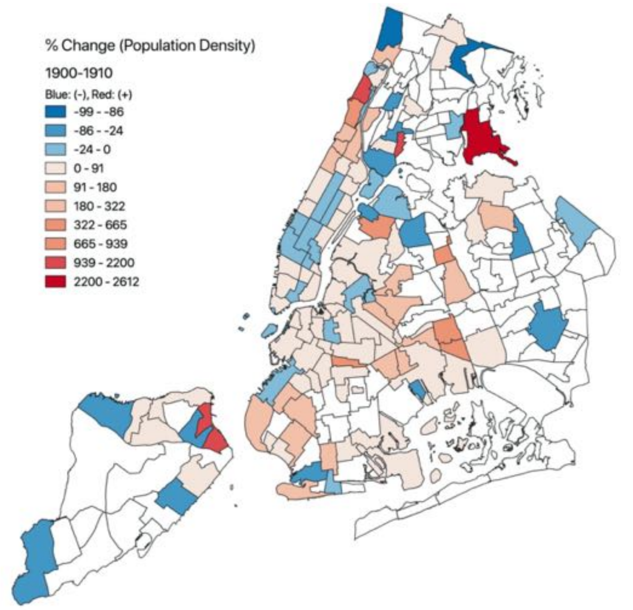
Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's creation using the complete-count US Federal Demographic Census.

Figure 8: % Change of Population Density

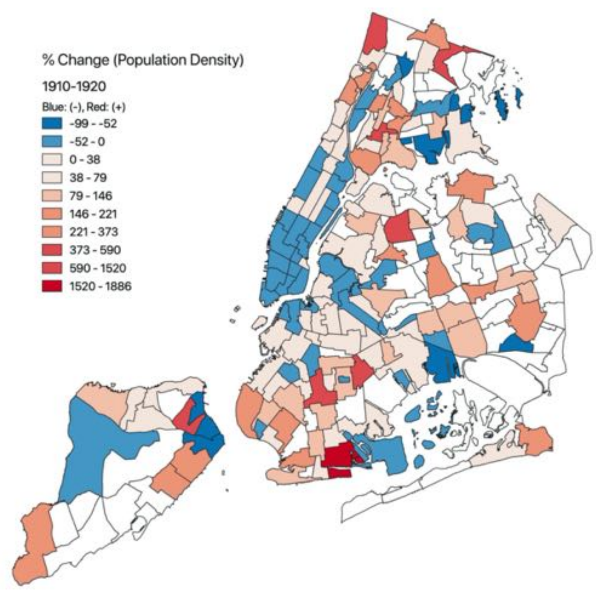
(a) 1880-1900 Population Density % Change



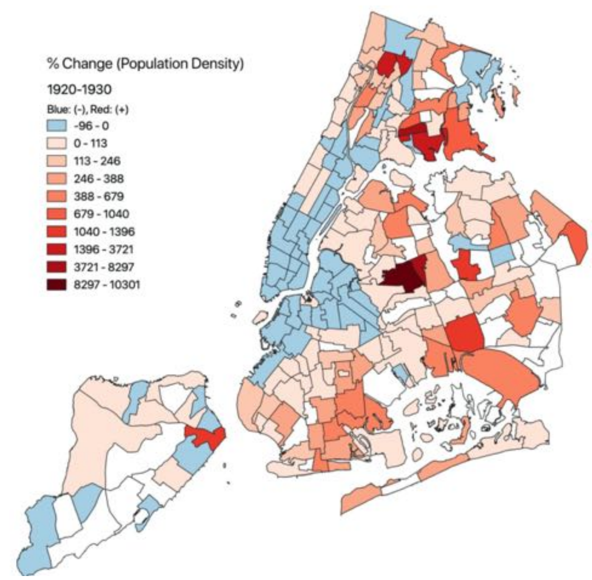
(b) 1900-10 Population Density % Change



(c) 1910-20 Population Density %Change



(d) 1920-30 Population Density %Change



Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's Creation using the complete-count US Federal Demographic Census.

4.2 Did the Rich Leave the Center of the City?

Jackson (1985) discusses the phenomenon in the 1850s NYC of the rich leaving the center of the city. He discusses the migration of the rich in the center of the city by quoting phrases concerning the 1850s New York such as "the desertion of the city by its men of wealth" and "many of the rich and prosperous are removing from the city, while the poor are pressing in."

If the popularly perceived pattern of the 1850s NYC had held true for my study period, the longitudinal database should reveal that leavers of the center of the city should be richer than the stayers. Therefore, among residents of the center of the city, I compare the occupational income of residents who later moved ("leavers") with that of those who stayed for the next decade ("stayers").

Throughout the period from 1880 to 1930, the longitudinal database shows that it was not the rich who left the center of the city. For example, Figures 9, 10, 11, 12 show that the mean occupational income of city-center leavers was lower than that of city-center stayers. In each NTA, blue shades (the darker blue, the poorer leavers) indicate leavers being poorer, whereas red shades (the darker red, the richer leavers) indicate leavers being richer than the stayers. At the center of the city, throughout the years between 1880 and 1930, in Figures 9, 10, 11, 12, the core of the city being consistently blue indicates that it was not the rich who left the center of the city—in fact, the leavers had lower mean occupational income than the center-stayers.

Regression results also show that it was not the rich who left the center of the city. I run logistic regression (also called as a logit model) to model the log odds of individuals' leaving the city relative to staying in the city in the later period, using the longitudinal data of individuals during the study period. The outcome of interest is identifying factors that explain whether individuals living in the core of the city in the early period leaves or stays the city boundary (5 boroughs) in the subsequent period. The predictor variables of interest are occupational income, nativity, race, and age.

Regression results in Tables 3, 5, 7, 9, 11 show that as occupational income increases, people who lived in the city center in the earlier period were less likely to leave the city. In terms of the nativity, being foreign-born relative to native-born with both native parents decreases the log odds of leaving the city center — this may be partially due to ethnic enclaves in Lower East Side of Manhattan near the city center. In terms of race, being non-white relative to white increases the log odds of leaving the city center and the degree of relative log odds across race differ; however, considering that the majority of residents in New York were white, this may be interpreted with caution. Finally, older people are more likely to leave throughout the study period.

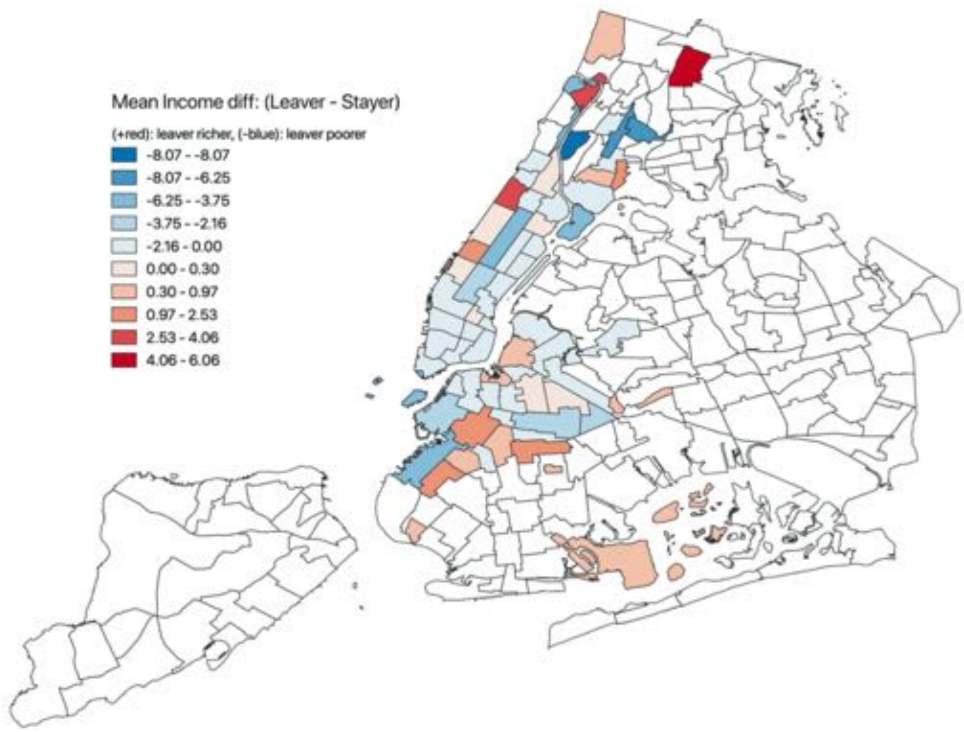
While the regression results in Tables 3, 5, 7, 9, 11 look at extensive margin of leaving or staying in the city among people who lived at the core of the city in the earlier period, Tables 4, 6, 8, 10, 12, 21 look at whether flows to the metro area may have been different from flows to outside the metro area (e.g. the city core leavers migrating to places like California that are strictly outside NYC metro area but in the country boundary), and flows within the city (i.e. the city core leavers migrating to the periphery of the city) relative the people who stayed in the city core both periods.

Regression results in Tables 3, 5, 7, 9, 11 show that relative to people people who stayed in the city center, as occupational income increases, people who lived in the city center in the earlier period were less likely to leave the city at every migration scale — leaving to NYC metro area, leaving to outside NYC metro area, moving to the periphery of the city and this holds up until the Great Depression. In terms of the nativity, being a foreign-born relative to native-born with both native parents increases the log odds of leaving the city center. Finally, older people were less likely to leave the city center.

The people whom public opinion perceive to be richer may be older and more likely to be native whites of native parentage (and therefore they are more "prestigious"). So, the public perception may have been that the leavers had higher social status, not that they had a higher income. However, the occupational income measure that I use for the analysis only depends on one's occupation, and it does not reflect factors such as one's race, nativity, or age, and such factors may have played more roles in determining one's income. This makes the accuracy of income measures more crucial. If there was wage discrimination against who people who were not old or not native whites with native parentage, then leavers of the core may have been richer. Not necessarily more skilled (in terms of occupation), but richer. Considering that income tends to increase with age, to the contemporary observers, the relatively old people's leaving the city center may have been interpreted as *"the desertion of the city by its men of wealth."*

Relatedly, Section 4.4.2 discusses decomposition of various flows of the core of the city including the relative income difference between leavers and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level. The people from the core who left the metropolitan area were richer than the people from the periphery who left the metropolitan area, and poorer people from outside NYC metro area migrated to the core over time, making the relative income at the core to decrease.

Figure 9: Neighborhood-level Mean Income Differences between Leavers and Stayers, 1880-1900



Note: Blue shades mean leavers' mean occupational income was lower than stayers, whereas red shades mean leavers' mean occupational income was higher than stayers in the Year 1880.

Table 3: Logit Results between Leavers and Stayers at the City level: 1880-1900 Males

[City Leavers]				
Occupational income	-0.00517**	-0.0101***	-0.0106***	-0.0121***
	(0.00199)	(0.00208)	(0.00212)	(0.00215)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.350***	-1.357***	-1.295***
		(0.205)	(0.205)	(0.206)
Native born: mother foreign, father native		-1.059***	-1.072***	-1.006***
		(0.284)	(0.285)	(0.285)
Native born: both parents foreign		-1.488***	-1.501***	-1.422***
		(0.0661)	(0.0670)	(0.0696)
Foreign-born		-0.177***	-0.191***	-0.206***
		(0.0526)	(0.0537)	(0.0539)
Race				
White			-	-
Black			-0.229	-0.226
			(0.180)	(0.180)
Chinese			0.156	0.218
			(0.377)	(0.378)
Age				0.00979***
				(0.00241)
[City Stayers]	(base outcome)			
N	9920	9920	9920	9920

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1880-1900 males

[City Core Stayers]: baseline comparison group				
[City leavers & NYC metro area stayers]				
Occupational income	-0.0152**	-0.0216***	-0.0223***	-0.0171**
	(0.00551)	(0.00561)	(0.00578)	(0.00592)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.292**	-1.295**	-1.512***
		(0.444)	(0.444)	(0.448)
Native born: mother foreign, father native		-0.472	-0.469	-0.709
		(0.717)	(0.717)	(0.719)
Native born: both parents foreign		-1.220***	-1.218***	-1.515***
		(0.169)	(0.171)	(0.180)
Foreign-born		-0.771***	-0.779***	-0.732***
		(0.151)	(0.152)	(0.152)
Race				
White			-	-
Black			0.789	0.762
			(1.064)	(1.064)
Chinese			13.81	13.56
			(772.0)	(767.9)
Age				-0.0338***
				(0.00635)
[City & NYC metro area Leavers]				
Occupational income	-0.00909*	-0.0151***	-0.0137**	-0.0105*
	(0.00430)	(0.00444)	(0.00453)	(0.00468)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-2.034***	-2.016***	-2.157***
		(0.348)	(0.348)	(0.351)
Native born: mother foreign, father native		-1.214	-1.174	-1.340*
		(0.624)	(0.624)	(0.626)
Native born: both parents foreign		-1.813***	-1.772***	-1.976***
		(0.141)	(0.142)	(0.151)
Foreign-born		-0.282*	-0.251	-0.220
		(0.128)	(0.129)	(0.129)
Race				
White			-	-
Black			1.598	1.573
			(1.012)	(1.012)
Chinese			13.69	13.52
			(772.0)	(767.9)
Age				-0.0224***
				(0.00513)

Continued

Table 4: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1880-1900 males (cont.)

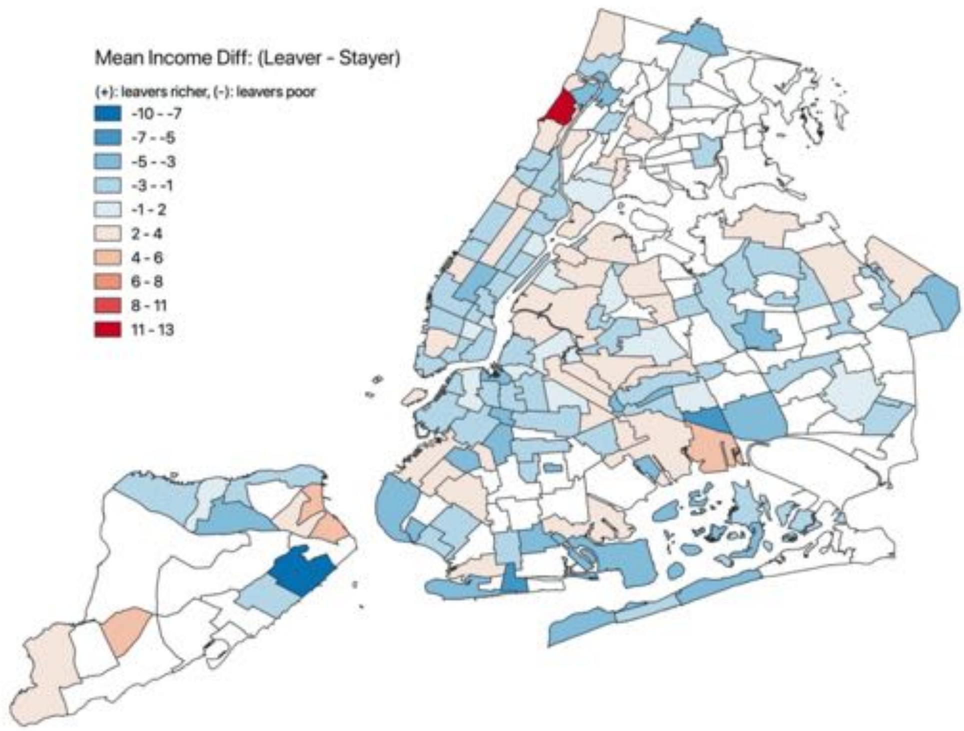
`[City Core Stayers]:  baseline comparison group`

[City Stayer & City Core Leavers]				
Occupational income	-0.00533	-0.00671	-0.00475	0.00112
	(0.00451)	(0.00461)	(0.00471)	(0.00486)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.685*	-0.659	-0.911**
		(0.345)	(0.345)	(0.350)
Native born: mother foreign, father native		-0.0412	0.0139	-0.264
		(0.628)	(0.628)	(0.632)
Native born: both parents foreign		-0.274	-0.217	-0.557***
		(0.143)	(0.144)	(0.154)
Foreign-born		-0.174	-0.128	-0.0714
		(0.134)	(0.135)	(0.136)
Race				
White			-	-
Black			1.865	1.836
			(1.019)	(1.020)
Chinese			13.70	13.42
			(772.0)	(767.9)
Age				-0.0396***
				(0.00543)
N	9920	9920	9920	9920

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 10: Neighborhood-level Mean Income Differences between Leavers and Stayers, 1900-1910



Note: Blue shades mean leavers' mean occupational income was lower than stayers, whereas red shades mean leavers' mean occupational income was higher than stayers in the Year 1900.

Table 5: Logit Results between Leavers and Stayers at the City level: 1900-1910 males

[City Leavers]				
Occupational income	-0.0105***	-0.0103***	-0.00978***	-0.0112***
	(0.00154)	(0.00160)	(0.00162)	(0.00164)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.377***	-1.373***	-1.318***
		(0.145)	(0.146)	(0.146)
Native born: mother foreign, father native		-1.222***	-1.218***	-1.173***
		(0.221)	(0.221)	(0.221)
Native born: both parents foreign		-1.003***	-1.000***	-0.981***
		(0.0532)	(0.0551)	(0.0552)
Foreign-born		-0.343***	-0.350***	-0.371***
		(0.0457)	(0.0481)	(0.0483)
Race				
White			-	-
Black			0.0324	0.0228
			(0.129)	(0.129)
Chinese			2.010***	1.983***
			(0.365)	(0.366)
Japanese			12.54	12.53
			(526.8)	(527.8)
Age				0.0106***
				(0.00148)
[City Stayers]	(base outcome)			
N	19085	19085	19085	19085

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1900-1910 males

[City Core Stayers]: baseline comparison group				
[City leavers & NYC metro area stayers]				
Occupational income	-0.0193***	-0.0197***	-0.0202***	-0.0171***
	(0.00362)	(0.00370)	(0.00376)	(0.00379)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.802*	-0.825*	-0.956**
		(0.321)	(0.322)	(0.323)
Native born: mother foreign, father native		-0.133	-0.159	-0.253
		(0.458)	(0.459)	(0.461)
Native born: both parents foreign		-0.209	-0.235	-0.284*
		(0.128)	(0.132)	(0.133)
Foreign-born		-0.140	-0.171	-0.123
		(0.109)	(0.114)	(0.114)
Race				
White			-	-
Black			-0.252	-0.236
			(0.314)	(0.314)
Chinese			13.60	13.90
			(483.6)	(548.2)
Japanese			-0.0292	-0.0355
			(6027.3)	(6776.7)
Age				-0.0244***
				(0.00369)
[City & NYC metro area Leavers]				
Occupational income	-0.0262***	-0.0252***	-0.0249***	-0.0238***
	(0.00256)	(0.00263)	(0.00267)	(0.00269)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.455***	-1.459***	-1.511***
		(0.226)	(0.227)	(0.227)
Native born: mother foreign, father native		-1.230**	-1.234**	-1.265***
		(0.375)	(0.376)	(0.377)
Native born: both parents foreign		-0.627***	-0.632***	-0.655***
		(0.0981)	(0.101)	(0.102)
Foreign-born		-0.114	-0.132	-0.116
		(0.0834)	(0.0874)	(0.0876)
Race				
White			-	-
Black			-0.0562	-0.0552
			(0.237)	(0.237)
Chinese			14.80	15.07
			(483.6)	(548.2)
Japanese			15.22	15.45
			(4208.0)	(4690.4)
Age				-0.00908***
				(0.00271)

Continued

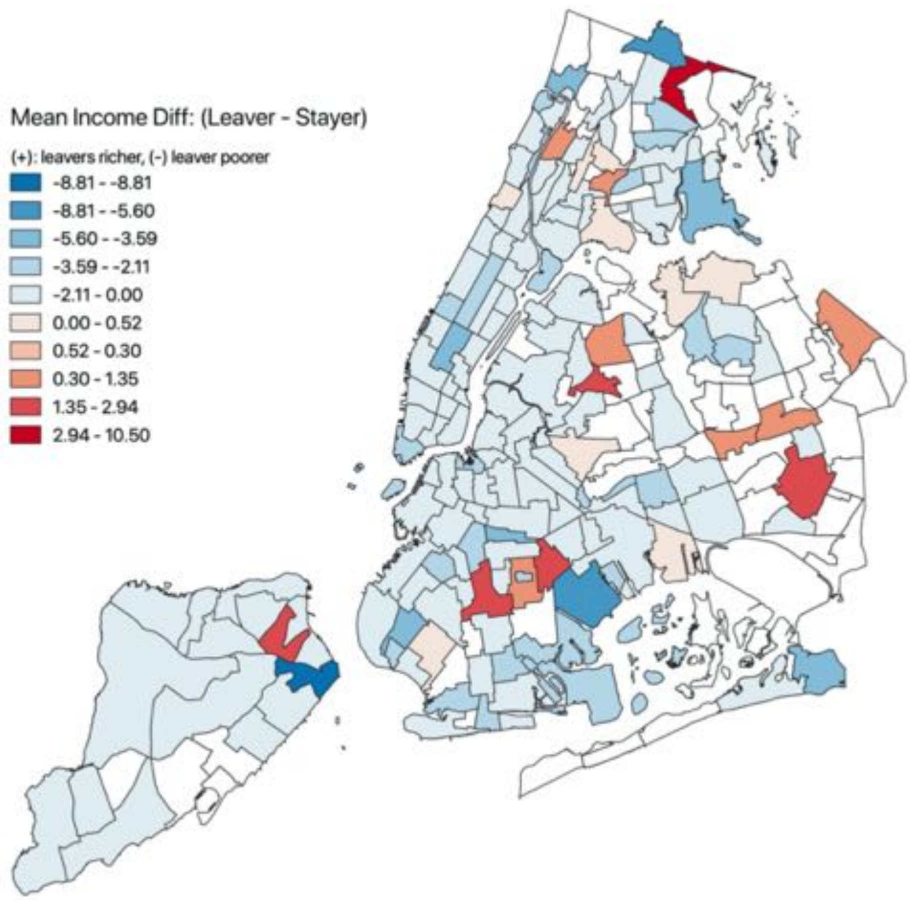
Table 6: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1900-1910 males (cont.)

[City Core Stayers]: baseline comparison group				
[City Stayer & City Core Leavers]				
Occupational income	-0.0193***	-0.0188***	-0.0191***	-0.0157***
	(0.00271)	(0.00281)	(0.00285)	(0.00288)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		0.0217	0.0101	-0.134
		(0.221)	(0.222)	(0.223)
Native born: mother foreign, father native		0.239	0.226	0.122
		(0.366)	(0.367)	(0.370)
Native born: both parents foreign		0.541***	0.528***	0.475***
		(0.104)	(0.108)	(0.108)
Foreign-born		0.295**	0.279**	0.332***
		(0.0911)	(0.0954)	(0.0958)
Race				
White			-	-
Black			-0.133	-0.114
			(0.260)	(0.261)
Chinese			12.91	13.22
			(483.6)	(548.2)
Japanese			-0.0173	-0.0185
			(4729.7)	(5291.0)
Age				-0.0271***
				(0.00290)
N	19100	19100	19100	19100

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 11: Neighborhood-level Mean Income Differences between Leavers and Stayers, 1910-1920



Note: Blue shades mean leavers' mean occupational income was lower than stayers, whereas red shades mean leavers' mean occupational income was higher than stayers in the Year 1910.

Table 7: Logit Results between Leavers and Stayers at the City level: 1910-1920 males

[City Leavers]				
Occupational income	-0.0119***	-0.0116***	-0.0111***	-0.0127***
	(0.000788)	(0.000814)	(0.000824)	(0.000835)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.522***	-1.498***	-1.465***
		(0.0807)	(0.0810)	(0.0811)
Native born: mother foreign, father native		-1.689***	-1.665***	-1.628***
		(0.122)	(0.122)	(0.122)
Native born: both parents foreign		-1.192***	-1.170***	-1.159***
		(0.0309)	(0.0318)	(0.0318)
Foreign-born		-0.214***	-0.199***	-0.204***
		(0.0235)	(0.0247)	(0.0247)
Race				
White			-	-
Black			0.215**	0.202**
			(0.0703)	(0.0703)
Chinese			1.664***	1.585***
			(0.150)	(0.150)
Japanese			2.114*	2.131*
			(1.035)	(1.036)
Age				0.00942***
				(0.000756)
N	65336	65336	65336	65336

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1910-1920 males

[City Core Stayers]: baseline comparison group				
[City leavers & NYC metro area stayers]				
Occupational income	-0.0169***	-0.0161***	-0.0171***	-0.0132***
	(0.00182)	(0.00186)	(0.00189)	(0.00191)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.821***	-0.873***	-0.954***
		(0.152)	(0.152)	(0.153)
Native born: mother foreign, father native		-1.008***	-1.060***	-1.147***
		(0.230)	(0.231)	(0.231)
Native born: both parents foreign		-0.509***	-0.564***	-0.585***
		(0.0668)	(0.0682)	(0.0683)
Foreign-born		0.0225	-0.0318	-0.0188
		(0.0550)	(0.0568)	(0.0569)
Race				
White			-	-
Black			-0.747***	-0.722***
			(0.206)	(0.206)
Chinese			-0.854*	-0.686
			(0.416)	(0.417)
Japanese			-0.343	-0.403
			(1406.6)	(1404.9)
Age				-0.0221***
				(0.00179)
[City & NYC metro area Leavers]				
Occupational income	-0.0240***	-0.0216***	-0.0207***	-0.0182***
	(0.00126)	(0.00131)	(0.00132)	(0.00134)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.868***	-1.827***	-1.878***
		(0.114)	(0.115)	(0.115)
Native born: mother foreign, father native		-2.007***	-1.967***	-2.020***
		(0.169)	(0.169)	(0.170)
Native born: both parents foreign		-1.282***	-1.242***	-1.255***
		(0.0494)	(0.0508)	(0.0509)
Foreign-born		0.116**	0.150***	0.157***
		(0.0406)	(0.0423)	(0.0424)
Race				
White			-	-
Black			0.328*	0.342**
			(0.127)	(0.128)
Chinese			1.008***	1.107***
			(0.226)	(0.226)
Japanese			14.14	14.09
			(933.6)	(930.9)
Age				-0.0138***
				(0.00128)

Continued

Table 8: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1910-1920 males (cont.)

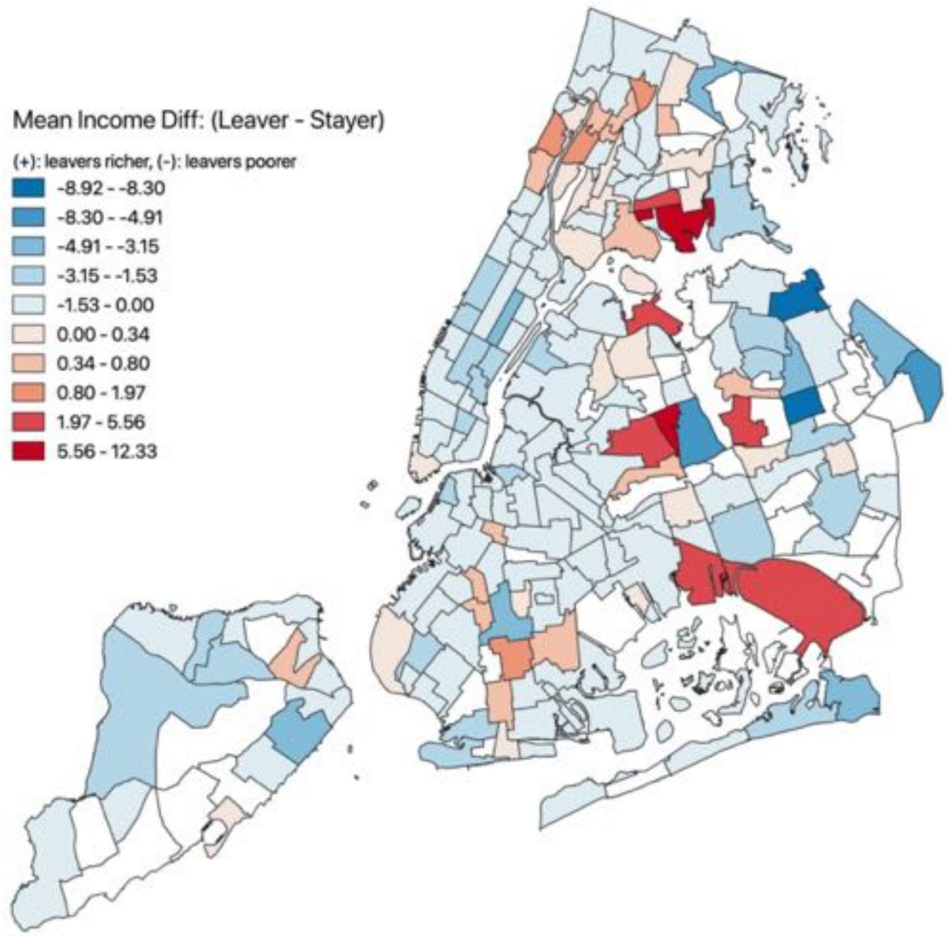
`[City Core Stayers]:  baseline comparison group`

[City Stayer & City Core Leavers]				
Occupational income	-0.0144***	-0.0121***	-0.0120***	-0.00648***
	(0.00129)	(0.00133)	(0.00134)	(0.00137)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.189	-0.182	-0.294**
		(0.0981)	(0.0987)	(0.0996)
Native born: mother foreign, father native		-0.168	-0.163	-0.284*
		(0.138)	(0.138)	(0.139)
Native born: both parents foreign		0.0641	0.0721	0.0395
		(0.0496)	(0.0511)	(0.0514)
Foreign-born		0.412***	0.422***	0.441***
		(0.0434)	(0.0451)	(0.0453)
Race				
White			-	-
Black			0.0350	0.0748
			(0.138)	(0.138)
Chinese			-1.088***	-0.842**
			(0.285)	(0.286)
Japanese			12.08	12.01
			(933.6)	(930.9)
Age				-0.0313***
				(0.00134)
N	65336	65336	65336	65336

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 12: Neighborhood-level Mean Income Differences between Leavers and Stayers, 1920-1930



Note: Blue shades mean leavers' mean occupational income was lower than stayers, whereas red shades mean leavers' mean occupational income was higher than stayers in the Year 1920.

Table 9: Logit Results between Leavers and Stayers at the City level: 1920-1930 males

[City Leavers]				
Occupational income	-0.0120***	-0.00744***	-0.00675***	-0.00976***
	(0.000510)	(0.000535)	(0.000540)	(0.000548)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.340***	-1.327***	-1.316***
		(0.0396)	(0.0397)	(0.0398)
Native born: mother foreign, father native		-1.302***	-1.288***	-1.249***
		(0.0574)	(0.0575)	(0.0577)
Native born: both parents foreign		-1.332***	-1.317***	-1.301***
		(0.0170)	(0.0173)	(0.0173)
Foreign-born		0.310***	0.319***	0.245***
		(0.0132)	(0.0135)	(0.0137)
Race				
White			-	-
Black			0.196***	0.178***
			(0.0361)	(0.0361)
Chinese			1.210***	1.180***
			(0.124)	(0.124)
Japanese			0.887**	0.896**
			(0.287)	(0.287)
Age				0.0175***
				(0.000505)
[City Stayers]	(base outcome)			
N	152589	152589	152589	152589

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1920-1930 males

[City Core Stayers]: baseline comparison group				
[City leavers & NYC metro area stayers]				
Occupational income	-0.0129***	-0.00998***	-0.0116***	-0.00765***
	(0.00108)	(0.00110)	(0.00112)	(0.00114)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.765***	-0.827***	-0.842***
		(0.0676)	(0.0678)	(0.0679)
Native born: mother foreign, father native		-0.685***	-0.750***	-0.794***
		(0.0972)	(0.0974)	(0.0976)
Native born: both parents foreign		-0.672***	-0.740***	-0.752***
		(0.0346)	(0.0350)	(0.0351)
Foreign-born		0.331***	0.273***	0.359***
		(0.0308)	(0.0312)	(0.0317)
Race				
White			-	-
Black			-1.175***	-1.152***
			(0.106)	(0.106)
Chinese			-0.874**	-0.843**
			(0.271)	(0.271)
Japanese			-1.531	-1.552
			(1.118)	(1.118)
Age				-0.0206***
				(0.00110)
[City & NYC metro area Leavers]				
Occupational income	-0.0244***	-0.0182***	-0.0179***	-0.0163***
	(0.000785)	(0.000817)	(0.000823)	(0.000837)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.842***	-1.845***	-1.848***
		(0.0570)	(0.0572)	(0.0572)
Native born: mother foreign, father native		-1.785***	-1.788***	-1.796***
		(0.0832)	(0.0833)	(0.0834)
Native born: both parents foreign		-1.450***	-1.453***	-1.452***
		(0.0263)	(0.0268)	(0.0269)
Foreign-born		0.548***	0.544***	0.566***
		(0.0231)	(0.0235)	(0.0238)
Race				
White			-	-
Black			-0.0784	-0.0626
			(0.0566)	(0.0567)
Chinese			0.124	0.140
			(0.164)	(0.164)
Japanese			0.569	0.565
			(0.521)	(0.520)
Age				-0.00523***
				(0.000799)

 Continued

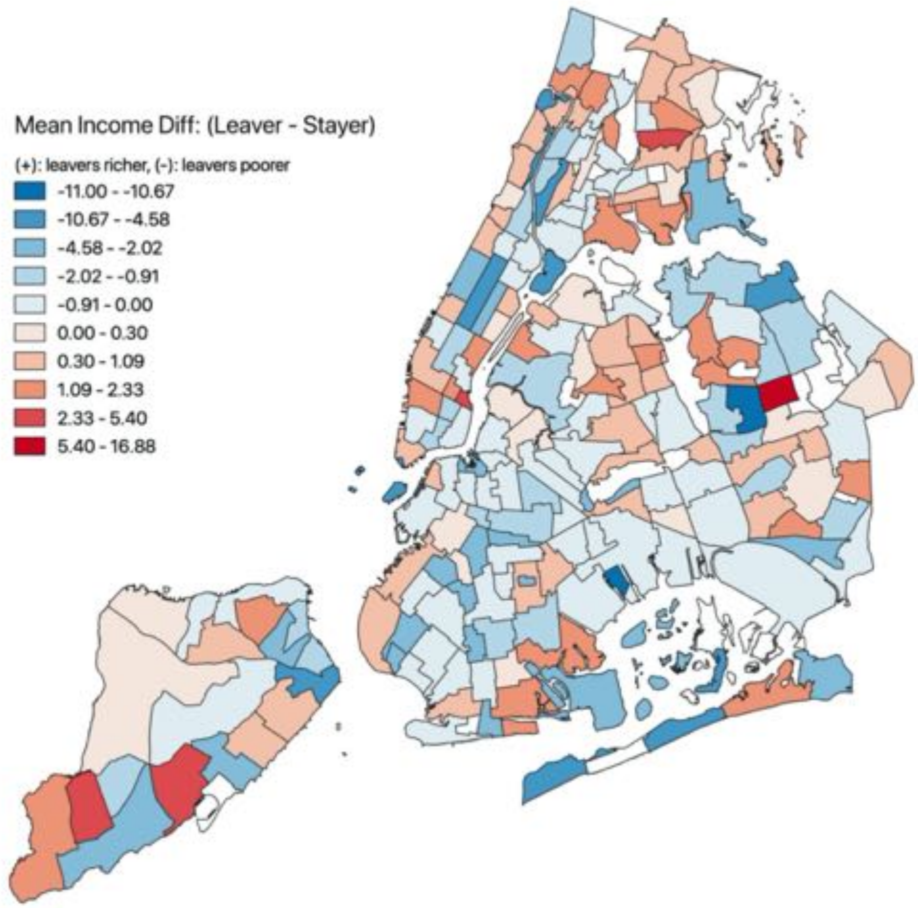
Table 10: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1920-1930 males (cont.)

`[City Core Stayers]:  baseline comparison group`

[City Stayer & City Core Leavers]				
Occupational income	-0.0131***	-0.0116***	-0.0126***	-0.00629***
	(0.000730)	(0.000754)	(0.000759)	(0.000779)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.269***	-0.303***	-0.325***
		(0.0409)	(0.0412)	(0.0416)
Native born: mother foreign, father native		-0.234***	-0.269***	-0.341***
		(0.0594)	(0.0596)	(0.0603)
Native born: both parents foreign		0.0916***	0.0537*	0.0303
		(0.0229)	(0.0234)	(0.0236)
Foreign-born		0.254***	0.225***	0.364***
		(0.0231)	(0.0236)	(0.0239)
Race				
White			-	-
Black			-0.515***	-0.476***
			(0.0592)	(0.0596)
Chinese			-1.748***	-1.693***
			(0.219)	(0.220)
Japanese			-0.568	-0.585
			(0.578)	(0.578)
Age				-0.0326***
				(0.000763)
N	152589	152589	152589	152589

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 13: Neighborhood-level Mean Income Differences between Leavers and Stayers, 1930-1940



Note: Blue shades mean leavers' mean occupational income was lower than stayers, whereas red shades mean leavers' mean occupational income was higher than stayers in the Year 1930.

Table 11: Logit Results between Leavers and Stayers at the City level: 1930-1940 males

[City Leavers]				
Occupational income	0.00198	-0.00555**	-0.00471*	-0.00676**
	(0.00194)	(0.00206)	(0.00209)	(0.00213)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.744***	-0.767***	-0.761***
		(0.129)	(0.129)	(0.129)
Native born: mother foreign, father native		-0.385*	-0.400**	-0.384*
		(0.152)	(0.152)	(0.152)
Native born: both parents foreign		-1.264***	-1.272***	-1.220***
		(0.0634)	(0.0642)	(0.0649)
Foreign-born		-0.681***	-0.722***	-0.778***
		(0.0555)	(0.0566)	(0.0578)
Race				
White			-	-
Black			-0.203	-0.227
			(0.177)	(0.178)
Chinese			0.751***	0.744***
			(0.158)	(0.158)
Japanese			0.935	0.836
			(0.867)	(0.868)
Age				0.0113***
				(0.00211)
[City Stayers]	(base outcome)			
N	8789	8789	8789	8789

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1930-1940 males

`[City Core Stayers]: baseline comparison group`				
[City leavers & NYC metro area stayers]				
Occupational income	0.00650	-0.00143	-0.00366	0.000959
	(0.00388)	(0.00405)	(0.00410)	(0.00419)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.551*	-0.551*	-0.557*
		(0.258)	(0.259)	(0.260)
Native born: mother foreign, father native		0.108	0.102	0.0665
		(0.308)	(0.308)	(0.309)
Native born: both parents foreign		-0.743***	-0.762***	-0.878***
		(0.128)	(0.129)	(0.131)
Foreign-born		-0.964***	-0.924***	-0.803***
		(0.121)	(0.122)	(0.124)
Race				
White			-	-
Black			-0.391	-0.339
			(0.465)	(0.466)
Chinese			-1.594***	-1.590***
			(0.475)	(0.475)
Japanese			-13.46	-12.95
			(1221.9)	(1047.5)
Age				-0.0251***
				(0.00439)
[City & NYC metro area Leavers]				
Occupational income	-0.00398	-0.0130***	-0.0130***	-0.0110***
	(0.00295)	(0.00307)	(0.00308)	(0.00314)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.903***	-0.907***	-0.905***
		(0.199)	(0.199)	(0.200)
Native born: mother foreign, father native		-0.439	-0.433	-0.449
		(0.260)	(0.260)	(0.260)
Native born: both parents foreign		-1.435***	-1.429***	-1.480***
		(0.101)	(0.102)	(0.104)
Foreign-born		-0.874***	-0.865***	-0.815***
		(0.0899)	(0.0918)	(0.0932)
Race				
White			-	-
Black			0.136	0.156
			(0.322)	(0.323)
Chinese			-0.152	-0.154
			(0.179)	(0.179)
Japanese			0.461	0.546
			(1.122)	(1.123)
Age				-0.0109***
				(0.00312)

Continued

Table 12: Multinomial Logit Results between Leavers and Stayers at Neighborhood Level: 1930-1940 males (cont.)

[City Core Stayers]: baseline comparison group				
[City Stayer & City Core Leavers]				
Occupational income	-0.00516	-0.00680*	-0.00875**	-0.00242
	(0.00291)	(0.00296)	(0.00298)	(0.00306)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.114	-0.0854	-0.0989
		(0.192)	(0.193)	(0.195)
Native born: mother foreign, father native		0.0877	0.115	0.0679
		(0.260)	(0.260)	(0.262)
Native born: both parents foreign		-0.0144	-0.00155	-0.163
		(0.0978)	(0.0990)	(0.101)
Foreign-born		-0.281**	-0.206*	-0.0365
		(0.0924)	(0.0940)	(0.0959)
Race				
White			-	-
Black			0.335	0.408
			(0.326)	(0.328)
Chinese			-2.080***	-2.070***
			(0.279)	(0.280)
Japanese			-1.029	-0.730
			(1.416)	(1.419)
Age				-0.0350***
				(0.00312)
N	8789	8789	8789	8789

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.3 Were the People Who Moved Into the Periphery Richer than Original Residents of the Periphery?

Jackson (1985) discusses Brooklyn's transformation from being essentially agricultural to the favorite residence of gentlemen of taste and fortune between the 1810s and the 1850s due to the regular steam ferry service to the NYC. During the early nineteenth century, Brooklyn became the "transit-hub" connected to the center of the city, and the influx of middle-class families changed the orientation of neighborhoods — "the little village of Bedford (now part of Bedford-Stuyvesant in Northeast Brooklyn), for example, used to be essentially rural until 1850. However, after the influx of middle-class families, and it had become part of the expanding metropolis, very few laborers remained, and the farmers had disappeared."[14]

If the pattern of early nineteenth-century Brooklyn as the periphery of the city as the transit spoke held for my study period, the longitudinal database should reveal that entrants who moved into the periphery were richer than original residents of the periphery of the city. Hence, I take the longitudinal data of individuals and compare the mean occupational income of residents who moved into the periphery and who stayed in the periphery at the NTA level.

The longitudinal data reveals that the entrants who moved into the periphery were *not* richer than the original residents of the periphery. For example, Figures 15, 16, 17 show that the entrants to the periphery had mostly lower mean occupational income than the original residents. Given each NTA in the City, I take the difference of mean occupational income of entrants and stayers at the periphery over the study period. In Figures 14, 15, 16, 17, given each NTA, blue shades (the darker blue, the poorer entrants) indicate entrants being poorer, whereas red shades (the darker red, the richer entrants) indicate entrants being richer than the stayers. Data during the study period indicates that the entrants to the periphery were, in fact, *not* richer than the stayers.

Regression results also support that new suburbanites were not richer than the people who already lived at the periphery. I run logit regression to model the log odds of individuals' entering into the city periphery, using the longitudinal data of individuals during the study period. The predictor variables of interest are occupational income, nativity, race, and age. Regression results in Tables 13, 15, 17, 19 show that as one's occupational income increases, the log odds of moving into the city periphery decreases. In terms of the nativity, being foreign-born relative to native-born with both native parents (which may be associated with one's "prestige to the public's eye) decreases the log odds of entering the city periphery. In terms of race, being non-white relative to white increases the log odds of moving into the periphery and the degree of log odds of outcome varies across race; however, considering that the majority of residents in New York were white, this may need to be interpreted with caution. Finally, older people were more likely to enter into the city periphery throughout the study period.

While the regression results in Tables 13, 15, 17, 19 look at extensive margin of entering

[14]Recited from Jackson (1985), originally from Gilman (1971).

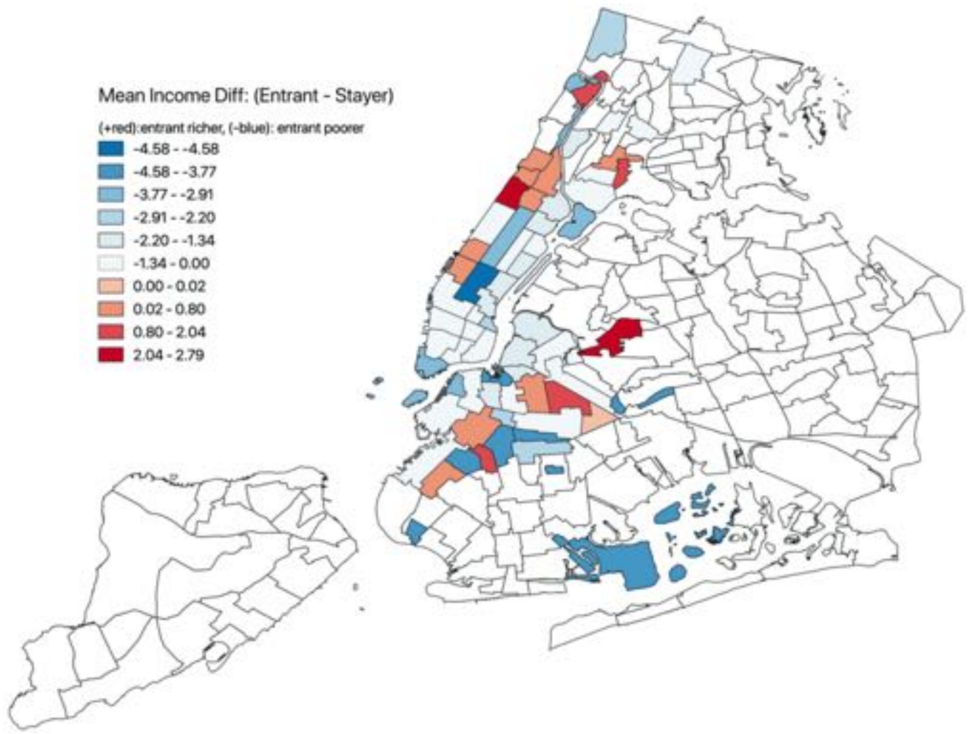
to the periphery of the city regardless of the nature of flows (i.e. whether entrants migrated to the city's periphery from NYC metro area, or migrated from Alabama, or migrated from the core of the city), Tables 14, 16, 18, 20, 22 look at whether flows from the metro area to the city periphery may have been different from flows from outside the metro area to the city periphery, as well as flows from the city core to the city periphery. Regression results regarding city periphery entrants that separately looks at entrants with varying origins tells us consistent story (as in periphery entrants at the extensive margin regardless of origins) that relative to people who stayed in the city periphery, as occupational income increases, people who lived somewhere other than the city periphery (at any migration origins ranging from the city core to outside NYC metro area) were less likely to migrate to the city periphery. In terms of race, being non-white relative to white has varying degree and signs depending on origins of migration, however, considering that the majority of residents in New York were white, this may need to be interpreted with caution. Finally, older people were less likely to migrate into the city periphery up until the Great Depression.

Related to my earlier discussion of income measures feature of reflecting occupation only and not reflecting other factors such as nativity and age that may have determined one's income should be noted in interpreting suburbanites' pattern of migration.[15] To the public's eyes, migration of the older to the periphery may have been associated as the movement of the "affluent." However, this only makes the accuracy of income measures more crucial.

Section 4.4.2 discusses decomposition of various flows of the periphery of the city including the relative income difference between entrants and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level. Regarding the relative income growth at the periphery, periphery entrants from anywhere (from the city core, NYC metro area, and outside NYC metro area) had higher mean income than the periphery leaving NYC metro area at all, and the relative magnitude of inflows were much bigger than outflows, making the periphery income increase. Furthermore, as Figure 22b shows, people who stayed at the periphery got richer as the metropolis grew.

[15]Features of occupational income measures are discussed in Subsection 4.2.

Figure 14: Neighborhood-level Mean Income Differences between Entrants and Stayers, 1880-1900



Note: Blue shades mean entrants' mean occupational income was lower than stayers, whereas red shades mean entrants' mean occupational income was higher than stayers in 1900.

Table 13: Logit Results between Entrants and Stayers at the City level: 1880-1900 males

[City Entrants]				
Occupational income	-0.00169	-0.00674***	-0.00538**	-0.00554**
	(0.00160)	(0.00171)	(0.00174)	(0.00175)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.529***	-1.514***	-1.548***
		(0.153)	(0.153)	(0.153)
Native born: mother foreign, father native		-1.125***	-1.119***	-1.133***
		(0.221)	(0.221)	(0.221)
Native born: both parents foreign		-1.832***	-1.812***	-1.899***
		(0.0542)	(0.0546)	(0.0563)
Foreign-born		-0.650***	-0.645***	-0.603***
		(0.0425)	(0.0432)	(0.0436)
Race				
White			-	-
Black			0.390*	0.330*
			(0.154)	(0.154)
Chinese			2.578***	2.484***
			(0.594)	(0.594)
Age				-0.0134***
				(0.00196)
[City Stayers]	(base outcome)			
N	13239	13239	13239	13239

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1880-1900 males

[City Periphery Stayers]: baseline comparison group				
[Periphery Entrants from NYC metro area]				
Occupational income	0.00473	-0.00355	-0.00357	-0.00414
	(0.00506)	(0.00519)	(0.00529)	(0.00531)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.431**	-1.431**	-1.589***
		(0.474)	(0.474)	(0.475)
Native born: mother foreign, father native		-0.399	-0.399	-0.453
		(0.594)	(0.594)	(0.596)
Native born: both parents foreign		-1.601***	-1.601***	-1.907***
		(0.166)	(0.167)	(0.174)
Foreign-born		-1.209***	-1.214***	-1.084***
		(0.147)	(0.148)	(0.150)
Race				
White			-	-
Black			0.0590	-0.139
			(0.613)	(0.614)
Chinese			12.67	13.69
			(452.3)	(887.0)
Age				-0.0432***
				(0.00620)
[Periphery Entrants from Non-NYC metro area]				
Occupational income	-0.00437	-0.0106**	-0.00881*	-0.00933*
	(0.00375)	(0.00391)	(0.00397)	(0.00399)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.737***	-1.713***	-1.860***
		(0.306)	(0.307)	(0.309)
Native born: mother foreign, father native		-1.379**	-1.368**	-1.416**
		(0.487)	(0.488)	(0.490)
Native born: both parents foreign		-2.092***	-2.061***	-2.346***
		(0.118)	(0.119)	(0.125)
Foreign-born		-0.828***	-0.812***	-0.693***
		(0.110)	(0.111)	(0.112)
Race				
White			-	-
Black			0.730	0.546
			(0.514)	(0.515)
Chinese			13.78	14.82
			(452.3)	(887.0)
Age				-0.0396***
				(0.00439)

Continued

Table 14: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1880-1900 males (cont.)

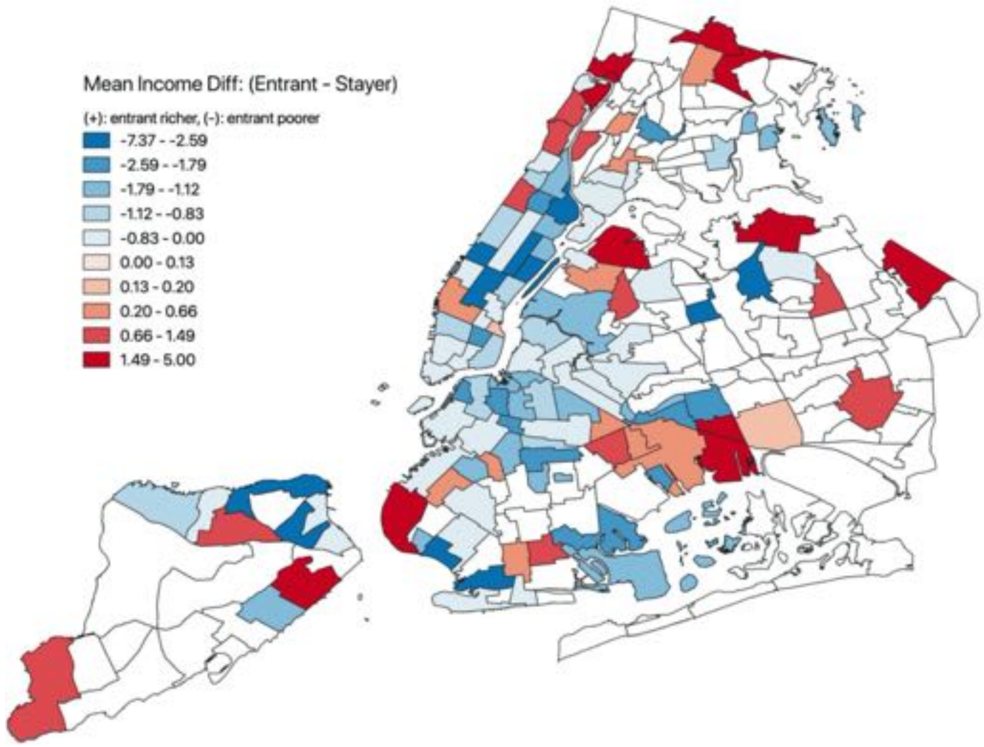
`[City Periphery Stayers]:  baseline comparison group`

[Periphery Entrants from the City's Core]				
Occupational income	-0.00226	-0.00367	-0.00340	-0.00379
	(0.00383)	(0.00395)	(0.00401)	(0.00402)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.205	-0.196	-0.313
		(0.298)	(0.298)	(0.299)
Native born: mother foreign, father native		-0.154	-0.149	-0.188
		(0.483)	(0.483)	(0.484)
Native born: both parents foreign		-0.242*	-0.232*	-0.457***
		(0.117)	(0.118)	(0.123)
Foreign-born		-0.225*	-0.215	-0.126
		(0.113)	(0.114)	(0.115)
Race				
White			-	-
Black			0.331	0.189
			(0.528)	(0.529)
Chinese			11.29	12.40
			(452.3)	(887.0)
Age				-0.0299***
				(0.00446)
N	13239	13239	13239	13239

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 15: Neighborhood-level Mean Income Differences between Entrants and Stayers, 1900-1910



Note: Blue shades mean entrants' mean occupational income was lower than stayers, whereas red shades mean entrants' mean occupational income was higher than stayers in 1910.

Table 15: Logit Results between Entrants and Stayers: 1900-1910 males

[City Entrants]				
Occupational income	-0.00774***	-0.00671***	-0.00608***	-0.00671***
	(0.000945)	(0.000986)	(0.000998)	(0.00100)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.354***	-1.328***	-1.272***
		(0.0710)	(0.0713)	(0.0716)
Native born: mother foreign, father native		-1.207***	-1.181***	-1.148***
		(0.114)	(0.114)	(0.114)
Native born: both parents foreign		-1.189***	-1.161***	-1.162***
		(0.0330)	(0.0338)	(0.0338)
Foreign-born		-0.143***	-0.117***	-0.170***
		(0.0287)	(0.0297)	(0.0301)
Race				
White			-	-
Black			0.331***	0.367***
			(0.0940)	(0.0941)
Chinese			1.360**	1.365**
			(0.427)	(0.428)
Japanese			14.06	14.12
			(1265.8)	(1265.7)
Age				0.0118***
				(0.00101)
[City Stayers]	(base outcome)			
N	47201	47201	47201	47201

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1900-1910 males

`[City Periphery Stayers]: baseline comparison group`				
[Periphery Entrants from NYC metro area]				
Occupational income	-0.0121***	-0.0109***	-0.0112***	-0.0100***
	(0.00256)	(0.00261)	(0.00265)	(0.00266)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.019***	-1.025***	-1.144***
		(0.173)	(0.174)	(0.175)
Native born: mother foreign, father native		-1.149***	-1.156***	-1.227***
		(0.294)	(0.295)	(0.295)
Native born: both parents foreign		-0.463***	-0.471***	-0.479***
		(0.0848)	(0.0863)	(0.0864)
Foreign-born		0.0536	0.0453	0.144
		(0.0760)	(0.0778)	(0.0787)
Race				
White			-	-
Black			-0.0542	-0.136
			(0.278)	(0.278)
Chinese			0.339	0.310
			(1.226)	(1.226)
Japanese			-0.430	-0.584
			(2134.9)	(3520.6)
Age				-0.0224***
				(0.00266)
[Periphery Entrants from Non-NYC metro area]				
Occupational income	-0.0145***	-0.0118***	-0.0108***	-0.0100***
	(0.00186)	(0.00191)	(0.00194)	(0.00195)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.616***	-1.574***	-1.658***
		(0.115)	(0.115)	(0.116)
Native born: mother foreign, father native		-1.474***	-1.431***	-1.481***
		(0.181)	(0.181)	(0.181)
Native born: both parents foreign		-1.048***	-1.002***	-1.011***
		(0.0638)	(0.0650)	(0.0651)
Foreign-born		0.181**	0.225***	0.292***
		(0.0589)	(0.0603)	(0.0609)
Race				
White			-	-
Black			0.609**	0.550*
			(0.214)	(0.215)
Chinese			1.327	1.298
			(1.009)	(1.009)
Japanese			12.58	13.47
			(1555.1)	(2564.6)
Age				-0.0154***
				(0.00199)

Continued

Table 16: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1900-1910 males (cont.)

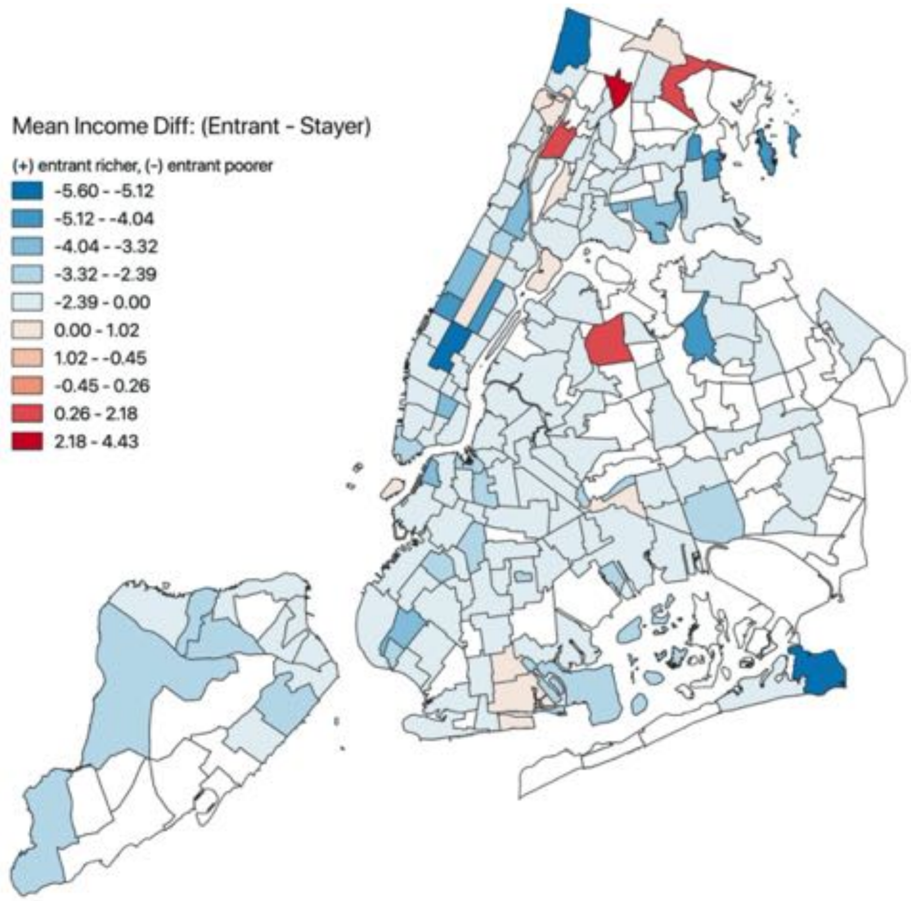
`[City Periphery Stayers]:  baseline comparison group`

[Periphery Entrants from the City's Core]				
Occupational income	-0.00803***	-0.00620**	-0.00585**	-0.00412*
	(0.00198)	(0.00203)	(0.00206)	(0.00208)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.270*	-0.254*	-0.426***
		(0.118)	(0.119)	(0.120)
Native born: mother foreign, father native		-0.317	-0.301	-0.405*
		(0.189)	(0.189)	(0.191)
Native born: both parents foreign		0.246***	0.264***	0.260***
		(0.0679)	(0.0692)	(0.0695)
Foreign-born		0.387***	0.405***	0.560***
		(0.0640)	(0.0655)	(0.0663)
Race				
White			-	-
Black			0.297	0.184
			(0.231)	(0.231)
Chinese			-0.0966	-0.133
			(1.096)	(1.096)
Japanese			-0.272	-0.486
			(1715.0)	(2828.2)
Age				-0.0344***
				(0.00214)
N	47201	47201	47201	47201

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 16: Neighborhood-level Mean Income Differences between Entrants and Stayers, 1910-1920



Note: Blue shades mean entrants' mean occupational income was lower than stayers, whereas red shades mean entrants' mean occupational income was higher than stayers in 1920.

Table 17: Logit Results between Entrants and Stayers at the City level: 1910-1920 males

[Entrants]				
Occupational income	-0.0166***	-0.0147***	-0.0134***	-0.0135***
	(0.000431)	(0.000443)	(0.000448)	(0.000448)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.618***	-1.564***	-1.555***
		(0.0345)	(0.0346)	(0.0346)
Native born: mother foreign, father native		-1.551***	-1.498***	-1.492***
		(0.0541)	(0.0542)	(0.0542)
Native born: both parents foreign		-1.205***	-1.147***	-1.151***
		(0.0149)	(0.0152)	(0.0152)
Foreign-born		-0.115***	-0.0603***	-0.0737***
		(0.0114)	(0.0118)	(0.0119)
Race				
White			-	-
Black			0.568***	0.572***
			(0.0328)	(0.0328)
Chinese			1.556***	1.545***
			(0.222)	(0.222)
Japanese			2.864***	2.889***
			(0.591)	(0.591)
Age				0.00385***
				(0.000426)
[Stayers]	(base outcome)			
N	206052	206052	206052	206052

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1910-1920 males

[City Periphery Stayers]: baseline comparison group				
[Periphery Entrants from NYC metro area]				
Occupational income	-0.0177***	-0.0154***	-0.0160***	-0.0154***
	(0.00108)	(0.00109)	(0.00111)	(0.00111)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.075***	-1.100***	-1.161***
		(0.0724)	(0.0727)	(0.0728)
Native born: mother foreign, father native		-1.155***	-1.179***	-1.222***
		(0.119)	(0.119)	(0.119)
Native born: both parents foreign		-0.636***	-0.663***	-0.641***
		(0.0346)	(0.0352)	(0.0353)
Foreign-born		0.205***	0.176***	0.252***
		(0.0287)	(0.0295)	(0.0298)
Race				
White			-	-
Black			-0.221*	-0.255**
			(0.0907)	(0.0908)
Chinese			2.146	2.191*
			(1.096)	(1.096)
Japanese			14.34	13.66
			(1072.8)	(832.2)
Age				-0.0224***
				(0.00105)
[Periphery Entrants from Non-NYC metro area]				
Occupational income	-0.0231***	-0.0193***	-0.0178***	-0.0172***
	(0.000652)	(0.000673)	(0.000681)	(0.000683)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.888***	-1.833***	-1.889***
		(0.0451)	(0.0453)	(0.0454)
Native born: mother foreign, father native		-1.796***	-1.743***	-1.783***
		(0.0697)	(0.0698)	(0.0701)
Native born: both parents foreign		-1.246***	-1.188***	-1.168***
		(0.0220)	(0.0225)	(0.0226)
Foreign-born		0.272***	0.327***	0.396***
		(0.0188)	(0.0194)	(0.0196)
Race				
White			-	-
Black			0.545***	0.513***
			(0.0551)	(0.0553)
Chinese			3.225**	3.264**
			(1.005)	(1.006)
Japanese			16.31	15.65
			(1072.8)	(832.2)
Age				-0.0204***
				(0.000664)

Continued

Table 18: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1910-1920 males (cont.)

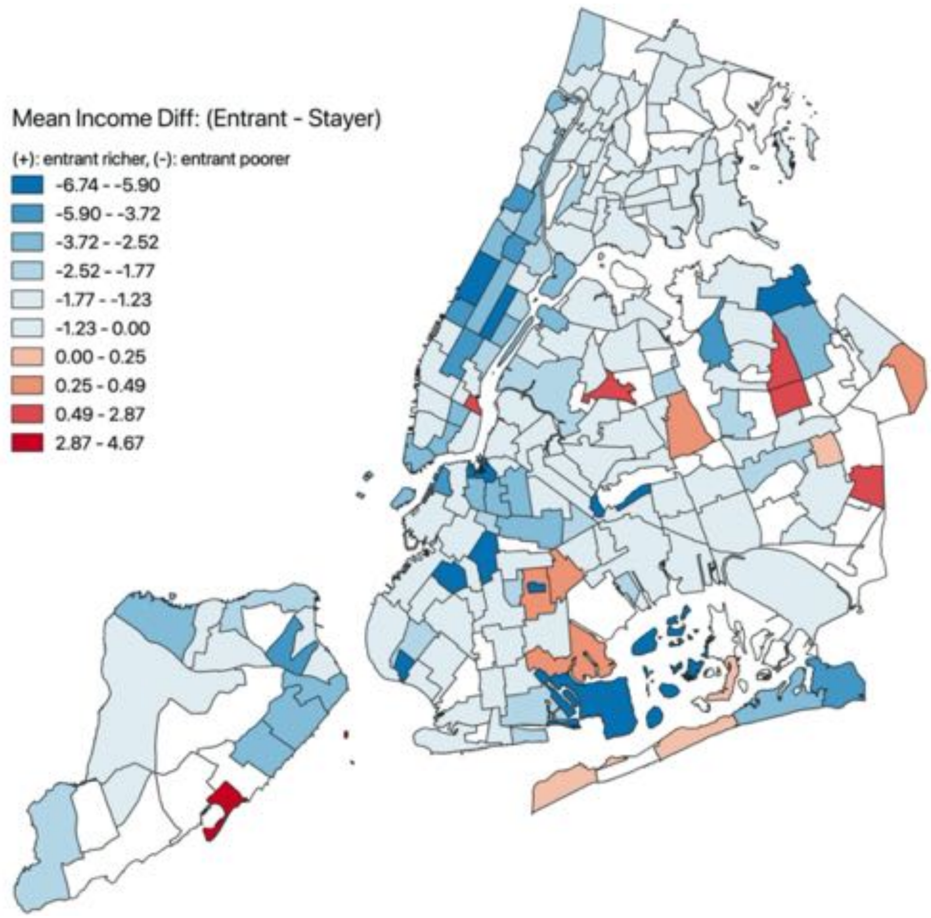
`[City Periphery Stayers]:  baseline comparison group`

[Periphery Entrants from the City's Core]				
Occupational income	-0.00775***	-0.00536***	-0.00549***	-0.00462***
	(0.000629)	(0.000644)	(0.000651)	(0.000656)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.198***	-0.210***	-0.293***
		(0.0351)	(0.0353)	(0.0357)
Native born: mother foreign, father native		-0.213***	-0.224***	-0.284***
		(0.0544)	(0.0546)	(0.0552)
Native born: both parents foreign		0.0650**	0.0524*	0.0838***
		(0.0209)	(0.0213)	(0.0215)
Foreign-born		0.492***	0.479***	0.591***
		(0.0195)	(0.0200)	(0.0203)
Race				
White			-	-
Black			-0.115	-0.160**
			(0.0605)	(0.0608)
Chinese			1.764	1.837
			(1.020)	(1.021)
Japanese			13.55	12.82
			(1072.8)	(832.2)
Age				-0.0321***
				(0.000660)
N	206052	206052	206052	206052

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 17: Neighborhood-level Mean Income Differences between Entrants and Stayers, 1920-1930



Note: Blue shades mean entrants' mean occupational income was lower than stayers, whereas red shades mean entrants' mean occupational income was higher than stayers in 1930.

Table 19: Logit Results between Entrants and Stayers at the City level: 1920-1930 males

[City Entrants]				
Occupational income	-0.0210***	-0.0152***	-0.0119***	-0.0119***
	(0.000361)	(0.000375)	(0.000379)	(0.000379)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.877***	-1.761***	-1.761***
		(0.0334)	(0.0335)	(0.0335)
Native born: mother foreign, father native		-1.750***	-1.632***	-1.631***
		(0.0473)	(0.0474)	(0.0474)
Native born: both parents foreign		-1.611***	-1.486***	-1.486***
		(0.0124)	(0.0128)	(0.0128)
Foreign-born		0.323***	0.437***	0.433***
		(0.00867)	(0.00907)	(0.00924)
Race				
White			-	-
Black			0.942***	0.943***
			(0.0192)	(0.0193)
Chinese			1.780***	1.781***
			(0.187)	(0.187)
Japanese			1.623***	1.626***
			(0.307)	(0.307)
Age				0.000872*
				(0.000358)
[City Stayers]	(base outcome)			
N	363947	363947	363947	363947

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 20: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1920-1930 males

[City Periphery Stayers]: baseline comparison group				
[Periphery Entrants from NYC metro area]				
Occupational income	-0.0149***	-0.00873***	-0.00984***	-0.00936***
	(0.000924)	(0.000925)	(0.000939)	(0.000940)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.207***	-1.268***	-1.276***
		(0.0704)	(0.0706)	(0.0706)
Native born: mother foreign, father native		-1.193***	-1.255***	-1.299***
		(0.106)	(0.106)	(0.106)
Native born: both parents foreign		-0.677***	-0.741***	-0.758***
		(0.0300)	(0.0305)	(0.0305)
Foreign-born		0.891***	0.831***	0.936***
		(0.0241)	(0.0246)	(0.0251)
Race				
White			-	-
Black			-0.647***	-0.685***
			(0.0643)	(0.0644)
Chinese			2.590*	2.591*
			(1.098)	(1.098)
Japanese			-0.534	-0.641
			(1.155)	(1.155)
Age				-0.0218***
				(0.000883)
[Periphery Entrants from Non-NYC metro area]				
Occupational income	-0.0227***	-0.0155***	-0.0127***	-0.0122***
	(0.000506)	(0.000524)	(0.000529)	(0.000531)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-2.253***	-2.169***	-2.177***
		(0.0406)	(0.0408)	(0.0409)
Native born: mother foreign, father native		-2.049***	-1.964***	-2.013***
		(0.0568)	(0.0570)	(0.0571)
Native born: both parents foreign		-1.609***	-1.519***	-1.539***
		(0.0166)	(0.0170)	(0.0171)
Foreign-born		0.644***	0.726***	0.843***
		(0.0135)	(0.0141)	(0.0144)
Race				
White			-	-
Mexican			1.943**	1.762*
			(0.724)	(0.724)
Black			0.526***	0.483***
			(0.0273)	(0.0275)
Chinese			4.023***	4.023***
			(1.007)	(1.008)
Japanese			1.513*	1.395*
			(0.592)	(0.593)
Age				-0.0243***
				(0.000502)

Continued

Table 20: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1920-1930 males (cont.)

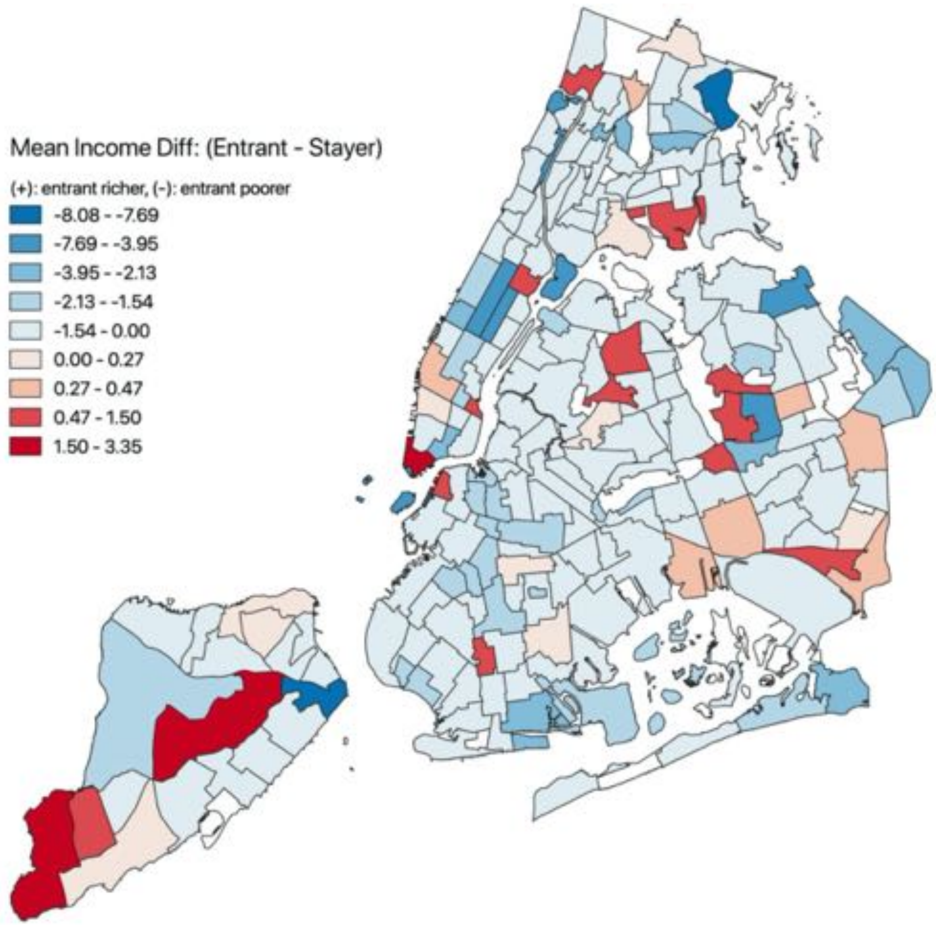
`[City Periphery Stayers]:  baseline comparison group`

[Periphery Entrants from the City's Core]				
Occupational income	-0.000953*	0.000674	-0.000479	0.000176
	(0.000434)	(0.000443)	(0.000448)	(0.000452)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.307***	-0.368***	-0.376***
		(0.0226)	(0.0228)	(0.0230)
Native born: mother foreign, father native		-0.254***	-0.316***	-0.380***
		(0.0328)	(0.0330)	(0.0334)
Native born: both parents foreign		0.181***	0.116***	0.0883***
		(0.0128)	(0.0132)	(0.0133)
Foreign-born		0.447***	0.387***	0.545***
		(0.0132)	(0.0135)	(0.0138)
Race				
White			-	-
Black			-0.715***	-0.771***
			(0.0304)	(0.0306)
Chinese			2.330*	2.326*
			(1.013)	(1.013)
Japanese			-0.274	-0.424
			(0.658)	(0.659)
Age				-0.0325***
				(0.000441)
N	363947	363947	363947	363947

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 18: Neighborhood-level Mean Income Differences between Entrants and Stayers, 1930-1940



Note: Blue shades mean entrants' mean occupational income was lower than stayers, whereas red shades mean entrants' mean occupational income was higher than stayers in 1940.

Table 21: Logit Results between Entrants and Stayers at the City level: 1930-1940 males

[City Entrants]				
Occupational income	-0.0111***	-0.00901***	-0.00757***	-0.00792***
	(0.00110)	(0.00114)	(0.00116)	(0.00116)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.285***	-1.216***	-1.223***
		(0.0875)	(0.0879)	(0.0882)
Native born: mother foreign, father native		-1.424***	-1.356***	-1.364***
		(0.123)	(0.123)	(0.123)
Native born: both parents foreign		-1.471***	-1.400***	-1.360***
		(0.0342)	(0.0352)	(0.0354)
Foreign-born		-0.339***	-0.271***	-0.374***
		(0.0278)	(0.0289)	(0.0300)
Race				
White			-	-
Black			0.483***	0.525***
			(0.0607)	(0.0609)
Chinese			0.811	0.898
			(0.524)	(0.523)
Japanese			-14.13	-13.86
			(693.0)	(611.5)
Age				0.0163***
				(0.00117)
[City Stayers]	(base outcome)			
N	169642	169642	169642	169642

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 22: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1930-1940 males

[City Periphery Stayers]: baseline comparison group				
[Periphery Entrants from NYC metro area]				
Occupational income	-0.00632*	-0.00599*	-0.00911***	-0.00891**
	(0.00265)	(0.00267)	(0.00273)	(0.00274)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.083***	-1.218***	-1.216***
		(0.168)	(0.169)	(0.169)
Native born: mother foreign, father native		-1.104***	-1.238***	-1.235***
		(0.243)	(0.244)	(0.244)
Native born: both parents foreign		-0.711***	-0.850***	-0.876***
		(0.0761)	(0.0784)	(0.0787)
Foreign-born		-0.633***	-0.766***	-0.704***
		(0.0690)	(0.0713)	(0.0732)
Race				
White			-	-
Black			-1.294***	-1.323***
			(0.180)	(0.180)
Chinese			-13.38	-13.43
			(1029.3)	(1028.7)
Japanese			0.110	0.0923
			(6244.5)	(6244.0)
Age				-0.0102***
				(0.00271)
[Periphery Entrants from Non-NYC metro area]				
Occupational income	-0.0122***	-0.00986***	-0.00877***	-0.00871***
	(0.00180)	(0.00185)	(0.00186)	(0.00186)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-1.992***	-1.967***	-1.967***
		(0.120)	(0.121)	(0.121)
Native born: mother foreign, father native		-1.939***	-1.914***	-1.914***
		(0.170)	(0.171)	(0.171)
Native born: both parents foreign		-1.585***	-1.558***	-1.565***
		(0.0573)	(0.0598)	(0.0600)
Foreign-born		-0.383***	-0.358***	-0.343***
		(0.0498)	(0.0524)	(0.0536)
Race				
White			-	-
Black			0.134	0.126
			(0.0981)	(0.0983)
Chinese			1.074	1.069
			(1.037)	(1.038)
Japanese			-0.180	-0.186
			(4296.4)	(4297.2)
Age				-0.00253
				(0.00188)

Continued

Table 22: Multinomial Logit Results between Entrants and Stayers at Neighborhood Level: 1930-1940 males (cont.)

[City Periphery Stayers]: baseline comparison group				
[Periphery Entrants from the City's Core]				
Occupational income	-0.000461	-0.000403	-0.00162	-0.00105
	(0.00182)	(0.00184)	(0.00186)	(0.00187)
Nativity				
Native born: both parents native		-	-	-
Native born: father foreign, mother native		-0.779***	-0.861***	-0.856***
		(0.112)	(0.114)	(0.114)
Native born: mother foreign, father native		-0.510***	-0.590***	-0.583***
		(0.153)	(0.154)	(0.155)
Native born: both parents foreign		0.0493	-0.0346	-0.0978
		(0.0564)	(0.0590)	(0.0594)
Foreign-born		-0.0910	-0.171**	-0.00649
		(0.0530)	(0.0555)	(0.0568)
Race				
White			-	-
Black			-0.623***	-0.693***
			(0.112)	(0.112)
Chinese			0.176	0.0472
			(1.119)	(1.119)
Japanese			16.06	16.03
			(3887.9)	(3889.2)
Age				-0.0263***
				(0.00194)
N	32523	32523	32523	32523

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.4 Income Changes between the Core and the Periphery

I discuss the aggregate results on relative income change between the core and periphery of the city and show how the results on the flows are compatible with the aggregate results. Section 4.4.1 discusses the trend of mean occupational income over the study period. Section 4.4.2 discusses decomposition of flows among the core, the periphery, and the rest of the country, along with associated income as well as the relative magnitudes of the flows.

The geographic units of analyses here are NTAs and I use the distance from the Battery to centroids of NTAs in the city. I define the core of the city as "transit hub" neighborhoods such as Downtown Manhattan and Midtown Manhattan where transit infrastructures were extremely highly concentrated, whereas the periphery of the city are "transit spoke" neighborhoods such as Upper Manhattan and outer boroughs of the city.

4.4.1 Occupational income

Figure 19 reveals that the mean occupational income decreases as the distance from the Battery increases while the slope of fitted values getting more flat from 1870 to 1900. In 1910, this slope stays flat, and then in 1920, the mean occupational income slightly increases as the distance from the Battery increases. In Years 1930 and 1940, the slope becomes even steeper, implying that the mean occupational income at the edge (relative to the center) of the city increases even further. Over time, the relative income was higher in the center of the city (relative to the periphery) in the first half of the study period, whereas the relative income in the periphery became higher in the second half of the study period.

Figure 20 shows that the percent change of mean occupation income gets higher as it gets further away from the center. However, note that in the earlier study period (till 1900), mean occupational income was increasing both at the center and the edge whereas, during 1910 and 1930, percent change of mean occupational income was negative at the center which means the mean occupational income was decreasing at the center of the city. At the very end of the study period (i.e. 1930-1940), the curve becomes close to nil both at the center and edge, implying that the mean occupational income almost stayed the same as the earlier decade.

Figure 19: Mean Occupational Income

(a) 1870

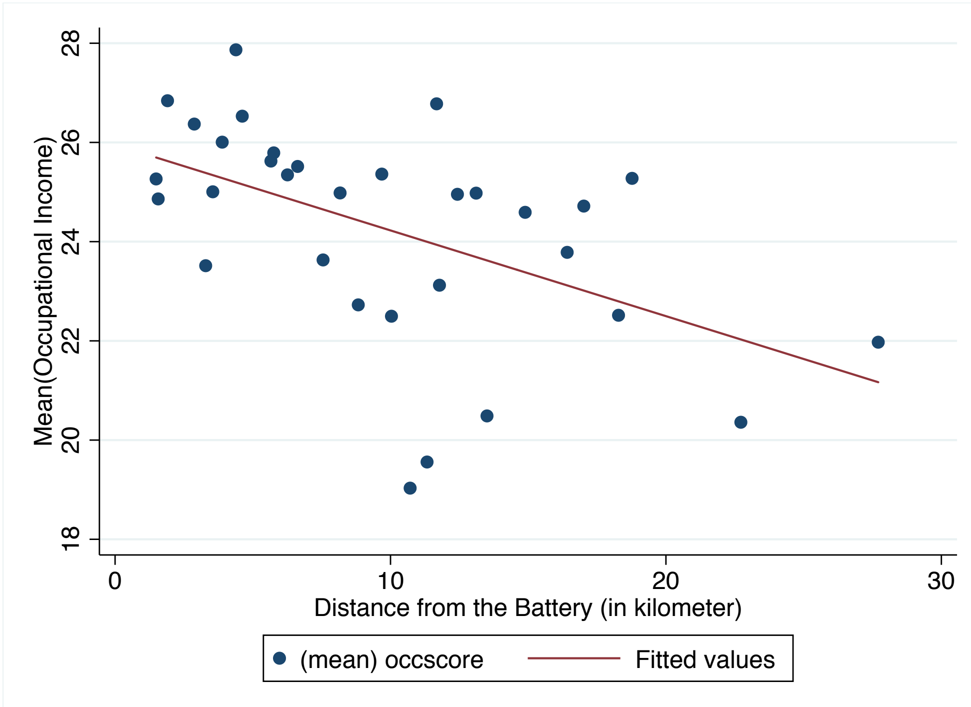
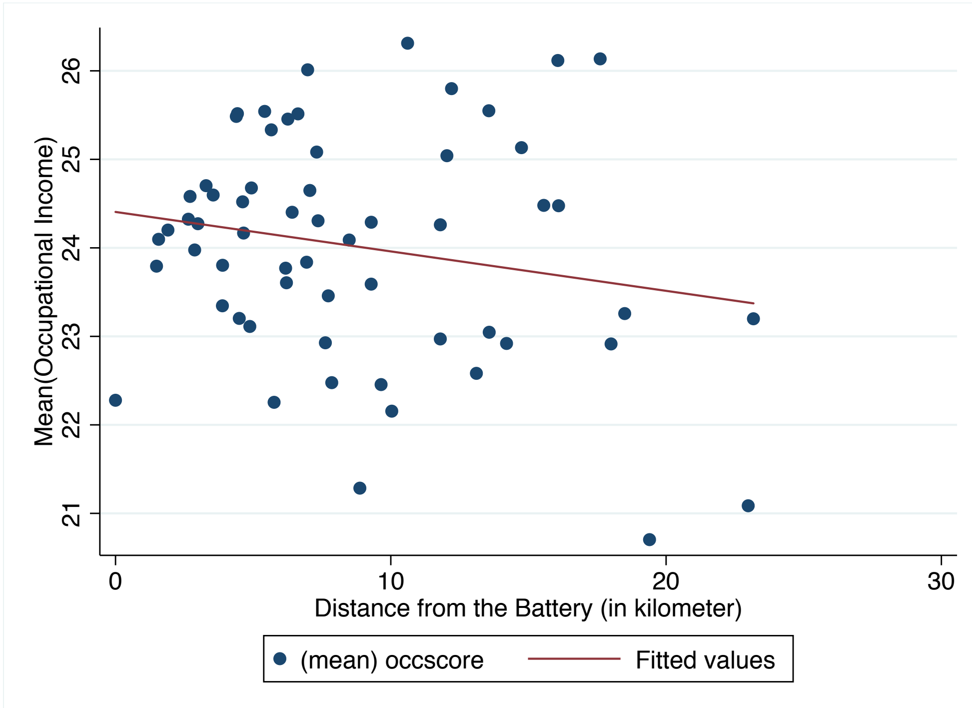


Figure 19: Mean Occupational Income

(b) 1880



(c) 1900

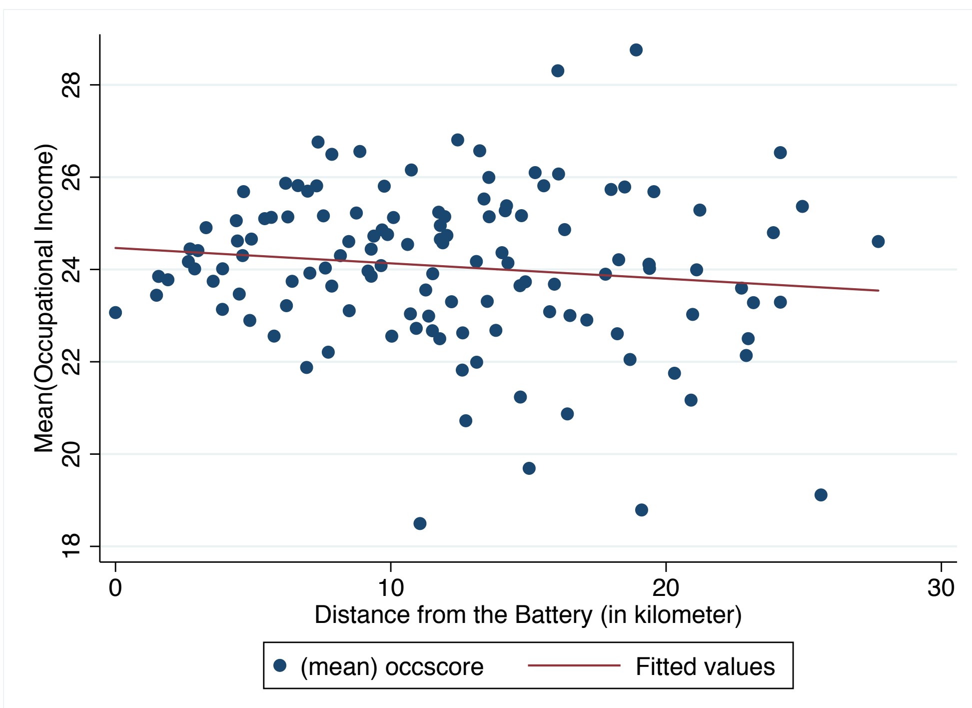
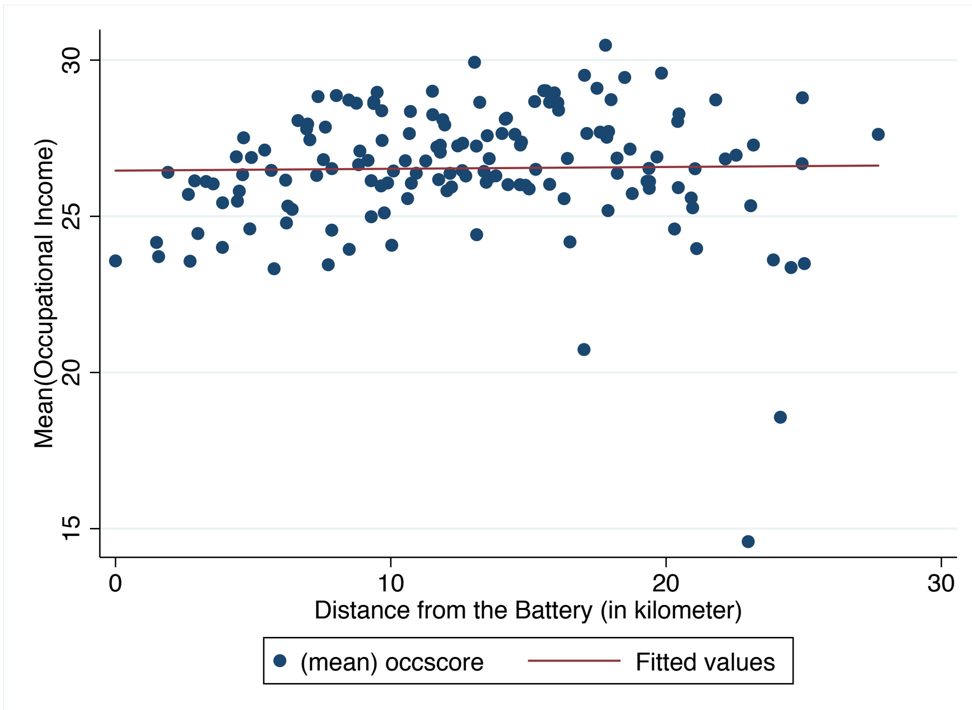


Figure 19: Mean Occupational Income

(d) 1910



(e) 1920

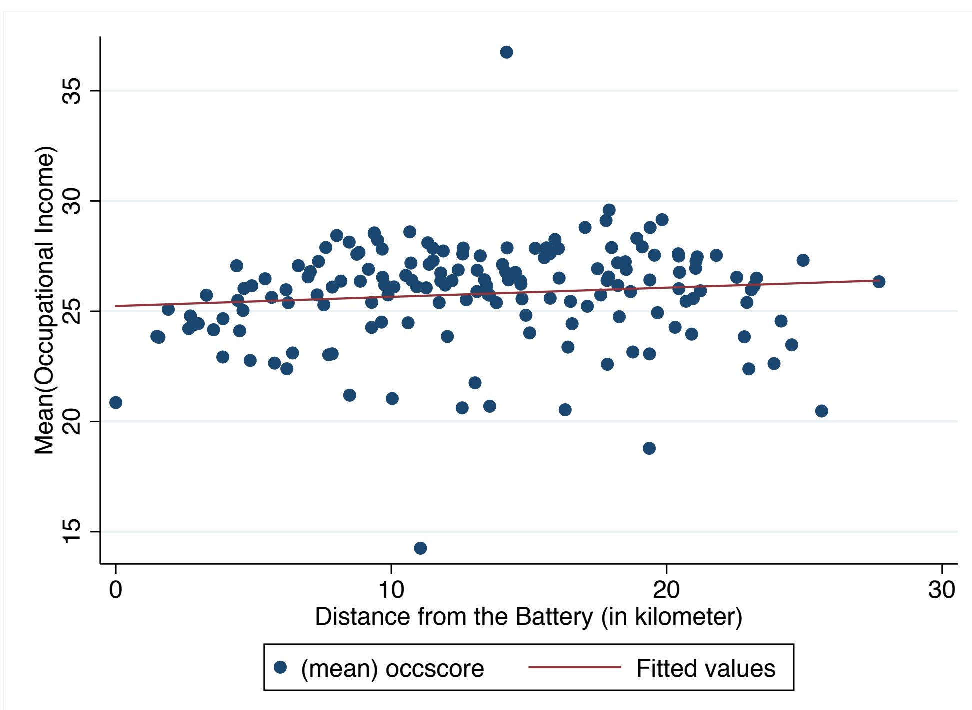
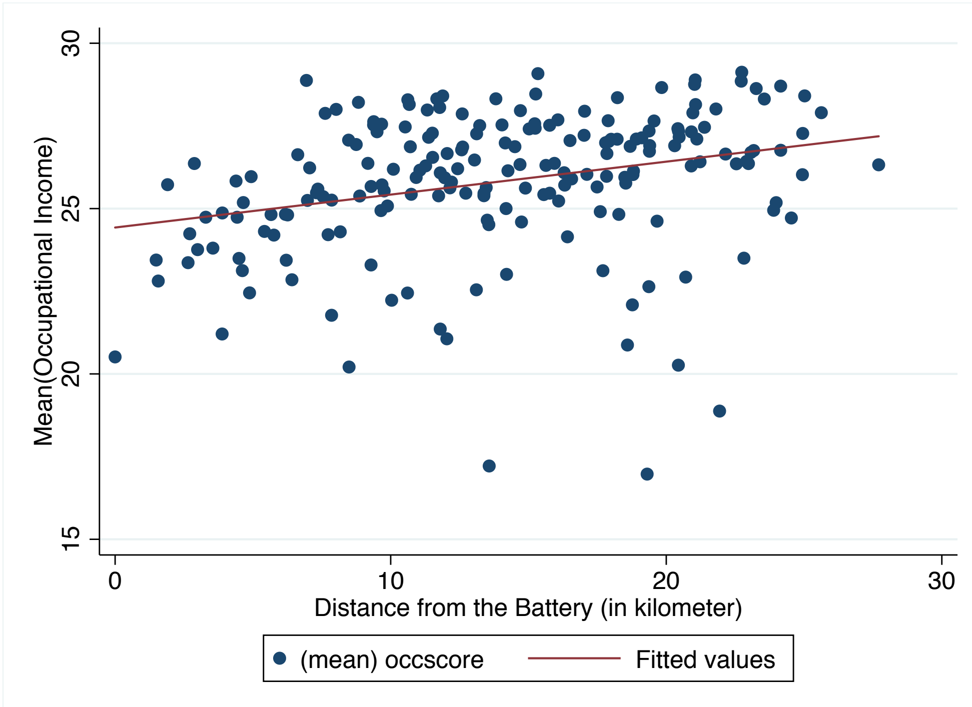


Figure 19: Mean Occupational Income

(f) 1930



(g) 1940

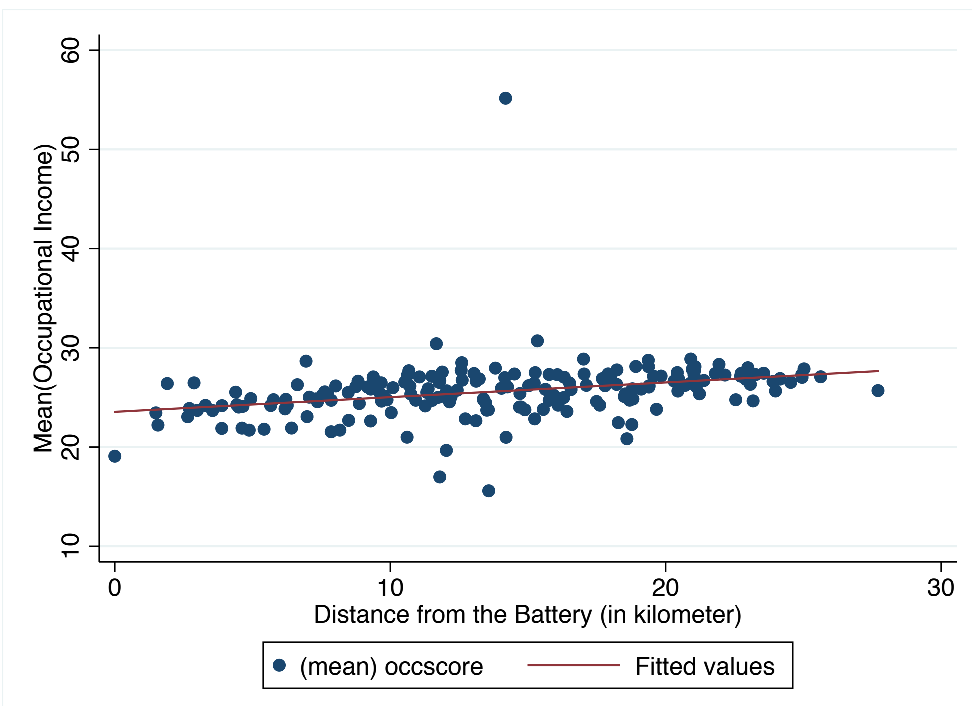
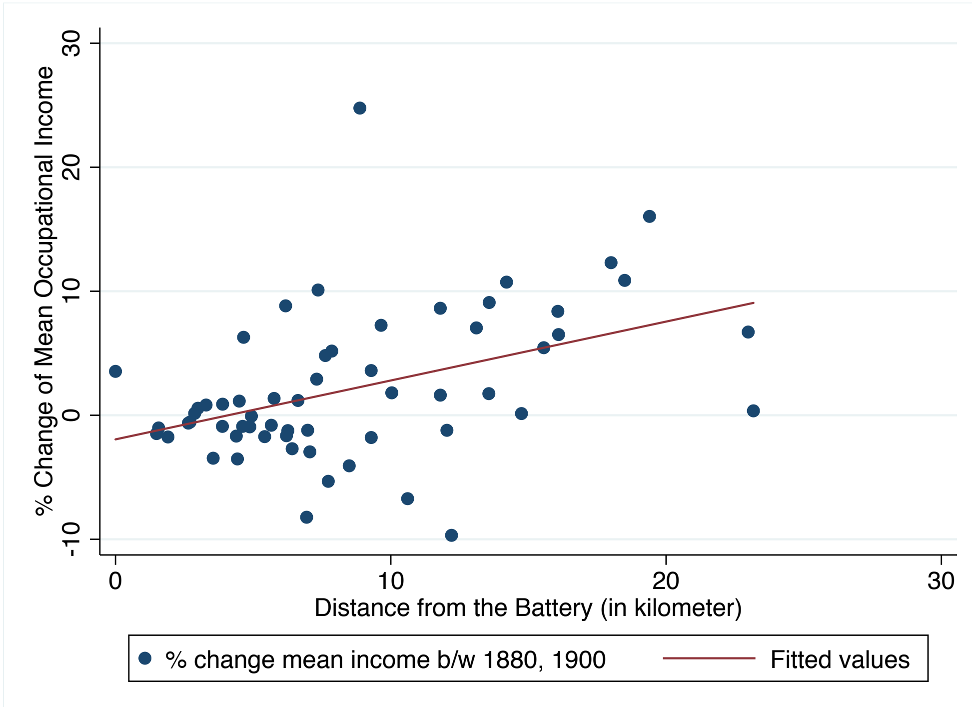


Figure 20: % Change of Mean Occupational Income

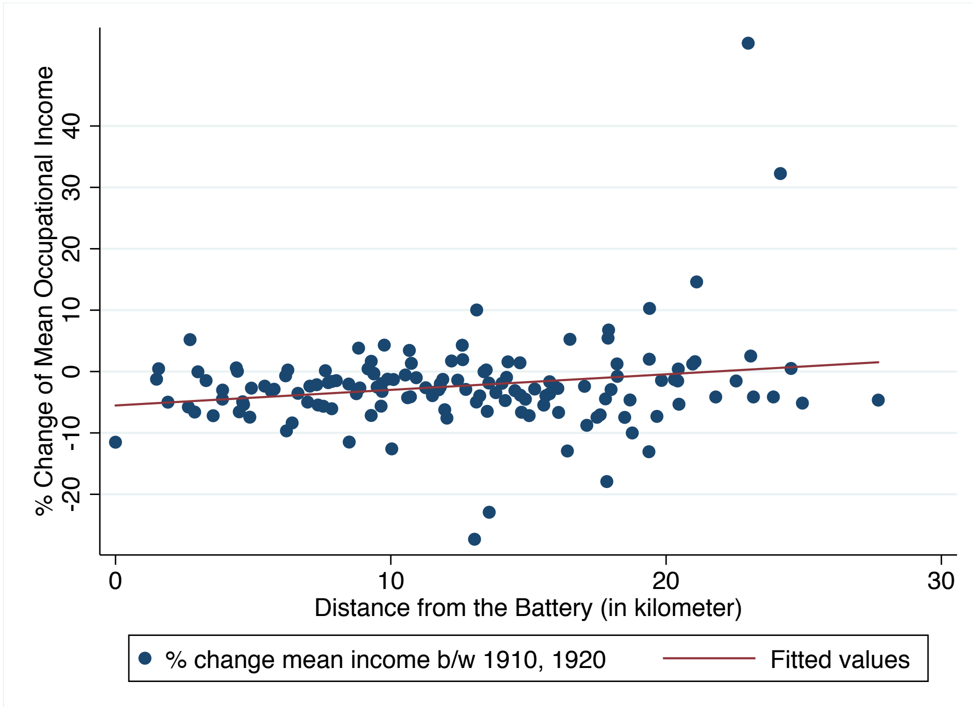
(a) 1880-1900



(b) 1900-1910

Figure 20: % Change of Mean Occupational Income

(c) 1910-1920



(d) 1920-1930

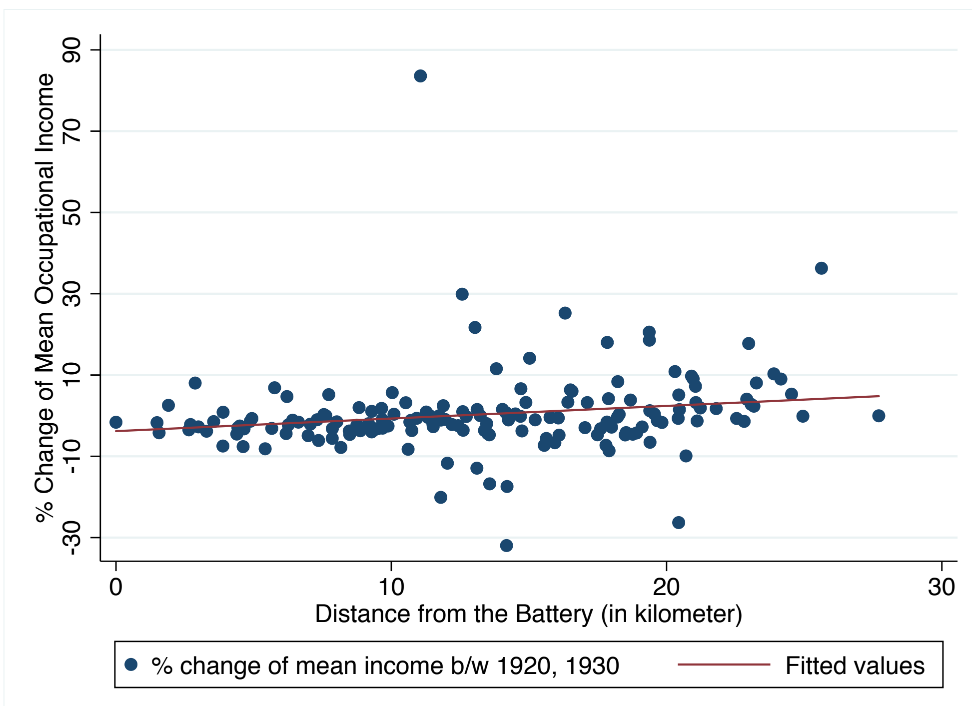


Figure 20: % Change of Mean Occupational Income

(e) 1930-1940

4.4.2 Decomposition of the various flows among the core, the periphery, and the rest of the world

Neighborhoods' income changes between two periods are composed of 6 factors: the relative difference between entrants and stayers; the change in income of stayers; the relative difference between leavers and stayers as well as the relative magnitudes of the flows. Section 4.2, 4.3 looks at the relative difference between leavers and stayers in the core and the relative difference between entrants and stayers in the periphery respectively in relation to Jackson (1985).

In this Section 4.4.2, I decompose various flows among the core, the periphery, and the rest of the country, along with associated incomes. As NTA-level results in Section 4.2, 4.3 show, flows within the metropolitan area are different from flows from outside the NYC-metropolitan area. For example, in terms of city core leavers, the original neighborhood residents leaving to the periphery of the city may be different (in terms of income and other characteristics such as age and race) from residents leaving to NYC metropolitan area such as Westchester County, or residents moving to outside NYC metro area entirely. Similarly, entrants to the periphery neighborhood in the city could be from another neighborhood in the city including the core of the city (as Jackson (1985) discussed), or from NYC metro area (e.g. Westchester county located in the north of NYC which is a part of NYC metro area), or from outside NYC metro area.

Specifically, I decompose the changes in the core and the periphery in the following way. In terms of the core, I look at various flows including the relative income difference between leavers and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level. In terms of the periphery, I look at various flows including the relative income difference between entrants and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level.

These decomposition analyses are complementary to results in Table 4, 6, 8, 10, 12 for leavers (relative to stayers at the neighborhood level) at the core of the city, and in Table 14, 16, 18, 20, 22 for entrants (relative to stayers at the neighborhood level) at the periphery of the city.

I look separately at flows within the city, flows within the metro area, and flows from the outside the metro area in analyzing neighborhood changes at the neighborhood level.

- Decomposition of the core of the city (leavers and stayers at the core of the city)

I decompose various flows of the core of the city including the relative income difference between leavers and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level. In Figure 21, the size of hollow circle denotes that relative ratio of such migration-type, whereas y-axis indicates the mean occupational income of each migration type. In Figure 21, as x-axis captures the number of flows, strictly positive sign indicates inflows (entrants) whereas strictly negative sign indicates outflows (leavers), and the distance away from 0 captures the total number of flows across migration-type.

Throughout the study period, neighborhood stayers at the core (in Lavender in Figures 21a, 21c, 21e, 21g) had the highest mean occupational income relative to other neighborhood leavers at a varying degree. Related to Jackson (1985), core leavers to the periphery in the city (in Cranberry) and to NYC metro area (in Orange) relative to the core stayers matter.

Figures 21a, 21c, 21e, 21g show the core stayers' income (in Lavender) was higher than those two groups throughout the study period. This is consistent with my findings in Section 4.2 that it was not the rich who left the center of the city. However, although the neighborhood stayer at the core may have been the richest, only a small fraction of people stayed in the same neighborhood and the majority of them left the core of the city — some migrated to the periphery of the city, others migrated to NYC metro area, and the others migrated outside the NYC metro area at all.

The relative magnitude of flows gives us a richer story regarding the evolution of the core of the city. First of all, till 1910, the proportion of leavers who are leaving to outside NYC metro area (in Teal) was higher than any other group, whereas starting in 1920, the proportion of neighborhood leavers moving to the periphery in the city became higher than any other group. This implies the magnitude of within-city internal migration increased greatly around 1920 which was at the peak of intra-city transit infrastructure investment after the Dual Contract. It is also notable that between Years 1920 and 1930, the magnitude of leavers to the periphery of the city and is astonishing — the number of leavers who were leaving the core of the city were almost five times bigger than the number of entrants to the core — implying that population decline in the core of the city was more dramatic than ever.

Therefore, although Jackson (1985)'s fundamental claim about the growth of high income at the edge relative to the center holds true for my study (which I will discuss in the following decomposition), Jackson (1985)'s claim of the rich leaving the center of the city as the mechanism for explaining the growth of high income at the edge does *not* hold true for my study. Jackson's straightforward inference of the rich leaving the center and moving to the periphery does not apply to my longitudinal data-based migration analysis. To recap, the core stayers were richer than any other leaver groups at any destination, and it was not the rich who left the core of the city.

The flows of entrants also capture how the change — change of incomes at the center declining relative to the center — actually happened. The core entrants' income was much lower than leavers and this is especially pronounced for core entrants from outside NYC metro area (in Maroon). Entrants from outside NYC metro area were the largest entrant group with the lowest mean income, and therefore, this must have caused the core of the city's income to decrease.

To recap, the transit changes in my study period had a similar nature of Jackson (1985) and the postwar period and incomes at the edge were rising relative to the center. However, the mechanism behind these changes was *not* a simple shuffling of the rich and poor.

- Decomposition of the periphery of the city (entrants and stayers at the periphery of the city)

I also decompose various flows of the periphery of the city including the relative income difference between entrants and stayers as well as the corresponding relative magnitudes of those flows at the neighborhood level. Throughout the study period, neighborhood stayers at the periphery of the city (in Lavender in Figures 21b, 21d, 21f, 21h, 21j) had a higher mean occupational income than other periphery entrant groups. Related to Jackson (1985), the income of periphery entrants from the core (in Maroon) relative to periphery stayers matter. Figures 21b, 21d, 21f, 21h, 21j show that income of the periphery entrants from the core (in Maroon) was lower than that of periphery stayers (in Lavender) throughout my study period.

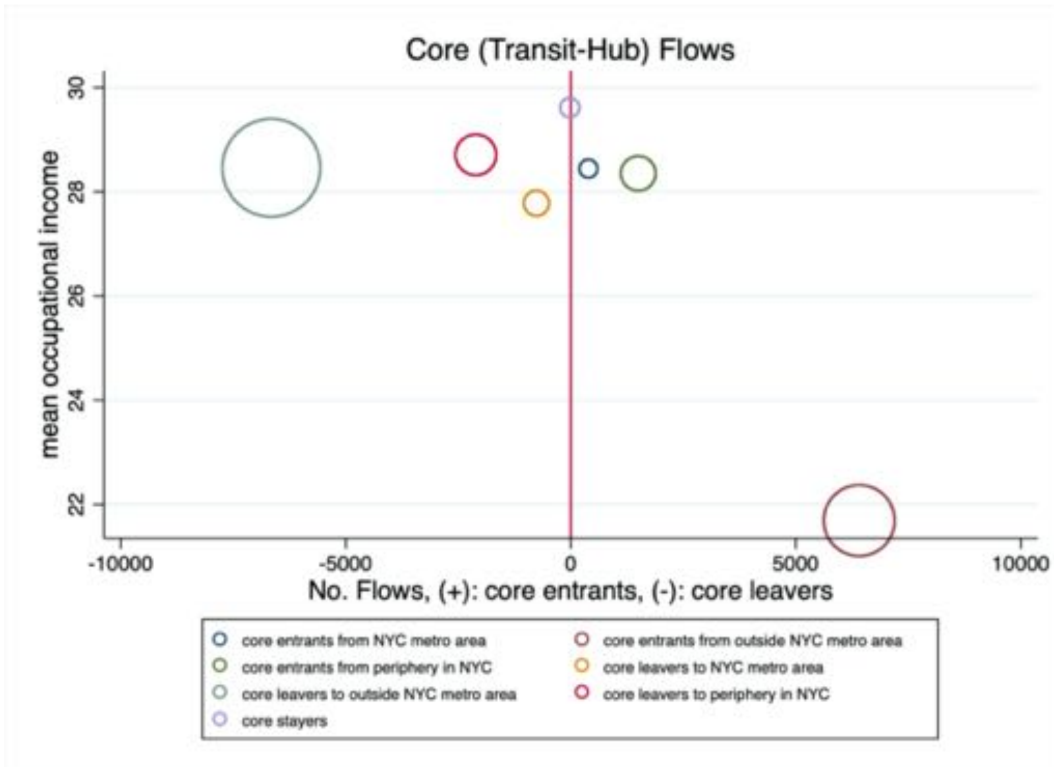
Therefore, Jackson (1985)'s straightforward inference about the rich from the core moving to the periphery as the primary mechanism for the edge's relative income growth does not hold for my study. The periphery entrants from the city core had lower mean income than periphery stayers, and their relative magnitude in terms of the number of people was fairly small. The primary mechanism behind the income growth are three forces: 1. the periphery leavers moving to outside New York metro area had lowest mean income than any other group, and they left the city periphery greatly (in Cranberry), 2. periphery entrants from outside NYC metro area (in Green) had much higher mean income than periphery leavers and magnitude of this inflow was big enough to dominate all the other forces, 3. the periphery stayers' income increased substantially (Figure 22b).

To summarize, incomes at the periphery were rising relative to the center due to entrants from outside NYC metro area with a higher income than periphery leavers and this flow was sizable both in terms of the relative income difference between leavers and entrants as well as the relative magnitudes of the flows.

Finally, the decomposition analyses show that the neighborhood stayers at the periphery were not poorer than most entrants into the periphery. However, Table 14, 16, 18, 20, 22 show that the new suburbanites at the periphery were not richer than the people who stayed at the periphery.

Figure 21: Mean Income and Magnitude of Flows Across Migration-type: 1880-1900

(a) Core Flows from 1880-1900 panel



(b) Periphery Flows From 1880-1900 panel

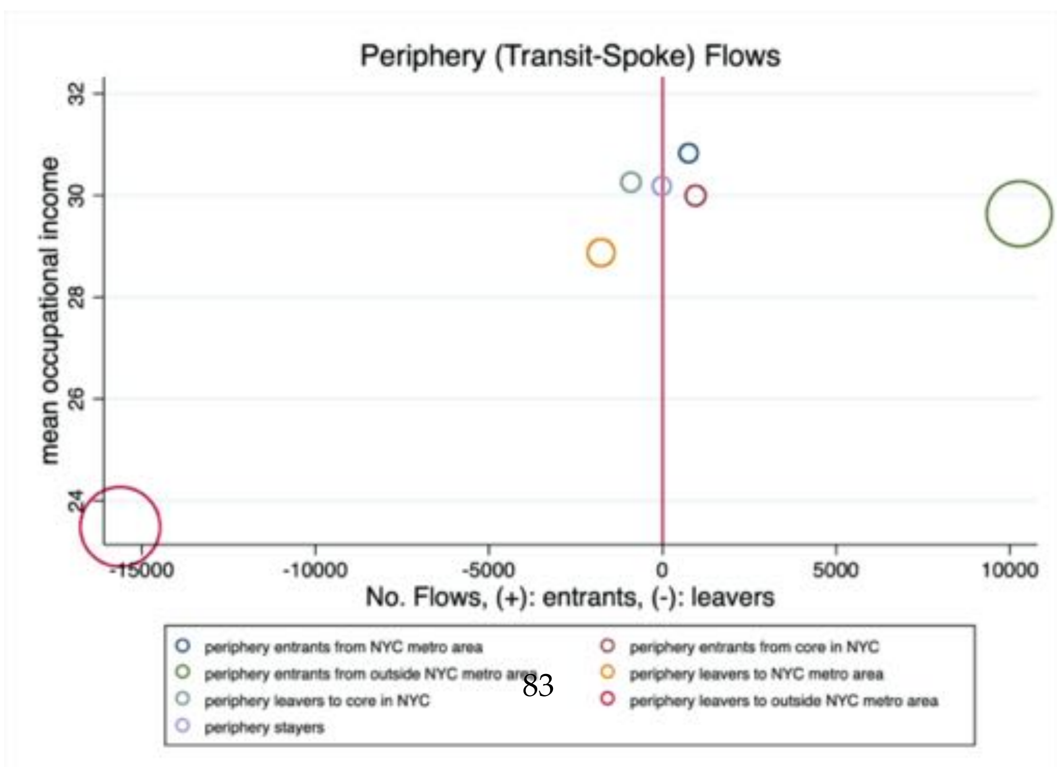
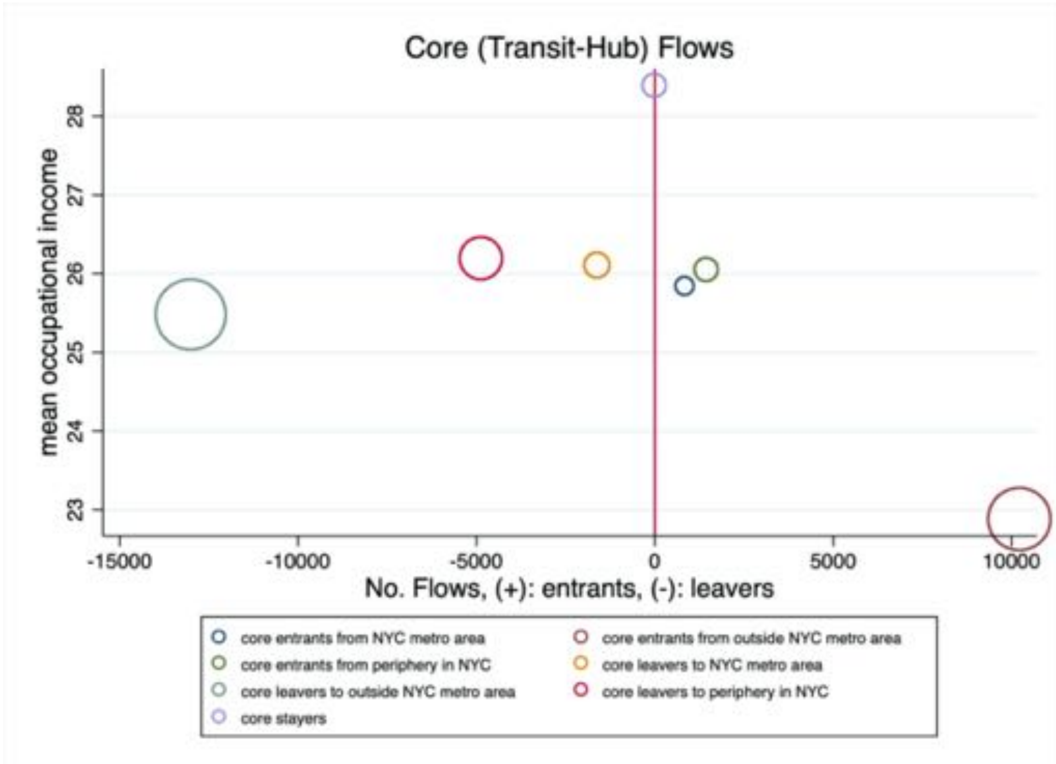


Figure 21: Mean Income and Magnitude of Flows Across Migration-type: 1900-1910

(c) Core Flows from 1900-1910 panel



(d) Periphery Flows From 1900-1910 panel

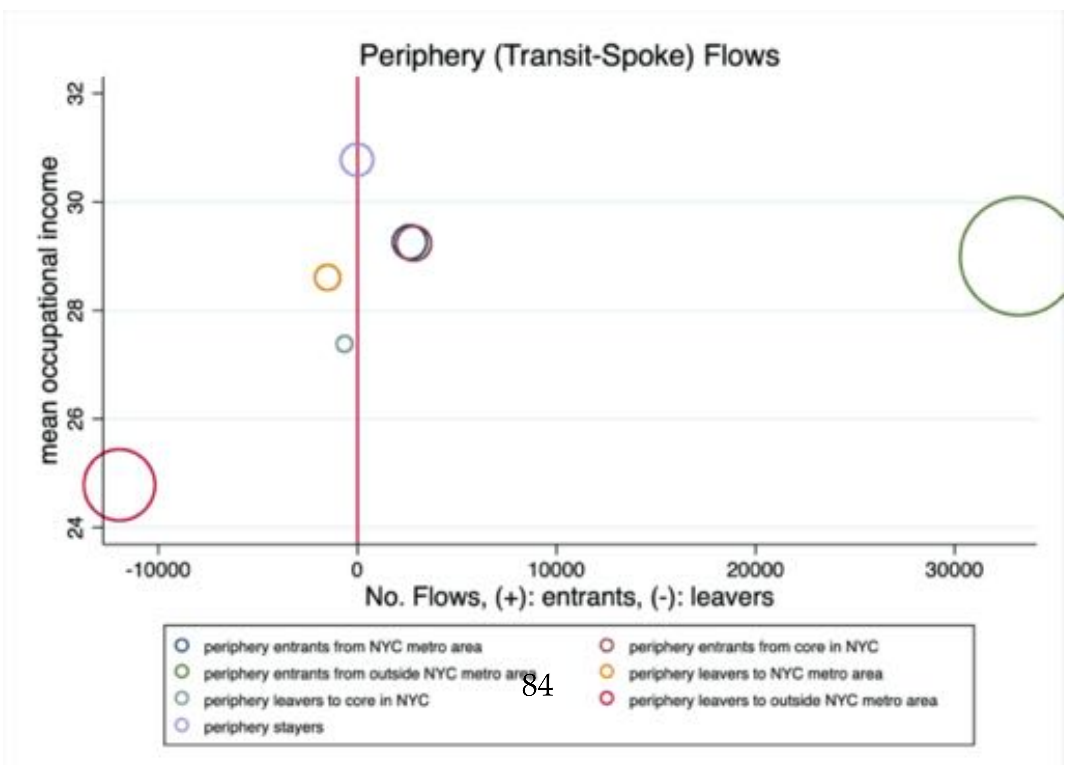
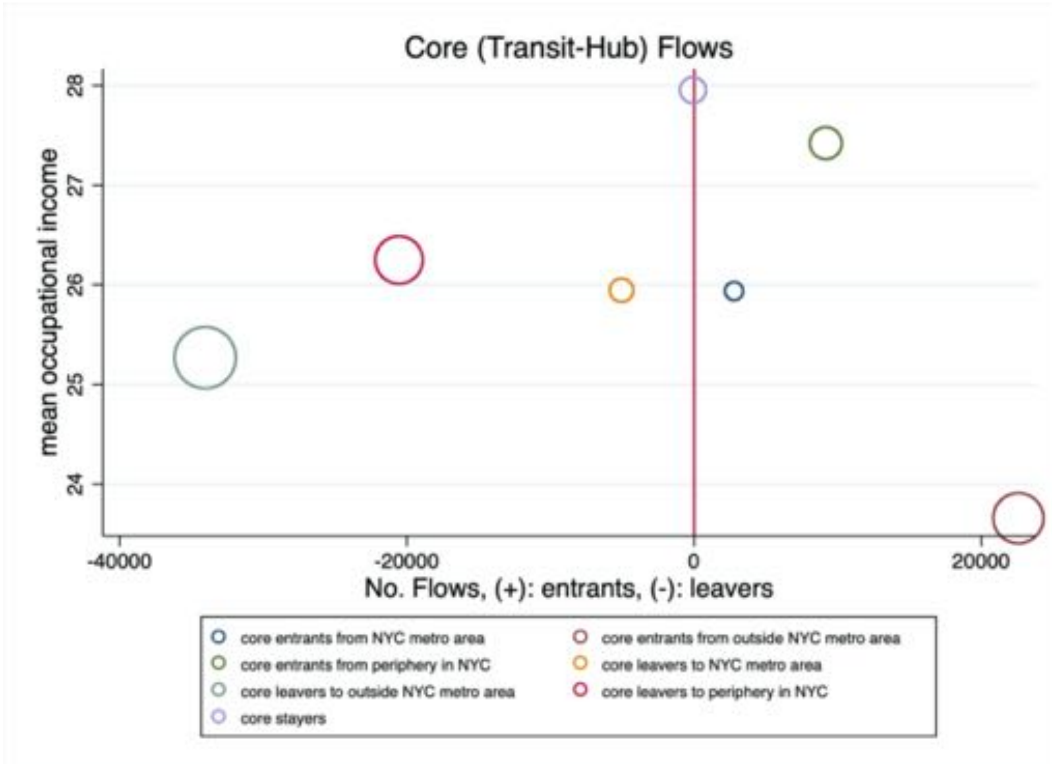


Figure 21: Mean Income and Magnitude of Flows Across Migration-type: 1910-1920

(e) Core Flows From 1910-1920 panel



(f) Periphery Flows From 1910-1920 panel

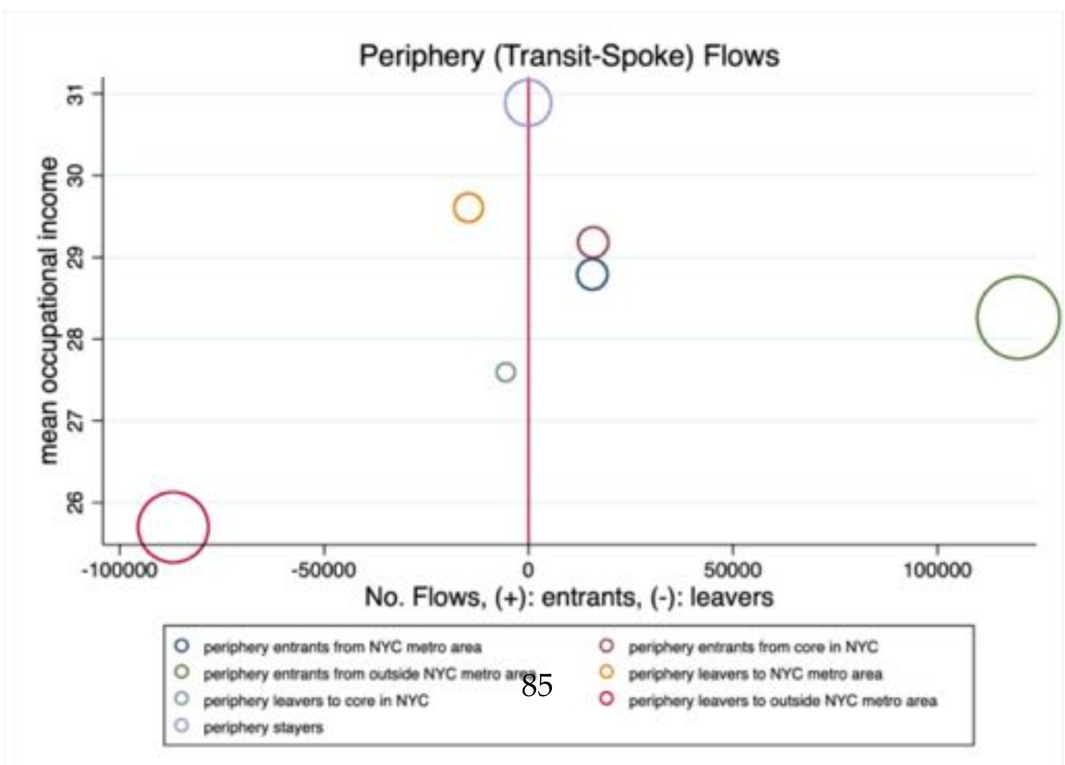
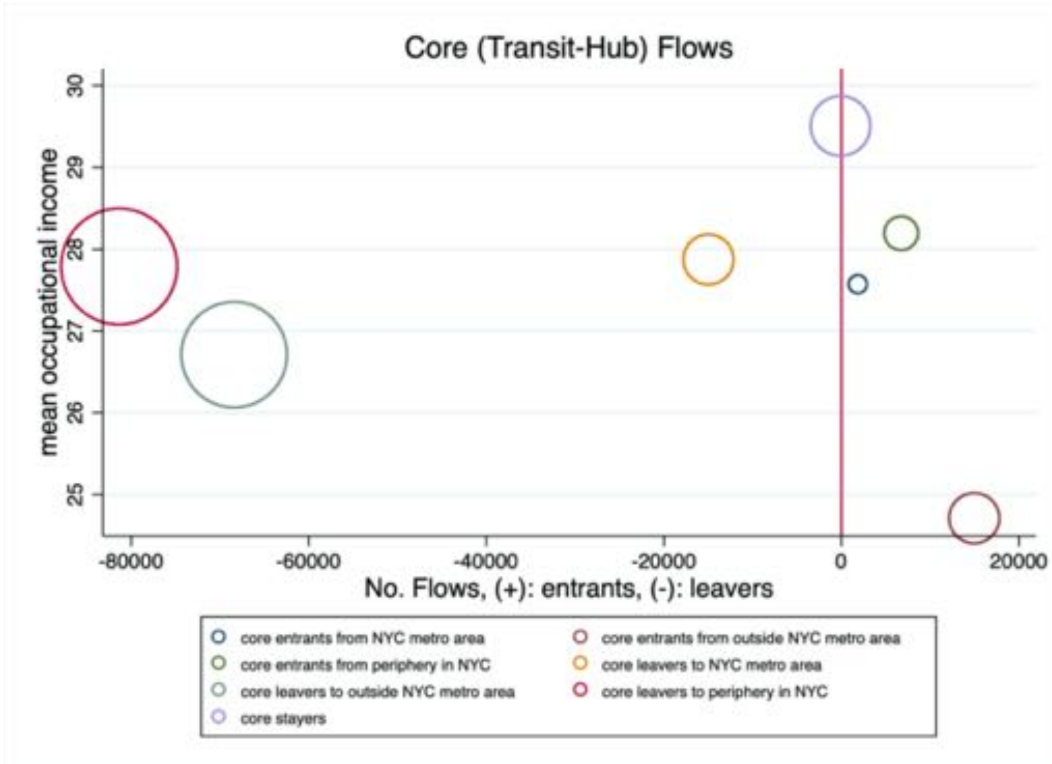


Figure 21: Mean Income and Magnitude of Flows Across Migration-type: 1920-1930

(g) Core Flows From 1920-1930 panel



(h) From 1920-1930 panel

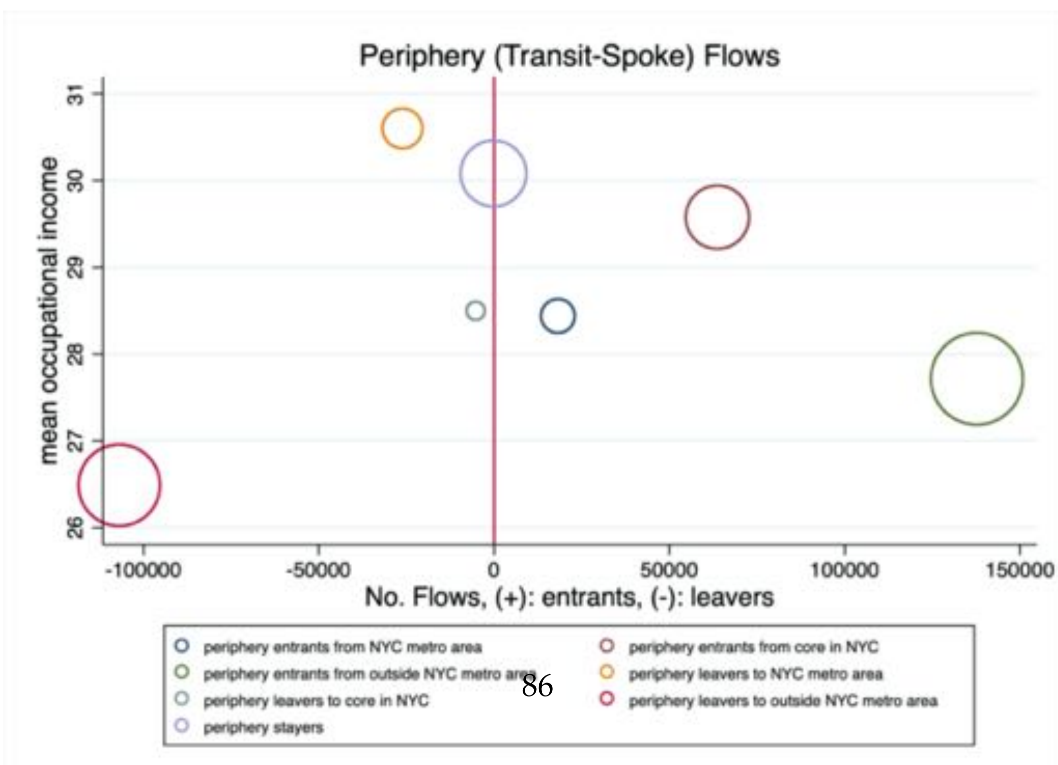
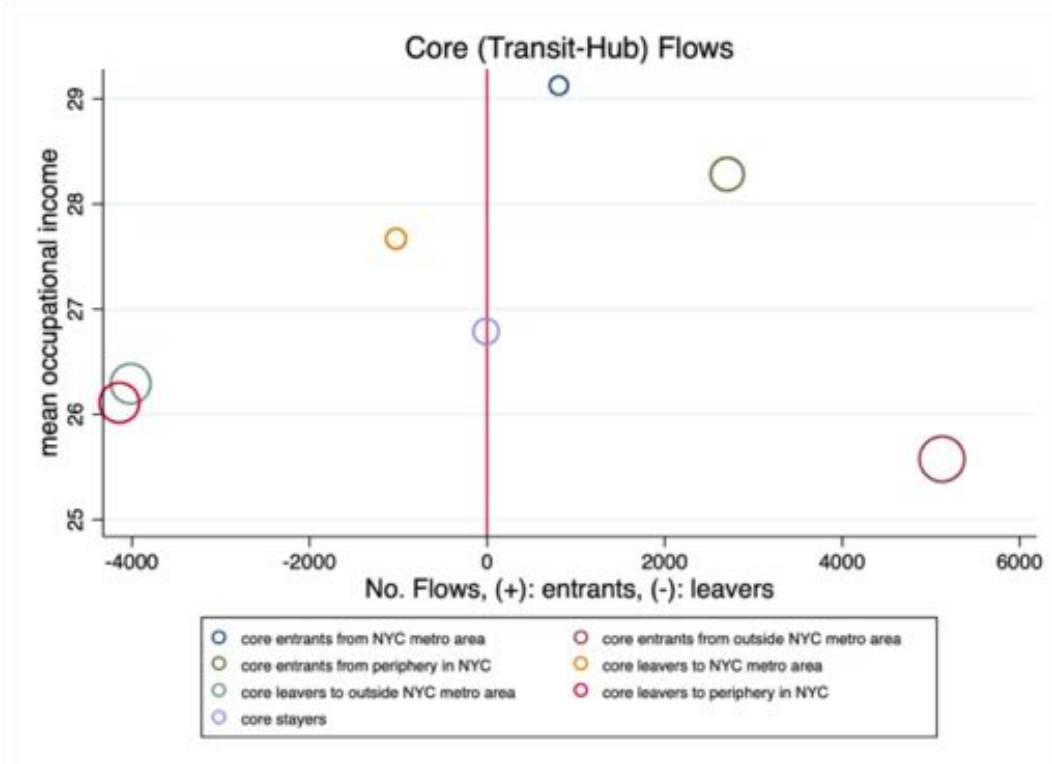


Figure 21: Mean Income and Magnitude of Flows Across Migration-type: 1930-1940

(i) Core Flows From 1930-1940 panel



(j) Periphery Flows From 1930-1940 panel

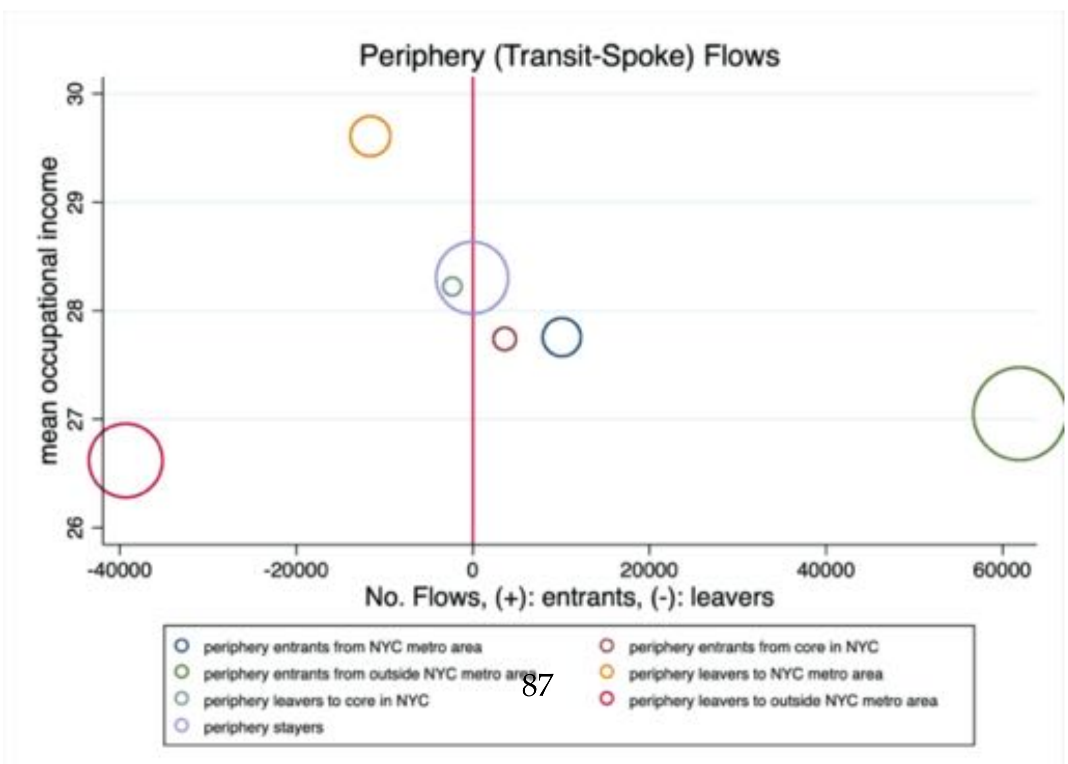
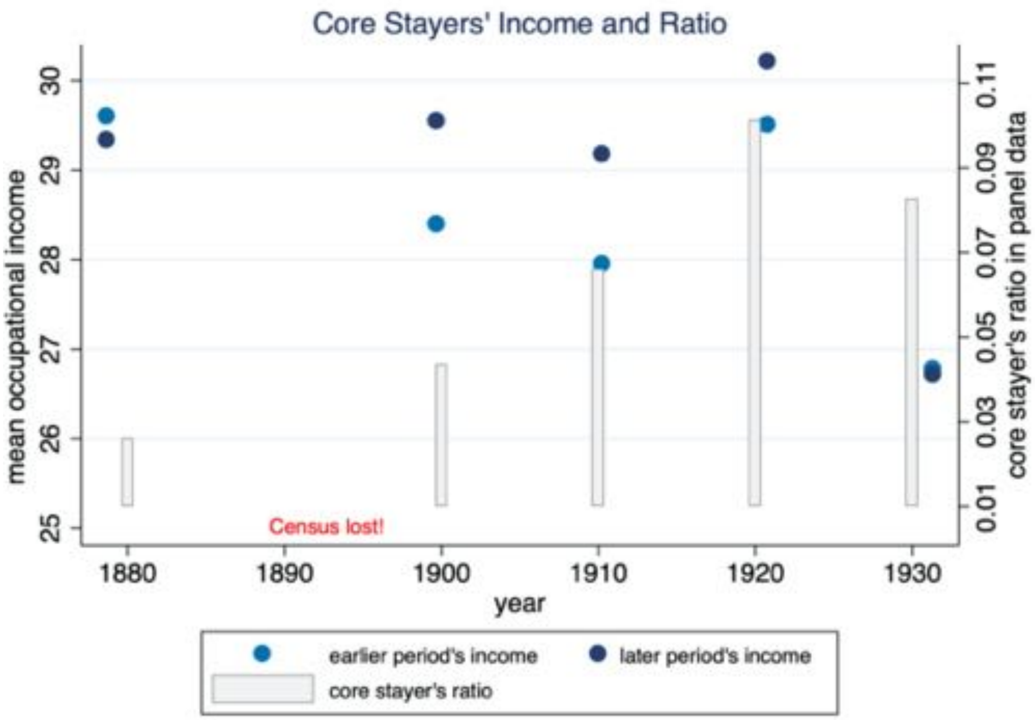
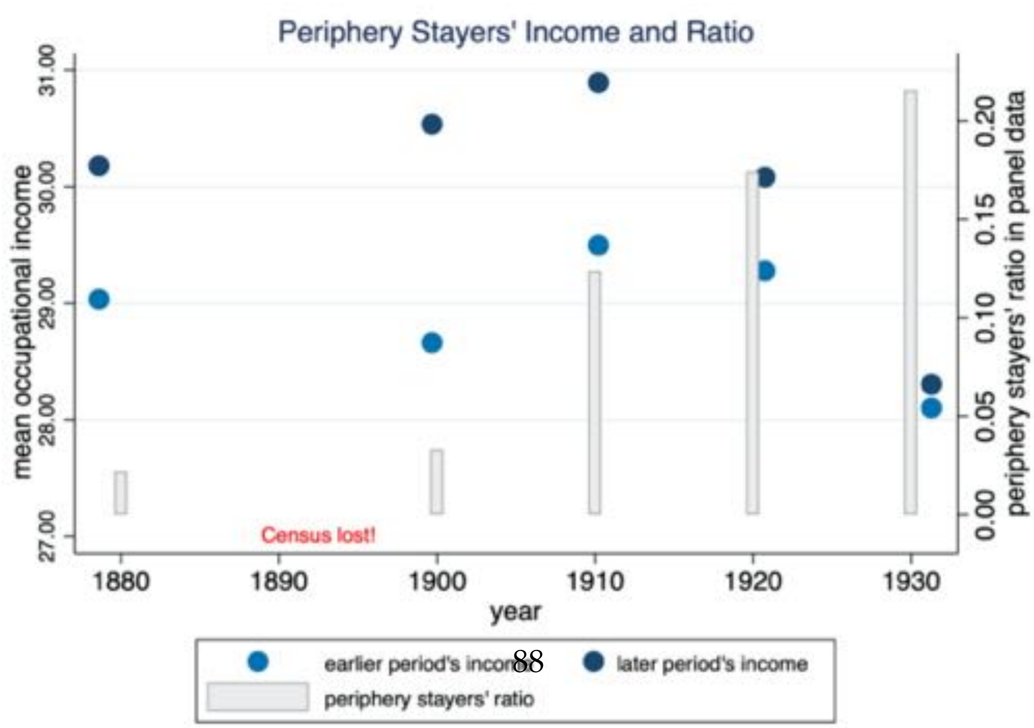


Figure 22: The Core and Periphery Stayers' Income and Ratio

(a) The Core Stayers



(b) The Periphery Stayers



5 Conclusion

With the 21st-century advanced techniques and computational power, I construct longitudinal database by linking complete-count US census records from 1870 to 1940. I analyze income and socioeconomic status of individuals who lived in the New York City and analyze whether the dynamic process of suburbanization in New York systematically differed for the poor and rich (and other characteristics).

Longitudinal data reveal that in the core, it was not the case either that rich people left or that poor people stayed; in the periphery, people who moved into the periphery were not richer than original residents. The suburbanization in prewar New York was probably different from postwar suburbanization. The people who lived in the central city were not poor; those who left were not more affluent.

My study period also captures the growth of high income at the periphery relative to the center as in Jackson (1985)'s period (1815-1875) and the postward period. However, unlike other works that do not use panel data, I use panel data of individuals to uncover the mechanism behind the growth of high income at the edge relative to the center. Instead of making an inference about who moved, left, and stayed, I show how the change actually happened.

Essentially, the transit infrastructure improvements and changes in my study period had the same nature of Jackson's period and the post war period—incomes at the edge rising relative to the center. However, the anatomy of how this change actually happened shows that incomes rising at the edge (relative to the center) was not a simple shuffling of rich and poor. Up until the Great Depression, flows of migrants from and to outside the NYC metropolitan area were the dominant force in changing average income. Richer people from outside migrated to the periphery, whereas poorer people from outside migrated to the core. The people from the core who left the NYC metropolitan area entirely were richer than the people from the periphery who left the NYC metropolitan area. Finally, people who stayed at the periphery got richer as the metropolis grew.

Finally, while this paper quantitatively shows the dynamic process of suburbanization in relations to transit infrastructure improvement, it still is not clear whether the welfare consequences differ across the rich and the poor (or high skill and low skill workers). Analyzing rigorous welfare comparisons offers a direction for future research.

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A Appendix

Appendix to Chapter 1

In this section, I describe the record linking procedure and relevant details. In constructing a panel of individuals, I use "Machine Learning," where the machine can learn the pattern of "true" and "false" matches and self-link individuals after learning the patterns of true and false matches from training datasets. This method is implemented to link individuals across census years while maximizing the match rate and representativeness of linked datasets. I link complete-count US Federal Decennial Demographic Census records from 1850 to 1940 with newly transcribed socioeconomic variables such as occupation and industry.

B Methodology

B.1 Machine Learning Approach of Record Matching

The "machine learning" approach for record linking borrows insights from computer science and statistics and I implement this method of classification and text comparison to link individual records. The rationale behind my choice of machine learning is to learn from big data. In essence, record linking without unique identifier is to predict whether certain linked records are "true" links of the same individual or not, based on a set of features such as first name and last name, age, and place of birth. Similar efforts have been pioneered by Goeken et al. (2011) that create the IPUMS linked samples. Feigenbaum (2015) links individual records of the 1915 Iowa State Census to their adult-selves in the 1940 US Federal Demographic Census records. Relative to the mentioned work, my record linking is far more extensive in the scope of matching as this involves complete-count US Federal Decennial Demographic Census records of all years from 1850 to 1940. I teach a machine to learn to predict based on a set of features. I create a training dataset in which contain both "true" and "false" matches and their characteristics (e.g some observations with "true" as an outcome would have same/very similar characteristics in terms of age, first and last name, parents' and his/her birthplaces whereas observations with "false" as an outcome would have quite different characteristics in terms of the above mentioned characteristics). In this case, the outcome is whether the matched records are "true" or "false" match, given the observed characteristics. By taking this training data, I build a prediction model, or learner, which will enable us to predict the outcome for new, unseen objects. A well-designed learner armed with a solid training dataset should accurately predict outcomes for new unseen objects.

I implement a supervised learning problem in the sense that the presence of outcome variable ("true" or "false" links) guides the learning process—in other words, the end-goal is to use the inputs to predict the output values. To summarize this process, I extract subsets of possible matches for each record and create training data in order to tune a matching algorithm so that the matching algorithm matches individual records by minimizing both false positives and false negatives while reflecting inherent noises in historical records. I have explored various models for model selection. By comparing and analyzing matched records that I match through various methods, I choose the random forest classification as it is *more conservative* in matching records—the number of matched records is lower than that of Support Vector Machine (hereafter, SVM)— and the number of unique matches are significantly higher than the standard SVM model. Although the choice of random forest classification may result in lower number match rate due to its conservative nature, I integrated household-level information in linking individual records to mitigate the concerns of low match rate.

A filtering process called "pruning" for non-unique matches

Although I largely follow the standard machine-learning record linking methodology suggested by Goeken et al. (2011), I have extended the techniques of Goeken et al. (2011) by inventing a two-step machine learning matching methodology. Especially, I make use of the parents and/or spouse information such as birthplaces and names to choose the "true" match among other candidate matches. This additional step of extracting household-level information and its use in selecting "true" matches among multiple candidates (instead of dropping non-unique matches, which have been the "standard" practices in the existing record matching literature) is novel. This procedure can not only save a number of matches that otherwise had to be dropped but also correct for the selection bias (people with common characteristics such as common first and last names may be systematically under-represented in linked datasets).

B.2 Record Linking in Practice: Innovations

The core of census matching is a classification problem. Given any pair of records from different census years, finding a true match is to find the mapping that classifies the pair as matched or unmatched based on the set of pre-determined features, including names, gender, age, race and birthplace. However, since this set of features is far from unique, there are cases where one individual has several candidate matches (e.g. there are many "John Smith" with same age).

Most record linking approaches throw away non-unique matches. One of the contributions of my record linking approach is the use of household-level information to turn the non-unique types of matches (second to fourth type) as unique matches. Specifically, I use father and mother's information such as their racial background, birthplaces, birth year) and use the same information for spouses of individuals. This not only increases the match rates but also alleviates the concern of systematic selection bias (e.g. people with common given given and last names may be systematically under-represented in the linked data).

B.2.1 Female Record Linking

Historically, as women typically change their last names after marriage (and in the absence of time-invariant individual-level unique identifiers such as social security number in historical records), female record linking has been challenging. To my knowledge, this is one of the first endeavors of linking historical female records. I assume that women's last names are likely to change if their marital status changes from single in the earlier period to married in the later period, and I do not consider record linking for such case. On the other hand, I assume one's last name is likely to remain the same if the marital status is either married to the same partner in both years, or married in the early period and then widowed or divorced in the later period; or remained single in both periods.

C The Transportation Revolution

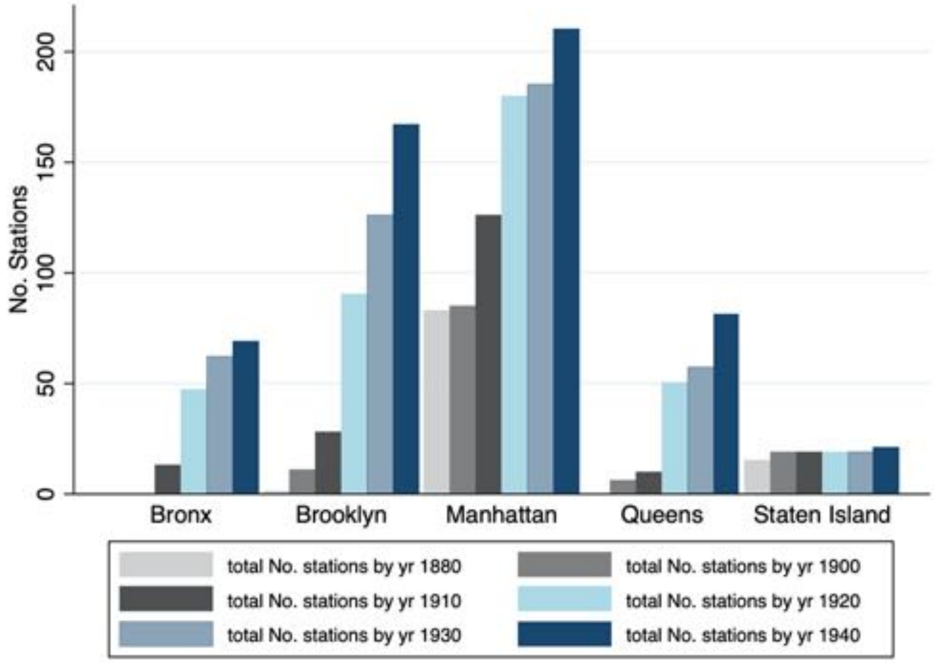
Transit infrastructure improved dramatically at both intra- and inter-city level during the study period. Figure 23 shows the total number of intra-city railways and subway stations by borough by the end of each decade during the study period. Especially, during the subway construction period between 1904 and 1920, the total number of stations grew by 200% and 113% in the Bronx, 87% and 105% in Brooklyn, 50% and 133% in Queens.

Inter-city transit infrastructure improvements at an unprecedented scale during the study period as well: electrification of railroads that served central Westchester county, Connecticut in 1907 and 1914 improved the efficiency and speed of railways greatly, the Hudson Tubes that connected New Jersey was built in 1908, and inter-city railway that connected NYC to the rest of the country with the opening of Penn Station in 1910.

C.1 Intra-city transit infrastructure changes

- Subways and Elevated Railways Construction and Network Change over Time

Figure 23: Total number of intra-city railway, subway stations



Source: Author's creation using New York Transit Museum Archive.

Figure 24 captures the evolution of spatial links by intra-city commuting transit infrastructure which are the elevated and subterranean railways. Before the introduction of the subway in 1904, New York City had a large central business district in lower Manhattan and a smaller business district in downtown Brooklyn. These districts were served by elevated railways and ferries and most of the services were operating in Manhattan. As Figure 24 shows, elevated lines ran north from the southern tip of Manhattan to the Bronx. There were very few east-west connections in Manhattan and this pattern persisted for the subway network in the twentieth century as well. Before the introduction of the subway in 1904, Manhattan was the only borough with rapid mass transit commuting infrastructure. Most outer boroughs (i.e. Queens, Staten Island, and the Bronx) did not have transit network into the 1910s and were semi-rural and underdeveloped. Figure 23 shows the total number of stations by the borough over time. The first decade of subway construction mostly served Manhattan and Brooklyn, whereas parts of Bronx, Queens and South Brooklyn received more subway constructions in the 1910s under the Dual Contracts. However, the rapid growth of the system largely was over by 1940.[16]

[16]The first underground line of the subway opened in 1904, almost 40 years after the opening of the first elevated railway in Manhattan. New York City subway was built by two private companies (the Brooklyn Rapid Transit Company (BRT, later Brooklyn–Manhattan Transit Corporation, BMT) and the Interborough Rapid Transit Company (IRT)) and one city-owned company (Independent Subway System (IND)). In 1940,

- Intra-city transit access measures by the elevated railways and subways

I define Transit Access (hereafter, TA) as the number of stations in each neighborhood.[17] The number of total stations as a proxy for transit access is convenient in understanding a form of hub-spoke distribution paradigm where a series of "spokes" that connect outlying points to a central "hub." Before the introduction of subways, lower Manhattan ("Downtown Manhattan") was the area where the transit network is extremely well connected ("transit hubs"). However, as subway expanded and inter-city transit infrastructure was largely built in Midtown Manhattan, "transit hubs" expanded from Downtown Manhattan to Midtown Manhattan. I describe the spatial links by inter-city transit infrastructure in the following Subsubsection C.2.

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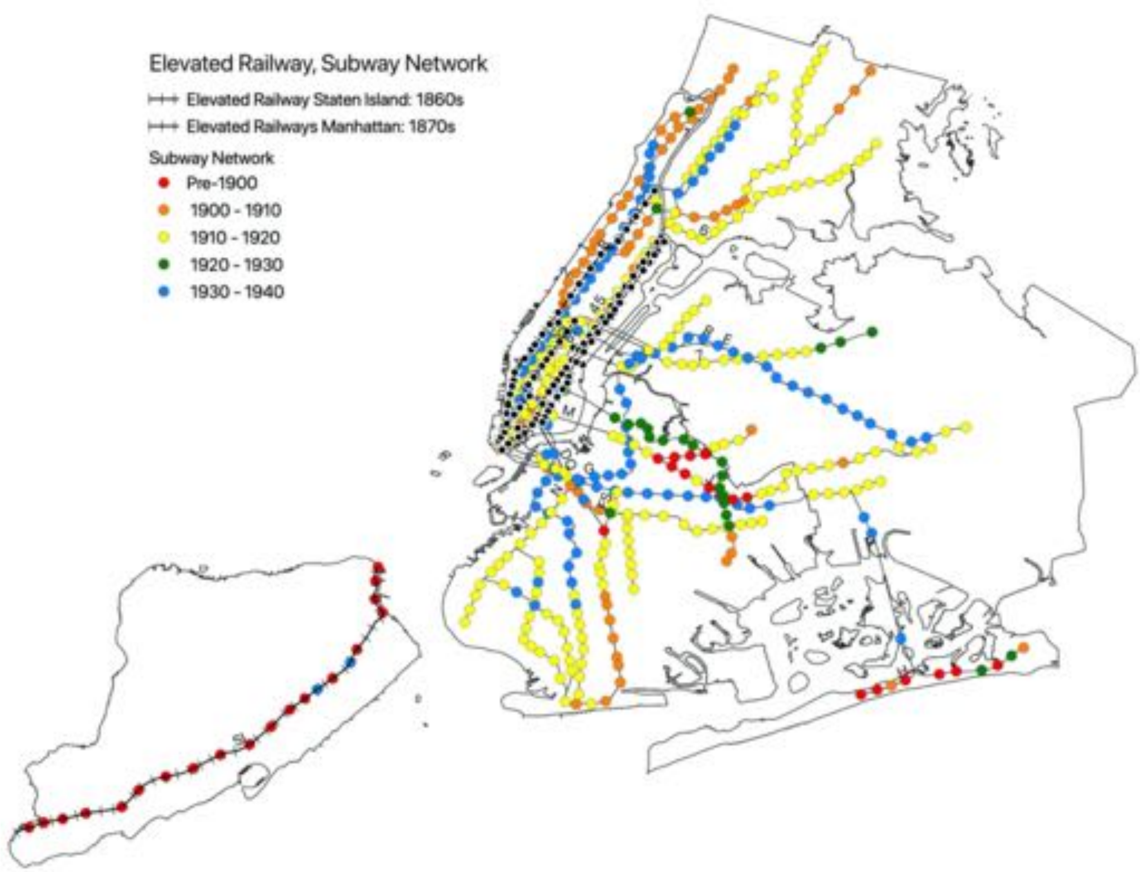
the city bought the two private systems and consolidated the transit network.

[17]In the Appendix, I map transit access change over the study period based on intra-city mass transit infrastructure (i.e. the elevated railways and subways)

Figure 24: Evolution of Spatial Links by the Elevated Railway, Subways

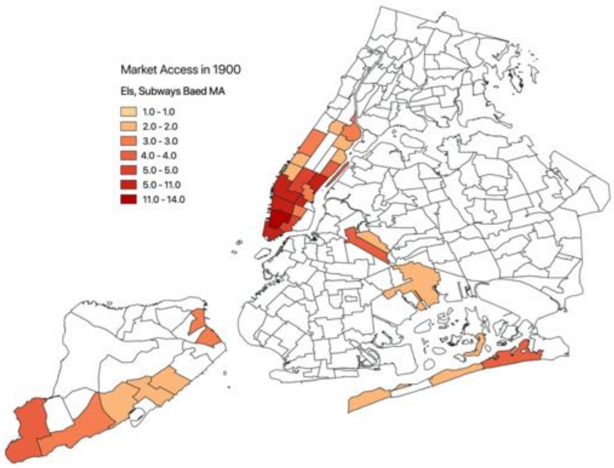


Note: The above figures show the evolution of intra-city spatial links in terms of the elevated railway, subways over study period. Different colors denote the opening years of transit links. Source: Author's Creation using New York City Department of City Planning's data called "LION" GIS data which is a base map representing the city's geographic features.

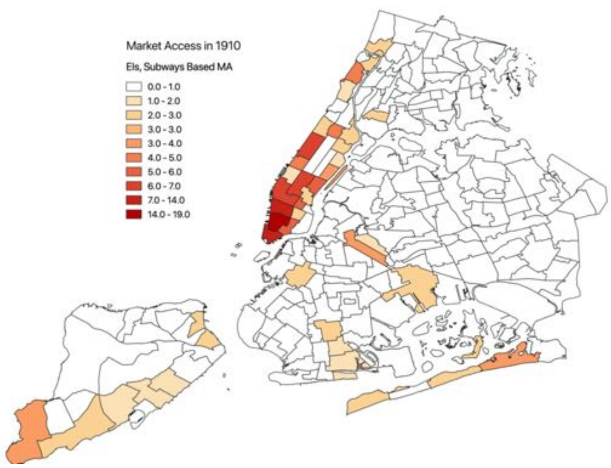
- Transit access changes based on the elevated railway and subway

Figure 25: The Els, Subways-Based Transit Access Measures by Decade

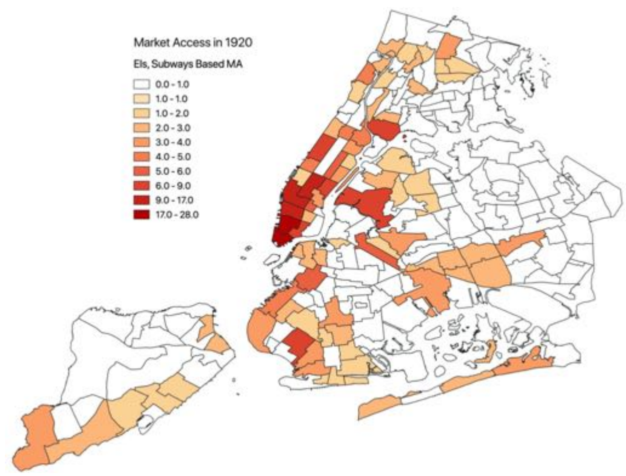
(a) Transit Access in 1900



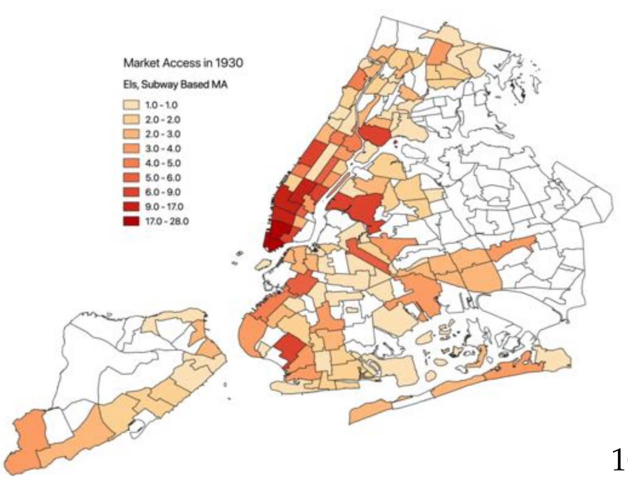
(b) Transit Access in 1910



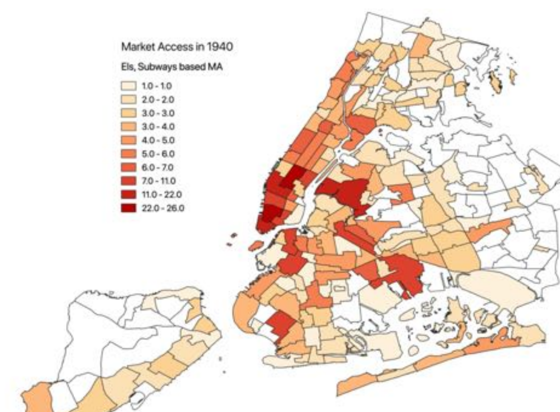
(c) Transit Access in 1920



(d) Transit Access in 1930



(e) Transit Access in 1940



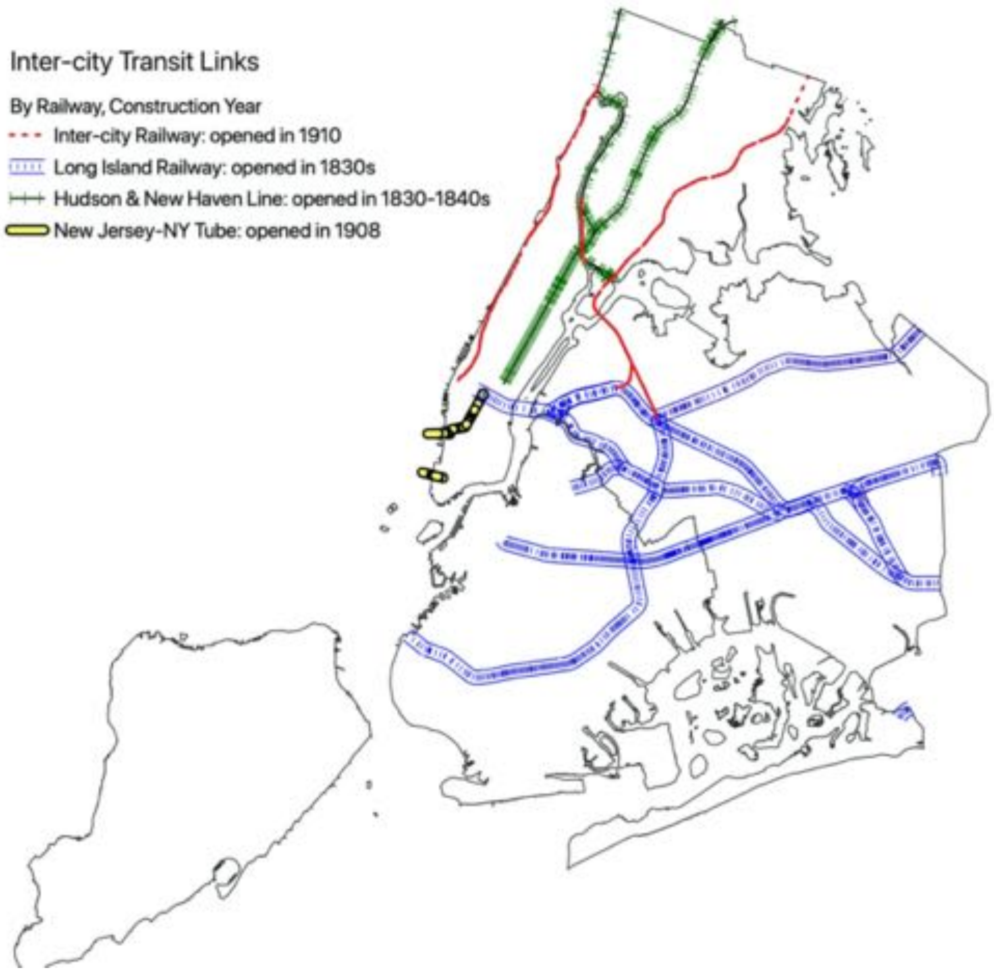
Note: The above figures show transit access by decade based on intra-city mass transit infrastructure (i.e. the elevated railways and subways).

C.2 Inter-city transit infrastructure changes

Inter-city transit infrastructure was largely concentrated in Midtown Manhattan, and the combination of both inter- and intra-city transit infrastructure improvements grew faster in Midtown than in Lower Manhattan. By the Year 1910, the inter-city transit infrastructure-based transit access in NYC experienced an unprecedented, spectacular growth—steam railroad began in the 1830s by New York and Harlem Railroad (Green line); by the 1840s, the same line served central Westchester county; Long Island Railroad (LIRR)-based commuter service was established largely by the 1860s (Blue line); the Hudson Tubes, which became Port Authority Trans-Hudson (PATH) opened in 1908 (Yellow line), and inter-city railway connected NYC to the rest of the country with the opening of Penn Station in 1910 (Red line). Figure C.2 shows the spatial pattern of inter-city transit infrastructure improvements over the study period. NYC's transit "hubs" expanded from Downtown Manhattan to Midtown Manhattan and this change and the extreme growth of Midtown Manhattan was partly due to inter-city railway infrastructure that connects the NYC's surrounding regions.[18]

[18] Jackson (1985) argues the first railroads were designed for long-distance rather than local travel. However, as railroad companies sought revenues, they built stations whenever their lines passed through rural villages on the outskirts of larger cities. Jackson (1985) argues that as inter-city railway fares were considered too high for most wage earners, such suburbanization was only for the "well-to-do."

Figure 26: Evolution of Inter-City Transit Infrastructure by Construction Year

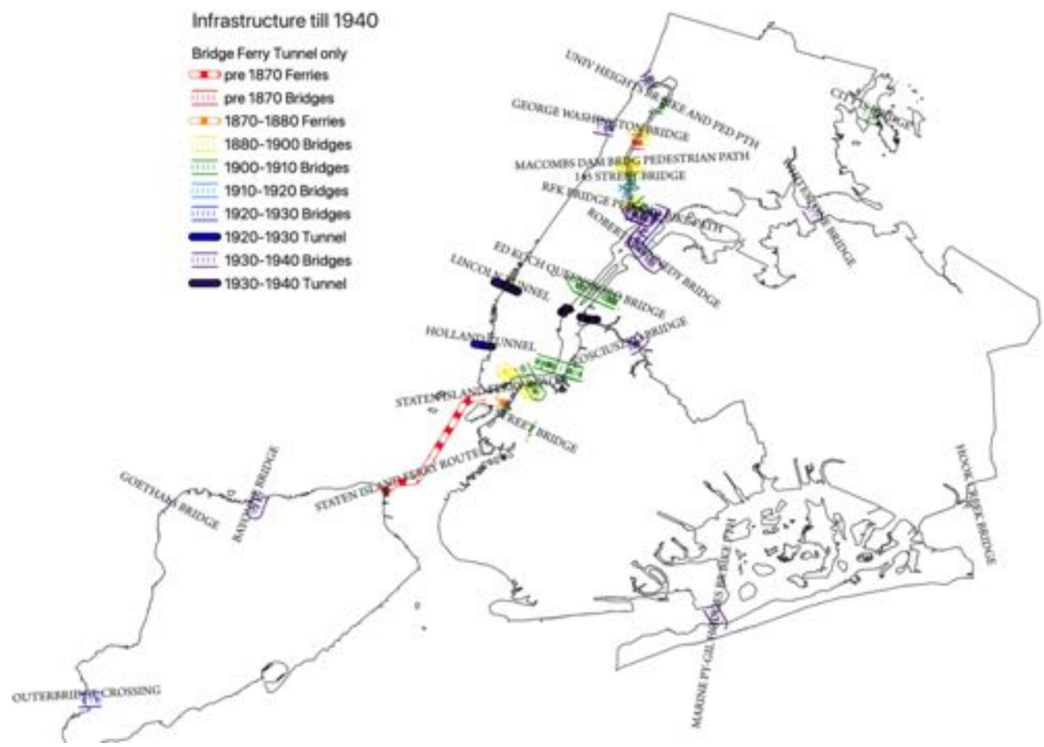


Note: The above figure shows the evolution of inter-city transit networks by railroad network and construction year. I construct the following information based on information provided by the New York City Transit Authority and related books (http://www.mta.info/).

- Bridges, Ferries, and Tunnels

Although the railway is my primary focus of the study, water-borne transportation played an important role in forming connections between the core and connecting regions such as Brooklyn, Staten Island, and parts of New Jersey. As the city economy depended on water-borne transport, extensive bridge-building followed: the Brooklyn Bridge (1883), Williamsburg Bridge (1903), Manhattan Bridge (1909), and Queensboro Bridge (1909) were constructed over the East River. The Hell Gate Bridge (1917) carried trains of the Pennsylvania Railroad and finally, George Washington Bridge (1931) connected New Jersey and New York City. In the Appendix, I map bridges, ferries, and tunnels that were constructed during the study period to connect boroughs in the City.

Figure 27: Evolution of Spatial Links by Bridges, Ferry, Tunnel



Note: The above figures show the evolution of intra-city spatial links in terms of bridges, tunnels, and ferries between census periods. Different colors denote the opening years of transit links. Source: Author's Creation using New York City Department of City Planning's data called "LION" GIS data which is a base map representing the city's geographic features.

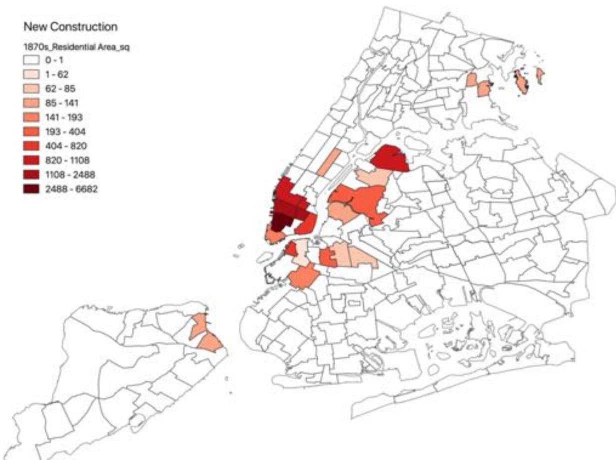
D Supplementary Figures

D.1 Different Land Use Creation

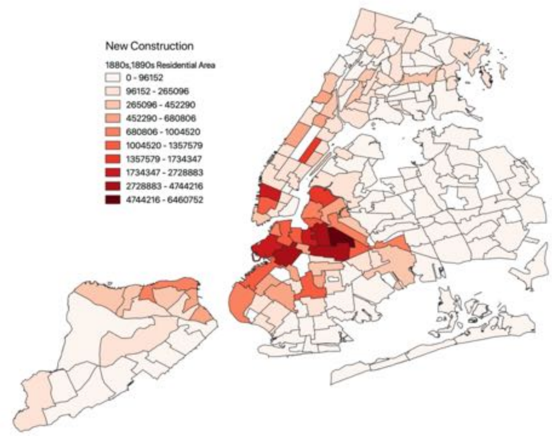
D.1.1 Residential Land Use Construction

Figure 28: New Construction of Residential-Use Land

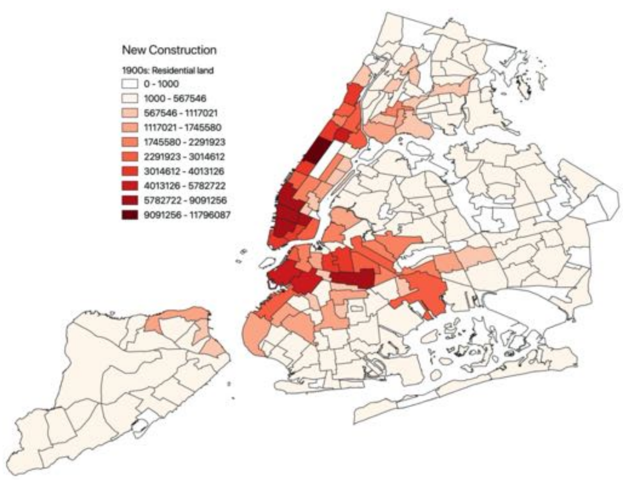
(a) 1870-1879 Residential Construction



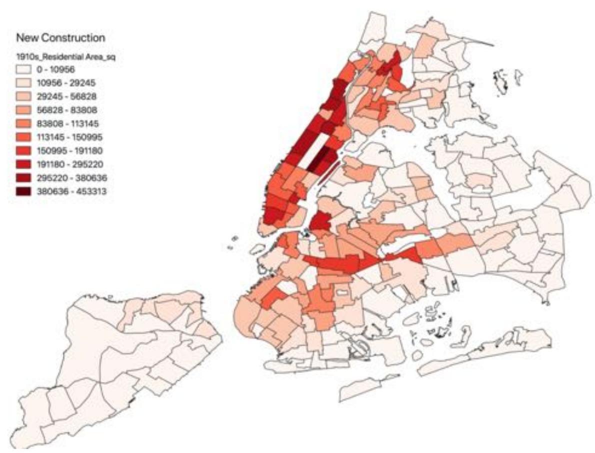
(b) 1880-1899 Residential Construction



(c) 1900-1909 Residential Construction



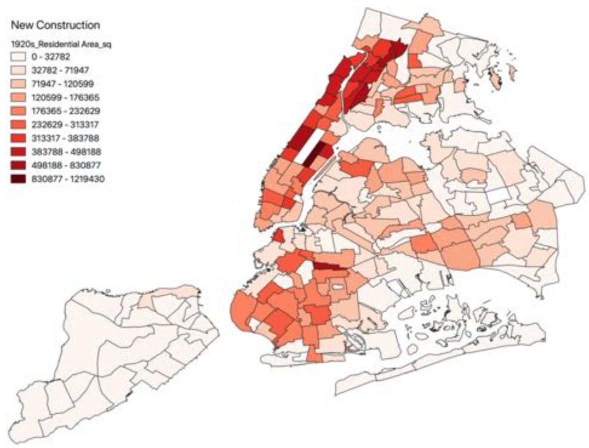
(d) 1910-1919 Residential Construction



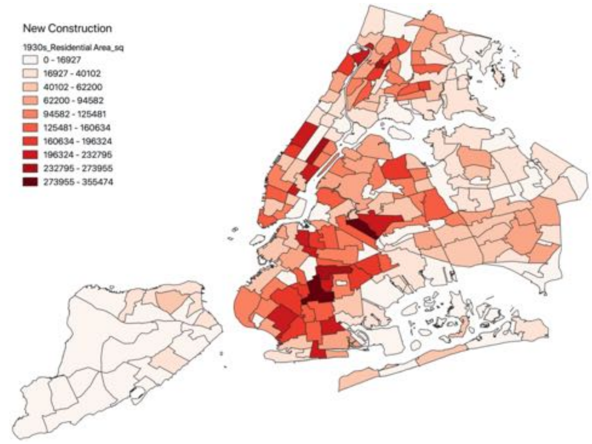
Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's Creation using the complete-count US Federal Demographic Census from 1870 to 1940.

Figure 28: New Construction of Residential-Use Land

(e) 1920-1929 Residential Construction



(f) 1930-1939 Residential Construction

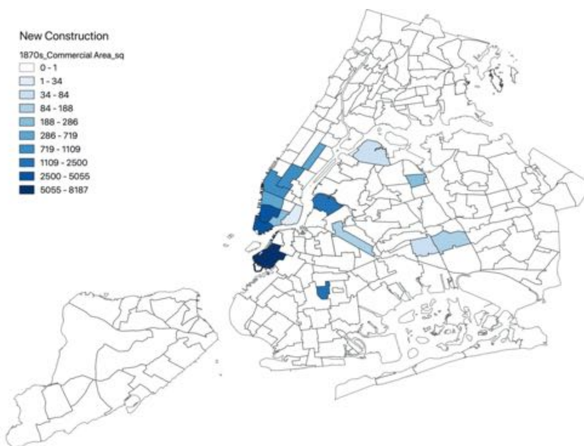


Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's Creation using the complete-count US Federal Demographic Census from 1870 to 1940.

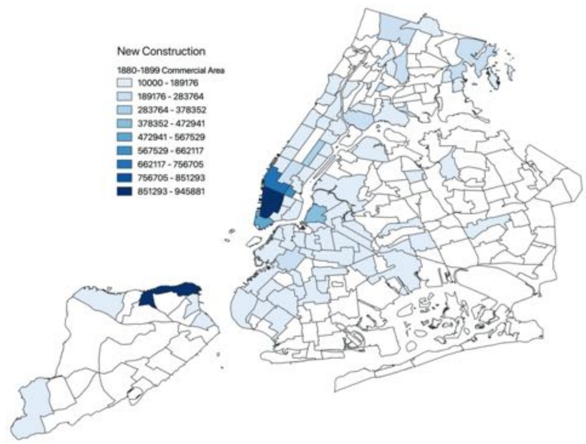
D.1.2 Commercial Land Use Construction

Figure 29: New Construction of Commercial-Use Land

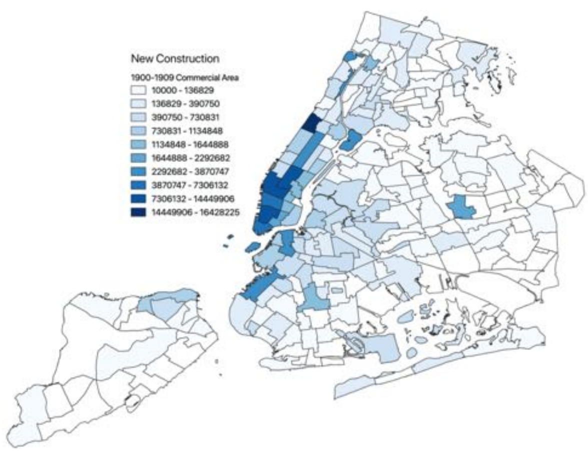
(a) 1870-1879 Commercial-Use Construction



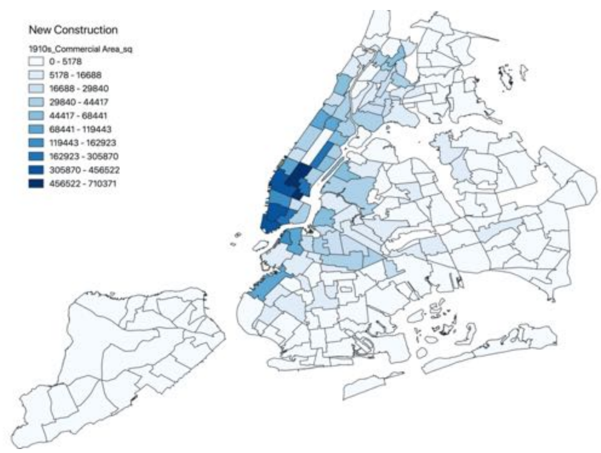
(b) 1880-1899 Commercial-Use Construction



(c) 1900-1909 Commercial-Use Construction



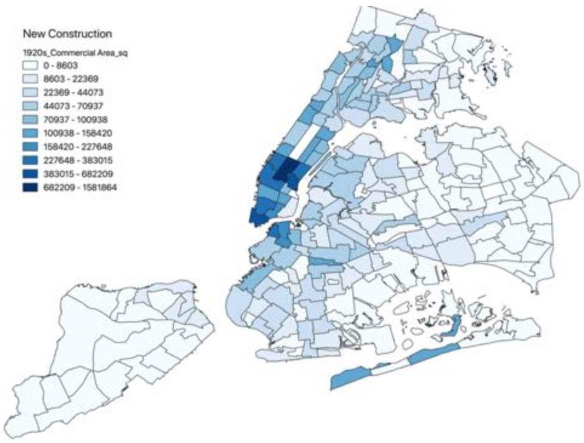
(d) 1910-1919 Commercial-Use Construction



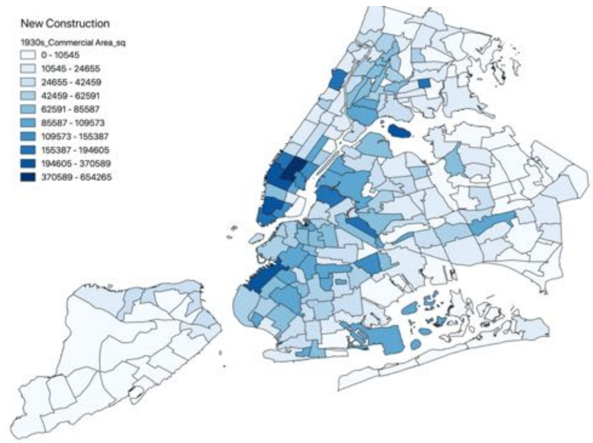
Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's Creation using the complete-count US Federal Demographic Census from 1870 to 1940.

Figure 29: New Construction of Commercial-Use Land

(e) 1920-1929 Commercial-Use Construction



(f) 1930-1939 Commercial-Use Construction



Note: The above figures show percent change of population density between two adjacent census periods. Source: Author's Creation using the complete-count US Federal Demographic Census from 1870 to 1940.

E Theoretical framework

In this section, I present the theoretical framework based on Allen and Arkolakis (2015), and Allen et al. (2018). This general equilibrium spatial framework features a dynamic setting where workers differing in skill and nativity choose where and how to migrate between different locations. This framework allows me to assess the welfare effects of transit-infrastructure driven market access improvement on workers with different nativity and skill in different locations.

E.1 Setup

Geography

There is a world comprised of a compact set $i \in \{1, ..., N\} \equiv \mathcal{N}$ of locations and inhabited by workers with different nativity n (foreign-born F, native-born U) and skills s(high skill h and low-skill l), each endowed with a unit of labor which they supply inelastically. Let $L_{it}^{n,s}$ denote the number of workers in location i of nativity n and skill s. In each location $i \in N$, the four type of workers combine their labor to produce a differentiated variety of good using a nested constant elasticity of substitution (CES) production function:

$$Q_i = (\sum_{s \in \{h,l\}} ((\sum_{n \in \{F,U\}} A_i^{n,s} (L_i^{n,s})^{\frac{\rho_s - 1)}{\rho_s}})^{\frac{\rho_s}{\rho_s - 1}}))^{\frac{\rho - 1}{\rho}})^{\frac{\rho}{\rho - 1}} \tag{1}$$

where $A_i^{n,s} > 0$ is the productivity of a worker of nativity n and skill s in location i, $\rho_s \geq 1$ is the elasticity of substitution across the nativity of workers of a skill s, and $\rho \geq 1$ is the elasticity of substitution across high-skill and low-skill workers.

Production

Workers in location i with (composite) productivity $A_i^{n,s} > 0$ earn an (endogenous) wage $w_i^{n,s}$. Product markets are perfectly competitive and a worker in location i of nativity n and skill $s$is paid a wage $w_i^{n,s}$ equal to her marginal product:

$$w_i^{n,s} = p_i \times (Q_i)^{\frac{1}{\rho}} \times ((\sum_{n \in \{F,U\}} A_i^{n,s} (L_i^{n,s})^{\frac{\rho_s - 1}{\rho_s}})^{\frac{\rho_s}{\rho_s - 1}})^{(\frac{1}{\rho_s} - \frac{1}{\rho})} \times A_i^{n,s} \times (L_i^{n,s})^{-\frac{1}{\rho_s}} \tag{2}$$

, where p_i is the equilibrium price of the differentiated variety produced in location i. Under perfect competition and production function above, $p_i$takes the following form:

$$p_i = (\sum_{s \in \{h,l\}} ((\sum_{n \in \{F,U\}} (A_i^{n,s})^{\rho_s} (w_i^{n,s})^{1-\rho_s})^{\frac{1}{1-\rho_s}})^{1-\rho})^{\frac{1}{1-\rho}} \tag{3}$$

where $P_i \equiv (\sum_{j \in N} (\tau_{ij} p_j)^{1-\sigma})^{\frac{1}{1-\sigma}}$ is the Dixit-Stiglitz price index, and $u_i^{n,s}$ is a type-specific amenity for each location.

Trade

As workers have CES preferences over varieties and each location produces a differentiated variety, workers will consume varieties produced in other locations. We assume that trade between locations is subject to "iceberg" trade costs such that $\tau_{ij} \geq 1$ units of a good produced in location $i \in S$ must be shipped in order for one unit to arrive in location $j \in \mathcal{N}$; As a result, the price of a differentiated variety from a location $i \in \mathcal{N}$ and in location $j \in \mathcal{N}$ is $p_{ij} = \tau_{ij} p_i$. Workers have CES preferences over varieties produced in all locations with elasticity of substitution $\sigma \geq 1$ and their indirect utility can be written as

$$W_i^{n,s} = \frac{w_i^{n,s}}{P_i} u_i^{n,s} \tag{4}$$

Given the setup of iceberg trade costs and perfect competition in the production market, gravity trade equation of the value of trade from location $i \in \mathcal{N}$ to location $j \in \mathcal{N}$, X_{ij}, can be written as:

$$X_{ij} = \tau_{ij}^{1-\sigma} (p_i)^{1-\sigma} P_j^{\sigma-1} E_j, \tag{5}$$

where E_j is the total expenditure in location j.

E.2 Migration

E.2.1 Migration decision on which labor market to face

The movement of people across locations are also subject to "iceberg" frictions. For simplicity, we take the initial distribution of heterogenous workers with different nativity and skill $\{L_{i,0}^{n,s}\}$ as exogenous and treat the migration decision as static. Then, a continuum of heterogenous workers $\nu \in [0, L_{i,0}^{n,s}]$ choose where to live in order to maximizer her welfare:

$$U_i^{n,s}(\nu) = \max_{j \in \mathcal{N}} \times \frac{W_j^{n,s}}{\mu_{ij}^{n,s}} \times \varepsilon_{ij}^{n,s}(\nu), \tag{6}$$

where $\mu_{ij}^{n,s} \geq 1$ is a migration friction common to all workers moving from location $i \in \mathcal{N}$ to location $j \in \mathcal{N}$ of type $\{n, s\}$, and $\varepsilon_{ij}^{n,s}(\nu)$ is a migration friction idiosyncratic to workers νdrawn from an extreme value (Fréchet) distribution with shape parameter $\theta^{n,s} \geq 0$. We assume that amenity of a particular place depends on an exogenous term and the local population:

$$L_{ij}^{n,s} = \left(\mu_{ij}^{n,s}\right)^{-\theta^{n,s}} \left(\frac{w_j^{n,s}}{P_j} u_j^{n,s}\right)^{\theta^{n,s}} \left(\Pi_i^{n,s}\right)^{-\theta^{n,s}} \left(L_{i,0}^{n,s}\right), \tag{7}$$

where $\left(\Pi_i^{n,s}\right) = \left(\sum_{j \in \mathcal{N}} \left(\mu_{ij}^{n,s}\right)^{-\theta^{n,s}} \left(W_j^{n,s}\right)^{\theta^{n,s}}\right)^{\frac{1}{\theta^{n,s}}}$.

Equation 7 is a gravity equation for migration: all else equal, there will be greater flows from location $i \in \mathcal{N}$ to location $j \in \mathcal{N}$ of type $\{n, s\}$ the lower bilateral migration costs of workers with nativity n and skills s, $\mu_{ij}^{n,s}$, the higher type-specific amenity in location $j \in \mathcal{N}$ for workers with nativity and skill pair $\{n, s\}$, $u_j^{n,s}$, the higher real wages in location $j \in \mathcal{N}$ for workers with nativity and skill pair $\{n, s\}$, $\frac{w_j^{n,s}}{P_j}$.

E.2.2 Neighborhood decision and commuting costs

Suppose now that the heterogenous workers with different nativity and skill choose which neighborhood to live ($k \in \mathcal{K}$), conditional on working in region j. All neighborhoods $k \in K$ are regions such that commuting to location j is feasible, with commuting cost κ_{jk}. Under the Cobb-Douglas preferences, worker preferences are defined over consumption goods and residential floor space, with the indirect utility for a worker $\nu \in [0, L_{i,0}^{n,s}]$ residing in ($k \in \mathcal{K}$), working in j is:

$$U_{jk}^{n,s}(\nu) = \max_{k \in \mathcal{K}} \times \frac{w_j^{n,s} u_k^{n,s}}{\kappa_{jk} P_k Q_k} \times \varepsilon_{jk}^{n,s}(\nu), \tag{8}$$

$$W_j^{n,s} = E_K U_{jk}^{n,s}(\nu) = \left[\sum_{k\in\mathcal{K}} \left(\frac{w_j^{n,s} u_k^{n,s}}{\kappa_{jk} P_k Q_k}\right)^{\Theta}\right]^{\frac{1}{\Theta}}$$

P_k is the price index for consumption goods; Q_k is the price of floor space, $w_j^{n,s}$is the wage of workers with nativity and skill $\{n,s\}$,κ_{jk} is an iceberg commuting cost between region j and neighborhood $k \in K$, and commuting costs are same across workers with different nativity and skill, and $\varepsilon_{jk}^{n,s}(\nu)$ is an idiosyncratic amenity draw that captures all the idiosyncratic factors that cause an individual to live and work in particular locations within the city, and $\varepsilon_{jk}^{n,s}(\nu)$ is a commuting friction idiosyncratic to workers νdrawn from an extreme value (Fréchet) distribution with shape parameter $\Theta \geq 0$.

where $\left(\Pi_i^{n,s}\right) = \left(\sum_{j\in\mathcal{N}} \left(\mu_{ij}^{n,s}\right)^{-\theta^{n,s}} \left(W_j^{n,s}\right)^{\theta^{n,s}}\right)^{\frac{1}{\theta^{n,s}}}$.

E.3 Equilibrium

Given a geography of the world, the model elasticities, and the initial distribution of population $\{L_{i,0}^{n,s}\}$, the equilibrium of the model is defined by a set of location observables such that:

1. (Law of Motion of Migration) Given wages and the price index, the number of workers of different nativity n (foreign-born F, native-born U) and skills s in each location is equal to the total flows of workers to that location:

$$L_{ij}^{n,s} = \left(\mu_{ij}^{n,s}\right)^{-\theta^{n,s}} \left(\frac{w_j^{n,s}}{P_j} u_j^{n,s}\right)^{\theta^{n,s}} \left(\Pi_i^{n,s}\right)^{-\theta^{n,s}} \left(L_{i,0}^{n,s}\right),$$

2. Given the number of workers in each location, the quantity of produced of the differentiated variety in each location takes the production function from Equation 1

3. (labor market clearing) Given the number of workers in each location, the equilibrium price and quantity produced of the differentiated variety, the equilibrium wage of each type worker with nativity and skill pair $\{n,s\}$ in each location is equal to its marginal product, as in Equation 2

4. (balanced trade) Given the quantity produced of the differentiated variety in each location, equilibrium prices are determined by the income and expenditure of a location being equal to its total sales:

$$p_i Q_i = \sum_{j\in\mathcal{N}} \tau_{ij}^{1-\theta} p_i^{1-\theta} P_j^{\sigma-1} p_j Q_j$$