Public housing design, racial sorting and welfare: Evidence from New York City public housing 1930-2010*

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Abstract

This paper investigates the long-run effect of public housing project design on neighborhood composition and rental prices in New York City from 1930 to 2010. Using a newly assembled dataset on the US census tract level and leveraging the staggered rollout of public housing, I document sizeable effects on racial composition. White population declined in tracts with public housing projects with significant spillover effects to adjacent tracts, while black population increased but only in public housing tracts. The effects on white and black population are driven by a specific project type called the "Tower in the park" – slim brick high-rises and vast green spaces in between. Falling rent prices around "Towers" indicate negative demand effects. In a cross-sectional analysis, I find that "Towers in the Park" are more associated with higher incarceration rates than non-towers, though incarceration rates cannot entirely explain spillover effects on white population. Finally, I evaluate the welfare consequences of these externalities using a static neighborhood choice model. The model demonstrates that removing public housing can increase amenity values and improve welfare. I find that these welfare gains can be explained by "Tower in the park" demolitions. This suggests that building design can mitigate negative externalities of public housing.

Keywords: Urban Economics, Public Housing, Externalities.

JEL codes: N92, O18, J15

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1 Introduction

Public housing programs aim to provide affordable housing to low-income households. However, as place-based programs, public housing projects can significantly impact their surroundings and play a crucial role in shaping neighborhoods. These housing externalities can alter the appeal of neighborhoods, and individuals with varying preferences may choose different locations based on these changes. Consequently, public housing can influence the local composition of residents. One argument concerning how these projects affect neighborhoods centers on building design, specifically the "Tower in the Park" concept – slender high-rises surrounded by extensive green spaces, which became emblematic for public housing in the United States (Plunz, 2016). Influential figures like Jane Jacobs and Oscar Newman notably criticized this design, contending that it inadvertently led to crime-ridden and lifeless environments due to the un-policeable indoor and outdoor spaces within these projects (Jacobs, 1992, Newman, 1997). In this paper, I study how the architectural layout of public housing projects in New York City from 1930 to 2010 generated externalities that impacted the racial composition of neighborhoods, rental rates, and welfare.

I establish a causal relationship between public housing construction, racial sorting, and rents.[1] The challenge in establishing causation lies in the circular relationship between public housing and the characteristics of the areas where it has been constructed. To address this, I leverage the staggered implementation of public housing projects across the city, employing a stacked difference-in-difference design following the methodology outlined by Blanco and Neri (2023). This framework utilizes the distance to public housing projects as a measure of treatment intensity, allowing for the estimation of disparate effects on rents and demographic outcomes. Specifically, treatment is defined at the census tract level. Outcomes in tracts near public housing projects are compared to slightly more distant tracts.

I assemble a novel panel dataset at the census tract level for New York City, combining newly digitized historical records with data from the US Census. I collect and digitize rental prices from the New York Times real estate section and information about New York City Housing Authority (NYCHA) projects from historical documents and the NYCHA development data books. Additionally, cross-sectional data on tract-level incarceration rates serve as a proxy for crime. Harmonizing census tracts to 2010 boundaries results in a balanced panel dataset covering 2,164 census tracts for each of the nine census years from 1930 to 2010.

Neighborhoods experience significant socioeconomic changes due to public housing. White pop-

[1] The study of public housing demolition dates back to the early stages of initiatives like the Moving to Opportunity projects. This body of literature centered around Chicago indicates moderately positive impacts from public housing demolition, particularly for residents and minority populations (Jacob, 2004, Chetty et al., 2016). More recent research has extended its scope to examine the consequences of demolitions on a broader range of outcomes, including rental rates and construction trends. It is important to acknowledge that studies involving alternative forms of affordable housing provision, such as the Low-Income Housing Tax Credit Scheme, housing vouchers, or mixed-income redevelopment, may not be directly comparable to the traditional government-operated public housing model.

ulation declinesned by 23% in treated tracts in the medium run (0-30 years) and further by 78% in the long run (40-60 years). Moreover, I find significant spillover effects, leading to an 18% medium-run decline of white population in adjacent areas and a 29% decline in the long run. In contrast, black population increases by up to 73% (0-30 years) and 54% (40-60 years) in treated areas, with no significant spillovers. Turning to property level renral prices, I find no statistically different effects on rent prices. However, I do not observe rent reductions at any distance.

Furthermore, I provide new evidence that these effects are driven by specific project types, namely "Towers in the Park". In line with the predictions of Jacobs (1992) and Newman (1997), I find that white population declines significantly in tracts with a "Tower"[2] (-79%) and adjacent tracts (-36%), while the effects for non-tower buildings are considerably smaller. Rent prices within "Tower" tracts also experience substantial declines, indicating negative demand effects, whereas price effects for non-tower buildings are minimal. Rents fall by 30% (0-30 years) and by 21% (40-60 years) in "Tower" tracts and by 16% in the long run around "Tower" buildings. Moreover, I do not find significant effects of changes in black public housing residents as drivers of white population losses in treated and adjacent tracts, ruling out potential tipping effects.

To delve deeper into the mechanisms, I conduct a cross-sectional analysis using 2010 incarceration rate data. This analysis reveals that "Tower in the Park" projects have higher crime rates than non-tower projects, although there is no evidence of spillover effects. However, I find supporting evidence that a one percent increase in "Tower"-incarceration rates leads to a fall of .21% in the white population within treated tracts, suggesting that stigma associated with "Tower"-style projects may render nearby neighborhoods unattractive (Tach and Emory, 2017).

To understand welfare implications, I incorporate these findings into a static model of neighborhood choice following Bayer et al. (2007), Almagro et al. (2023) which allows households to sort into neighborhoods based on preferences for public housing type. This assessment informs current policy debates centered around two questions: Should we continue public housing, and if so, what kind of public housing should be developed? The objective here is to study counterfactual szenarios where I modify the characteristics of public housing. This exercise aims to provide policymakers with insights into the effects of different public housing designs.To carry out this analysis, I need to empirically estimate preference parameters, which cannot be recovered from the difference-in-difference design. In the model, I recover the preference parameters by instrumenting all endogenous variables with tract characteristics 1.5 to 2.5 miles away from a given tract. I use these parameters and the structure of the model to estimate the change in welfare from two counterfactual scenarios. Welfare is then expressed as a rent equivalent, which is required to make households in the counterfactual

[2] Jacobs (1992) never provided a clear definition of what a "Tower in the Park" is. In Section 5.1, I use the two distinguishing criteria: it must be of sufficient height with a sufficiently low ground coverage. I establish a threshold for the height of 7.9 stories using the New York Department of Buildings requirements. To determine a threshold for ground coverage, I use the average of 23% across public housing projects. Moreover, I show that only considering quality and importance - proxied by area share - yields results that explain spillovers.

scenario indifferent to the actual scenario. The rent equivalent is given in dollars per month.

In the first scenario, I eliminate all public housing projects, assuming all units in the city become private. Over time, welfare gains decline and stabilize after 1970, settling at approximately \$200 for White households and \$400 for Black households. The model also sheds light on how welfare is generated without public housing. Welfare gains are most pronounced in treated tracts and lowest in the second neighborhood ring. In contrast, rent prices are lower in the counterfactual scenario, particularly in the second ring. Consequently, the demand for distant locations decreases when public housing is removed, leading to welfare gains in remote areas due to reduced rental costs. Residents in public housing tracts benefit primarily because they have a stronger preference for not living in close proximity to public housing projects.

In the second scenario, I explore the removal of "Tower in the Park"style public housing. I calculate rent equivalents by considering household preferences for both "Tower" and non-tower projects. Removing "Towers" results in welfare improvements of \$72 for Whites and \$161 for Blacks. Conversely, removing non-tower buildings has considerably smaller effects, with welfare gains of \$30 for White households and \$69 for Black households.

Note that while the removal of both types of public housing leads to welfare improvements, the largest gains are associated with the elimination of "Towers." These findings indicate that revamping "Tower in the Park" style public housing can enhance the overall quality of life in neighborhoods. For instance, redeveloping these projects and their surrounding areas by adding more private or mixed-income units or integrating them into the existing urban fabric through architectural modifications could be viable solutions. However, it's crucial to weigh the feasibility of such initiatives against the benefits they bring to the community.

This paper contributes to three broad literatures. Firstly, it aligns with the literature investigating the external impacts of affordable or subsidized housing construction. Two key findings from this literature are worth noting. In the context of public housing demolitions in Chicago, previous studies have identified significant positive effects. Within a quarter-mile radius of demolition sites, all types of serious crimes decreased by 8.8%, with this effect diminishing as distance from the demolished projects increased (Sandler, 2017). Additionally, house prices and rents increased by up to 20% over the ten years following the demolition. Furthermore, in the long run, residents were less likely to be low-income and black (Blanco, 2022). Secondly, within the context of affordable housing construction, there are considerable amenity effects. Low-Income Housing Tax Credit (LIHTC) developments or the transition to mixed-income housing, can attract higher-income homebuyers in low-income areas Diamond and McQuade (2019), Blanco and Neri (2023). In New York City, subsidized housing has generated significant price appreciation in the immediate vicinity (Schwartz et al., 2006). Federal public housing constructed between 1977 and 2000 has not typically led to reductions in property values (Ellen et al., 2007).

My paper contributes to this literature in two distinctive ways. Firstly, it takes a long-term perspective by studying the introduction of public housing from 1930 to 2010. The results indicate that the effects for "Tower in the Park" style projects are symmetric to results obtained from the demolition in public housing. Secondly, I explore the role of heterogeneous building design, a departure from previous literature that assumes homogeneity. I demonstrate that low-scale projects integrated into the urban fabric can have minimal environmental consequences. Given that "Towers" were primarily constructed between 1940 and 1970, while low-scale projects came afterward, this finding aligns with the conclusions of Ellen et al. (2007).

Another related area of research explores how historical factors shape cities and towns. Two papers closely related to mine are those by Dalmazzo et al. (2021) and de Bromhead and Lyons (2022), which investigate the effects of historical housing policies on population dynamics and their consequences. In a broader context, geographic features, transportation infrastructure, or disruptive events like wars and catastrophes can have enduring effects on agglomeration and population (Bleakley and Lin, 2012, Ager et al., 2020, Heblich et al., 2020, Dericks and Koster, 2021). My contribution to this literature is by utilizing public housing as a population-shifting mechanism to odentify neighbohood effects. It directed demand away from certain areas and altered the composition of those areas. Additionally, I contribute by assessing the causal effects of public housing in the context of America's largest city.

Finally, my paper adds to the literature that employs structural models to investigate the effects of urban policies. Previous studies have examined the causes of geographic racial segregation, including theoretical models of segregation, measurements of segregation indexes over time, and estimations of tipping points and White flight (Schelling, 1971, Cutler et al., 1999, Logan and Parman, 2017, Card et al., 2008, Lee, 2022, Boustan, 2010). In this sense, public housing in NYC can be seen as causally accelerating existing pattern of segregation on a more granular spatial scale. I contribute to this literature by building upon the frameworks of Bayer et al. (2007) and Almagro et al. (2023). My paper complements these previous approaches by examining the location choices of ethnic groups due to heteringenous preferences over buildig design. Importantly, I can rule out effects due to changes in resident composition. To recover choice parameters, I utilize plausibly exogenous changes in tract exposure to public housing and residents in public housing.

The paper proceeds as follows; Section 2 provides details on the historical context and describes the data. Section 3 introduces the empirical analysis. In Section 4, I estimate the long run effects of public housing. In Section 5, I estimate the effect of "Tower in the Park" style structures. Section 6 introduces the theoretical model and the estimation procedure of the model's parameters. Lastly, Section 7, details the counterfactual mechanism and presents welfare estimates for black and white population.

2 Context and Data

In this section, I describe the historical context, highlighting the most important events that characterize the development of public housing and racial dynamics of racial segregation in New York City. Then, I provide a quick overview of the primary data used in the analyses and their sources.

2.1 Background

U.S. public housing construction began in response to the Great Depression, as economic stimulus by the Public Works Administration (PWA) in 1933. While the primary goal of the PWA was job creation in construction, its second objective was slum clearance. Both objectives of public housing construction were emphasized in the Housing Act of 1937, which aimed to combat "unsafe and unsanitary housing conditions" by creating the U.S. Housing Authority to fund local housing projects (Allen and Van Riper, 2020, Radford, 2008, Fogelson, 2003).

New York City emerged as a pioneer in public housing starting in 1936. By 1940, New York City accounted for over a quarter of all U.S. public housing units. These projects, managed and developed by the New York City Housing Authority (NYCHA), aimed to replace and remodel slums with well-maintained housing complexes. Newly constructed projects were mainly low-rise buildings and remained within the existing's 19th and early 20th-century building environment (Williams (2014), Bloom (2008), Marcuse (1986) and Figure 23). For this project, I only consider governmentally run affordable housing construction among the various types of provision due to its scale and physical attributes[3]. In addition to increasing neighborhood quality, projects were subject to the racial prejudices of their times, which is reflected in the struggle to accept only tenants of certain status and color. Screening measures ensured tenants were married couples with two children and an employed head of household, and projects were largely segregated to keep them appealing to white residents (Allen and Van Riper, 2020, Bloom, 2008, Marcuse, 1986, Vale and Freemark, 2012).

After World War II, the U.S. faced a housing shortage, exacerbated by returning servicemen. In response, the 1949 Housing Act aimed to ramp up public housing construction, while slum clearance remained a major objective under Title I[4]. Between 1950 and 1970, New York experienced a surge in public housing, surpassing pre-war era construction with 72,499 units in the 1950s and still 42,721 units in the 1960s. This amounted to 25% of all units built in New York City in the 1960s.

[3]In addition to public housing, New York City experimented with publicly subsidized affordable housing called "The Mitchell-Lama" program enacted by state law in 1955. It should encourage developers to build affordable middle-class housing and to stem middle-class flight out of New York City. In exchange, developers were granted low-interest loans or real estate tax benefits. From 1950-1970, New York's public housing construction surpassed those from the Mitchell-Lama program. (Woodfill, 1971).

[4]It is worth emphasizing that Robert Moses, who chaired the Mayor's Slum Clearance Committee, wielded considerable authority in New York's urban renewal initiatives. Nevertheless, the extent of his involvement in the housing program is less thoroughly researched (Caro, 1975).

During this time, project design shifted to slim high-rises surrounded by open areas, which became known as the "Tower in the Park" architectural style (Plunz, 2016). This change in building type is characeterized by a decrease of ground coverage from 27% to 15%, while the average project height increased from 5 to 16 stories. Construction costs per room remained low at $17,317 (in 2010 $) in both decades, well below the $26,783 of pre war projects (see Figure 23). Also during this period, the demographics of public housing residents underwent a significant shift. As New York City's population shifted towards urban immigrants, more than half of all newly developed projects were allocated to Blacks and Hispanics from 1950 to 1970. By Dec. 1971, it became apparent that Whites were leaving public housing projects (Friedman, 1966). Thus, projects played a crucial role in influencing changes in the spatial distribution of New York's population. In 1950 a tract with a public housing project was having on average 4,577 Whites, 1,453 more than the average tract in the rest if the city. In 2000, there were on average 717 Whites, 636 less than average tract in the rest of New York (For more details see Figure 21a and Figure 24).

Demographic shifts and the "Tower in the park" design garnered criticism and reduced public support. Famously, Jane Jacobs and Oscar Newman blamed the "Tower in the Park" as an utopian idea that generates crime-driven and unlively places by having large, un-policeable indoor and outdoor spaces, lacking potential care of residents and shop-owners (Jacobs, 1992, Newman, 1997). Rising opposition resulted in a policy shift at the local level in favor of low-density public housing in middle-income neighborhoods (Clapp, 1976).

In the early 1970s, federal support for public housing experienced a decline. The Housing and Community Development Act of 1974 notably reduced funding for new public housing construction and instead favored market- and income-based affordable housing provision (Vale and Freemark, 2012). During this period, the challenges associated with public housing became increasingly apparent. Residents reported rising crime rates and noticeable deterioration of housing stock throughout the 1970s (Bloom, 2008).

By the 1980s, there was a notable shift in focus towards community-based organizations and market-oriented subsidies, such as the Low-Income Housing Tax Credit (LIHTC). As a result, public housing programs were left to manage existing units, leading to rapid deterioration and mismanagement. In New York City, this era saw a sharp decline, both absolutely and relatively, in public housing construction. The few projects that were constructed tended to be low-rise and often consisted of single houses (Wyly and DeFilippis, 2010). Towards the end of the 1980s, a national commission identified severely distressed public housing units, prompting the implementation of the HOPE VI Program in 1993. HOPE VI aimed to address this issue by either demolishing, rehabilitating, or rebuilding these units. Nationwide, from 1993 to 2010, approximately 97,000 units were demolished, with residents relocating to other public housing or receiving housing vouchers. In New York, although HOPE VI was utilized to a limited extent, it had a significant impact, with Prospect Plaza in Brooklyn being the first NYCHA development to undergo demolition under the program in 2005 (Goetz, 2012, Fernandez, 2010).

2.2 Data

I assemble a spatially disaggregated data set on public housing in New York City from 1930 to 2010. The primary data source for New York City is the United States population census, which I augment with data on public housing projects and the construction environment in 2002 and 2010.

Demographic information The basis for the analysis are historical data on New York City from the United States federal census from 1930 to 2010 on census tract level. The outcome variables of interest from the census are demographic tract characteristics such as total, white and black population[5] Using information on public housing residents in a tract in each year from the NYCHA development dat book allows me to distinguish between private residential population. A challenge when building a geographical panel level data set are boundary changes over time. Census tract boundaries experience substantial changes throughout most of the 20th century, especially for Brooklyn, Kings County and Queens County. Therefore, I adjust the earlier tracts to 2010 census tract boundaries using overlapping area weights to obtain a balanced panel. A potential drawback of this procedure is that it assumes tract-level observations are uniformly spatially distributed. I check the robustness of this approach by comparing population statistics on Borough level to the reweighed series on Borough level. For most of the Borough deviation from the Borough average in small and mainly a problem for the year 1940. For this year the census reports population counts for health districts instead of census tracts in NYC. Details of these procedures and sources are available in Appendix C.3.

Housing market outcomes I use the housing unit counts in the federal census to measure housing stock. As discussed above, housing counts have been reweighed by overlapping area weights and in Appendix C.3. Information on the number of public housing units obtained from the NYCHA development data book allows me to distinguish between private construction within a tract and public construction. To obtain private market rental information, I digitize rent prices and ask price levels from the New York Times real estate section for each decennial census year from 1930 to 2010 to investigate how public housing affected rents. Only properties for which exact address or cross-street information was available have been used to ensure the correct geolocation, and the Google Maps API has been used to geocode the rental data. Moreover, listings were required to have at least information on dwelling size. Using property-level rent data has come at an advantage

[5]Only population, median contract rent, ownership, and black and white population are consistently available from 1930 to 2010. Other variables such as median home values, dwelling counts and unemployment are available from 1940 onwards. There are two reasons that prevent me from including median contract rent as an outcome variable.

and a cost. First, it avoids the drawbacks of the census dataset. The census data are generally top-coded and only allow respondents to select given price ranges, though this varies across years. Moreover, the reported median contract rent on the tract level likely captures the rent paid in a public housing unit rather than market rents. The cost of using newspaper data, notably the New York Times, is twofold. First, given the nature of the New York Times as an upper-middle-class newspaper, properties in there may not be a representation across all market segments and are biased towards the upper end of the market. However, any newspaper does not cover the bottom end of the market. Second, a considerable drawback of this data is that it is biased towards Manhattan, and only specific areas like Midtown or the Upper West and East Side are continuously covered. Appendix B Figure 15 shows the spatial extent of the data and the location of tracts with public housing units. Another drawback of the rent is that it reflects the upper end of the market instead. Therefore, the results would only be representative of a subset of the real estate market. I show the full description of the collection procedure, summary statistics, and an example image of the source in Appendix C.2, Table 8 and Figure 25b.

Public housing characteristics I amend the census data with information on public housing projects from 1936 to today, which allows testing for potential channels through which public housing could affect its neighborhoods. I obtain this information from the NYCHA Development Data Book, available annually from 1948 to today. It provides information on funding sources, population, size, rent per room, type of development, construction and development costs of each project, and the construction date. Information for the year 1940 in the NYCHA Development Data Book is inferred from archival sources from the Wagner and LaGuardia Archives. Moreover, I augment this data with information on racial composition, such as the number of white, black, Hispanic, and Chinese residents of the projects obtained from the Wagner and LaGuardia Archives for all projects constructed until 1971. I spatially match public housing projects with 2010 census tracts to obtain the area share of a tract designated for public housing. However, this results in some projects being situated in two tracts because of their size. To adjust for this, I reweigh our demographics, apartments, and ground coverage by the area of the given project part as a share of the total project area. Finally, I obtained information on maintenance requirements for NYCHA developments in US dollars for 2011. An example of race statistics is shown in Figure 25.

Crime To identify potential disamenity effects generated by public housing, I obtain 2020 tract-level State incarceration rates. These data have been sourced from the New York State prison population numbers, and incarceration rates at the census tract levels are from the Prison Policy Initiative (PPI). They reflect the number of individuals incarcerated in a New York State prison during the 2010 census count. Only individuals with a valid New York State address were allocated to their residential census tract prior to imprisonment. Consequently, neighborhood incarceration rates are derived from the census tract of residence before incarceration, independent of the prison's location. Figure Figure 17 in Appendix B illustrates the geographic dispersion of incarceration rates.

Sample The final sample consists of a panel of 2164 census tracts based on 2010 tract boundaries per year from 1930 to 2010. The final set has 225 public housing tracts and ca. 1,500 rental observations per year. All prices and costs had been deflated by the CPI deflator and normalized to the 2010 CPI level. Summary statistics are provided in Appendix C. The following section describes the empirical strategy to estimate the causal effects of public housing and further transformations of the data.

3 Empirical Strategy

In order to estimate the long-term effects of public housing on population and rents, I use a difference-in-differences strategy, leveraging the variation in the timing of public housing project construction across the city (as shown in Figure 12). I use census tract-level outcomes as well as property-level rental data. Specifically, I assign treatment at the tract level based on whether or not a tract had a public housing project in at least one census year. This allows me to compare population changes and rents over time between tracts with and without public housing projects. In a complementary step, I use distance rings around each public housing project to use property-level rental data. I use the completion date as the relevant event triggering the effect, as commonly used in the literature (Asquith et al., 2023, Pennington, 2021).[6]

The primary challenge in the empirical analysis is to select a plausible comparison group that accurately reflects what would have happened to housing and other outcomes in the absence of public housing. Ideally, one would conduct an experiment randomly assigning public housing projects to census tracts. However, such an experiment is not feasible. Instead, I must address the concern that the allocation of public housing across the city can be correlated with pre-construction tract and household characteristics. For example, construction sites were chosen based on the price of land and the population density, which makes such tracts more likely to be selected for construction than those without. Another challenge derives from the allocation procedure of NYCHA. Anecdotal evidence suggests that NYCHA selected its tenants from nearby areas rather than considering their location choices (Goodman, 2019). Thus, given that I am interested in the ethnic composition of the population as the outcome variable, I have to rule out mechanical changes in population com-

[6] Since I use decennial census years, the first time a project is observed after completion is at the end of the corresponding decade. For example, projects completed from 1961 to 1970 will be observed as treated in 1970. Thus, treatment effects in a given census year are a weighted average of all projects within a given treatment year cohort or period.

position at the neighborhood level – larger than tracts – stemming from the ethnic composition of the projects themselves. To overcome this issue, I utilize a stacked difference-in-differences design following Blanco and Neri (2023) that uses the variation in proximity to public housing projects to define the comparison group. This approach assumes that proximity determines the intensity of treatment.

I use rings made up of census tracts. Because tracts have fixed boundaries, proximity is defined by being adjacent to a public housing project. I construct two rings of tracts around each treated tract. The outer ring serves as the comparison group to treated tracts and tracts in the inner ring. Treated tracts have been excluded from any other first or second ring, such that the control group of each treated tract solely consists of never-treated tracts. Figure 14 in Appendix B illustrates the spatial layout of fixed tract rings. For property level rental data I match geocoded properties with the corresponding tracts.[7]

The identifying assumption is that, in the absence of public housing, the outcome of interest would have changed similarly in both rings. In other words, the only difference between units in the inner and outer rings, after controlling for observables, is their distance to the projects because they belong to the same neighborhood. Furthermore, because proximity determines treatment intensity, tracts that are sufficiently far away (the outer ring) should not have been affected by public housing. I generate a dummy for each ring dummy and interact with those with dummies for each pre and post-treatment year for the corresponding project. Finally, all tract information are appended to each project ring for the given census years. The control group consists of census tracts in the second neighbor-ring.[8] Property level rental data are matched with 2010 census tratcts in each census year. I estimate the following event study equation at the census tract/property m, project p, and year t level:

$$y_{m,p,t} = \sum_{r \in R} \sum_{\tau=-60}^{60} \beta_{\tau,r} \left(t - Y_p, r = r(m,p)\right) + \delta' \mathbf{X_{m,p,t}} + \rho_{p,t} + \zeta_{p,r(m,p),c} + u_{m,p,t} \tag{1}$$

The parameter of interest, denoted as $\beta_{\tau,r}$, captures the effect of the arrival of public housing on demographics and rents over time in each treated tract, relative to tracts in the outermost rings. I interact each time dummy with an indicator for the ring $r(m,p)$ in which a tract or a housing unit

[7] I also estimate the effect on property-level rental data using rings around each public housing unit and match properties to the corresponding ring. Under both approaches, tracts and properties will appear several times in different rings around different projects due to the overlapping nature of rings. Figure 14 in Appendix B illustrates the spatial layout of fixed tract rings and the distance rings for two public housing projects.

[8] The validity of this strategy requires that demographics and rents are as good as randomly distributed across control and treatment, conditional on observed neighborhood characteristics. I test this assumption by checking whether there are significant differences in the porbability of being treated between the treatment and control group based on the outcome variable. I regress a dummy equal to one for being treated and zero for being in the second ring on the outcome variables. I report these balance tests in Appendix C **??**. Using a set of fixed effects a one percent increase of total population and white has no effect on the probably being treated. However, there is a positive and significant effect for Blacks. Therfore, I control for black population at the baseline. These results are confirmed using a non-stacked panel of census tracts in Table 5.

m around project p is located. Y_p denotes the year when a project p was completed and the set of rings is defined as $R = \{Treated, 1string\}$.[9]

Project-specific controls are included to capture variations in the evolution of outcome variables across rings for each project. Project-census year fixed effects ($\rho_{p,t}$) account for time patterns across all rings surrounding each project p, while project-ring-neighborhood (NTA) fixed effects ($\zeta_{p,r(m,p),c}$) control for baseline differences of tracts across each ring, allowing for differences among tracts located in the same neighborhood but on opposite sides of a ring. This pattern is similar for property level outcomes only that I control for project-ring-tract fixed effects ($\zeta_{p,r(m,p),c(m)}$).

Using tract level analysis I only control for the outcome variable at baseline. For the porperty level data, I control property characteristics.[10] Allowing controls ($\mathbf{X_{m,p,t}}$) to vary by project, $\beta_{\tau,r}$ becomes a weighted average of project-specific treatment effects. This is achieved by running Equation 1 separately for each project and then aggregating the coefficients using regression weights.[11] This design involves stacking multiple difference-in-differences analyses together to estimate treatment effects across various subgroups, thereby improving the accuracy and robustness of the estimates. Recent studies have shown the effectiveness of this approach in dealing with heterogeneous treatment effects, highlighting its potential as a valuable tool for researchers and practitioners in various fields. Specifically, project years are weighted equally; within each project year, every census tract is given equal weight. Standard errors are clustered at the neighborhood (NTA) level for census tracts and the project level for the project regression.[12]

Additionally, I estimate a version of Equation 1 that aggregates post-treatment event year dummies into a medium and long run interval: $Post0-30$ (0 to 30 years) and $Post40-60$ (40 to 60 years). This division allows me to obtain more informative DiD estimates. Pooled effects will net out potential spikes or confidence and are based on the fact that effects for demographics and rent often materialize in the urban context. The following estimation equation aims to capture such differential effects over time:

$$y_{m,p,t} = \sum_{r \in R} \left(\theta_{0r} Post^{0-30}_{p,t} + \theta_{1r} Post^{40-60}_{p,t}\right) \times \mathbb{1}(r = r(m,p)) + \delta' \mathbf{X_{m,p,t}} + \rho_{p,t} + \zeta_{p,r(m,p),c} + u_{m,p,t} \quad (2)$$

[9] Instead of using census tracts, I also use flexible distance rings around projects to utilize the granularity of the property level rental data. I use 250m, 300m, 350m and 400m radii. The sets of rings for alternative radii are $\{0-250m, 250-500m\}$, $\{0-300m, 300-600m\}$, $\{0-350m, 350-700m\}$ and $\{0-400m, 400-800m\}$. Properties in the third ring are the omitted category.

[10] As controls, I include the number of rooms and dummies if a dwelling was furnished and had AC, water, or heat included in the rental price.

[11] A stacked difference-in-differences design is a reliable approach for accounting for heterogeneous treatment effects, something traditional difference-in-differences estimators may not be able to handle effectively (Callaway and Sant'Anna, 2021, Sun and Abraham, 2021, Borusyak et al., 2021).

[12] In Appendix D.4, I report effects using a basic event study in a panel set-up. I compare treated to control areas in this set-up, excluding the first ring around projects. I report estimates using a doubly robust DiD estimator following Sant'Anna and Zhao (2020).

I report results from estimating Equation 2 in Apopendix D.1.

Nevertheless, this estimation strategy has a significant limitation that needs to be addressed. Namely, I do not consider general equilibrium effects, whereby projects could affect rents and population across the city. Projects can make neighborhoods more or less attractive than others, reducing or increasing the demand for different ethnic and income groups. Additionally, projects can increase the housing supply of low-income housing in the city. The aggregate effect on the city level should be minor, with the most significant impact being concentrated close to the projects. In the face of population effects, a concern with this strategy could be that individuals sort themselves in nearby areas, which would violate the Stable Treatment Unit Value Assumption (STUVA). In Appendix C Figure 21b, I show the deviation of the primary outcome variables by treatment and control group from the long-run trend of the average tract in the rest of New York City. The treatment group deviates substantially from the rest of New York City over time. However, the control group follows closely the overall city trend. If individuals would sort themselves into the control areas, we would expect those areas to differ from the average trend in the rest of the city. If significant city-wide effects exist, my estimates could be underestimated, but the relative comparisons across rings would remain unaffected. Furthermore, rent prices are forward-looking: the path of price effects should start at the moment when information about construction first arrives. Such anticipation effects are absorbed since treatment effects are averages of all projects completed at any time within a census decade, and estimates are a composite of anticipation and completion effects.

4 Reduced form estimates

I present two sets of findings. First, I show the long-run effects of public housing construction on rent prices and the existing housing stock. Results reveal only very light effects on the housing market. Second, I report population and racial composition results over the long run from 1930 to 2010. Reduced form estimates show a substantial decline in white population in treated and adjacent tracts.[13]

Effects on Prices: Rents and Construction. Public housing construction has a zero effect on private market rent prices in treated tracts while having minor positive effects in its immediate surroundings. Panel a and b in Figure 1 display the effects on total units and units net of public housing units in a given census tract. Housing units have been normalized by the land available for construction in each tract. As outlined in section 2.1, public housing replaces the existing stock while adding only slightly to it. There is a positive effect of construction on total housing units in a census tract, adding up to 15% of the stock of total units as compared to the control ring.

[13] Because I find substantial effect sizes, I convert all point estimates from log points to percent using $exp(\hat{\beta}) - 1$.

However, private residential units are significantly reduced. The results suggest that public housing construction leads to a decline of private housing units of 50% on average, stabilizing immediately after construction. Pooled results in Figure 27 show a long-run differential decline in private units from -45% to -67%. Moreover, I report small but significant declines of units of -7% in tracts within the first ring.

Figure 1 Panel c plots event study results for property level rental data. Housing units within a treated tract and and those in the first ring experience no effect relative gains to the omitted group (units in the outermost ring). However, properties in treated tracts exhibit positive rent effects 50 to 60 years after public housing construction. I report pooled results using Equation 2 are reported in Appendix D, Figure 27g. Medium-run estimates for rents in treated tracts are insignificant and range from -1.3% (0-30 years after construction) to 0% (40-60 years after construction). Thus pooled effects cancel out the rent hikes in the last decades after public housing construction.[14]

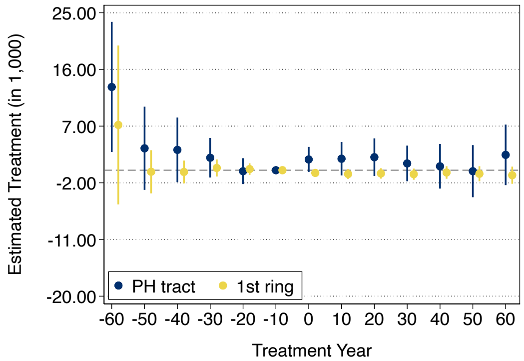
An important dimension of heterogeneity is the construction period. Not only was the housing program substantially altered after 1970, also the type and extend of buildings sthemselves changed. I investigate these changes by estimating Equation 1 for buidlings constructed before and after 1970. An adavantge of the tacked research design is that all projects belomging to either and their rings can be easily dropped. Buildings constructed after 1970 have no significant effect on rent prices within the first and second ring 30 years after construction (see Appendix D).

However, this result is subject to significant limitations. Firstly, the rental listings reflect the upper end of the market and only capture a particular market segment. Second, because of the geogrpahic concentration of the data, the results are biased towards teh effect of public housing construction in Manhattan rather than in New York City.

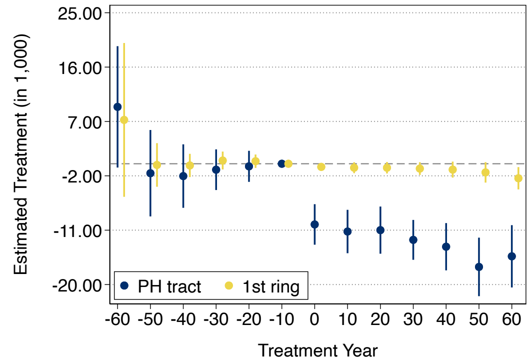
These results align with research on public and affordable housing investments in New York City. First, as shown by Ellen et al. (2007) federal public housing constructed between 1977 and 2000, federally subsidized developments have not typically led to reductions in property values and have led to increases in some cases. Furthermore, Schwartz et al. (2006) showed that investment in subsidized housing between 1987 and 2000 increased with project size and decreased with distance from the project sites. In this paper, I show that later-constructed public housing projects do not cause prices to fall in the immediate neighborhood. Moreover, I report for the first time the long-run consequences of federally subsidized developments built during the program's height in the 1950s and 1960s, which are large-scale compared to most buildings completed after the 1970s. Those were low scale with three to four stories and had moderate densities. Moreover, the result reflects more recent research on public housing demolitions in that there are adverse long-run effects on rent prices (and potentially property prices) (Blanco, 2022, Hunt, 2009).

[14]These results are confirmed using alterantive distance rings (see Figure 28)

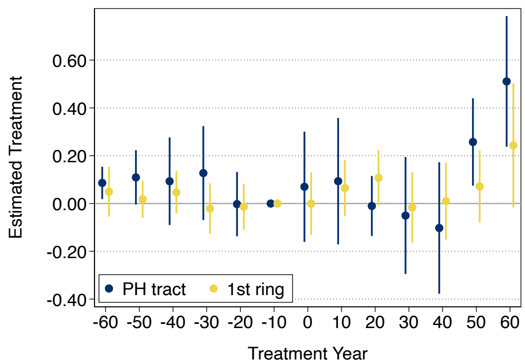
Figure 1: Effect on rents and housing units



(a) Housing units



(b) Priv. housing units



(c) log(Rent)

Note: The figure plots report coefficients $\hat{\beta}_{\tau,r}$ in Equation 1; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals. Panel c uses property level rent data controlling for property characteristics such as number of rooms, if heating, water and furniture were included in the rent; Panel a and b use population counts from the US census; all estimates are weighted by the freqencey of observations within a rings; the omitted category is tracts within a second ring.

Population and racial composition. Public housing construction significantly impacts demographics by shifting population over space. Project construction changed the racial composition of neighborhoods through resident selection. Figure 2 displays results from estimating Equation 1 on total tract population, tract population minus public housing population, and white and black population. Pooled estimates using Equation 2 are reported in Appendix D Figure 27. Since I take the natural logarithm of the outcome variables, $\beta_{\tau,r}$ can be interpreted as the percentage difference in the outcomes between the respective ring and control, holding all other factors constant.

Panel a shows that tracts with public housing projects experience an increase of up to 27% in total population relative to the omitted group (tracts in the outermost ring), a figure that goes down to a fall in total population by 9% within the first ring. This effect is highly significant. The population living in private developments significantly decreases by 31% in treated areas (Panel b) while the effect for the first ring is similar (–9%). While those effects set in immediately and are stable for the whole observation period in the treated tract, the short-run effect within adjacent areas reports a population decline from –7% (0-30 years after construction) to a long-run decline of 15% (0-30 years after construction) (See Appendix D Figure 27).

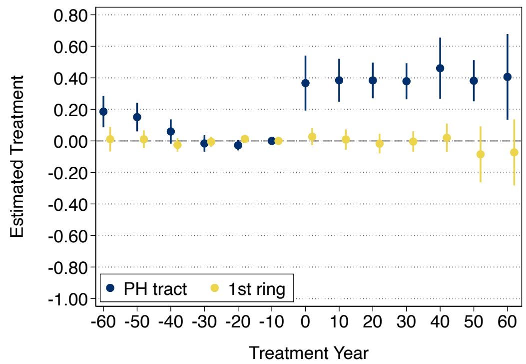
Panel c and d show the effect of public housing construction on the log of the total white and black populations. The arrival of public housing increases white population slightly for up to two decades after construction before entering a longer decline. Results from estimating Equation 2 reveals that within the first 30 years after construction, the white population declined by about -17% percent, further falling to –72% for 40 to 60 years after construction. Moreover, there is a significant long-run decline within nearby tracts, totaling about -34% in the long run. Conversely, the overall black population increased by about 80%. In contrast to the white population, there is no significant negative effect on the total black population in the broader area.

Results closely reflect the pattern of allocation as outlined under section 2.1. The short positive effect for the white population reflects the overall allocation pattern for newly constructed projects and the corresponding outflow of whites from the projects. Similarly, black population intake in projects increases population immediately after construction in the long run. Therefore, construction is associated with a change in the racial composition of tracts in which public housing is constructed relative to the outmost ring.

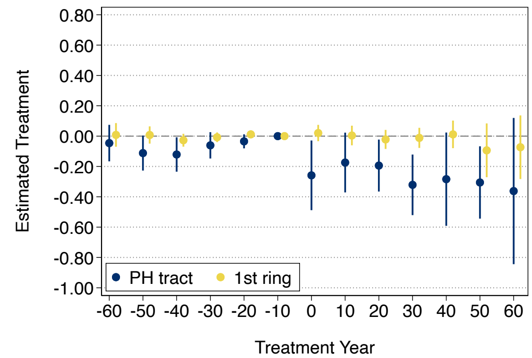
The magnitude and behavior of the estimated effects suggest that they are very local and have no general equilibrium consequences. Second, potentially, all population movements for the black population are absorbed by the project itself. Tract population is instead exchanged, and spillover materializes only for whites, indicating differential population losses in nearby areas are due to declines in population.

An essential dimension of effect heterogeneity is the period in which projects have been constructed. As shown in section 2.1, the type of building changed from "Tower in the Park" style buildings - slim high-rises with low ground coverage - to small projects on scattered sites. This shift occurred mainly in the 1970s and was accompanied by legislation fostering vouchers for private-sector apartments. I thus estimate Equation 1 separately for projects constructed before and after 1970. This allows me to use data from the La Guardia and Wagner archives on the racial distribution of projects available until 1970. I, therefore, can distinguish between white and black residents in a census tract living in public housing and in private developments. This information, though, is only available for projects consecrated before 1972. I assume that black and white population in those projects remains constant afterwards. Results are shown in Appendix D Figure 30. Population estimates for the construction period after 1970 in Panel 30b have no significant effects and

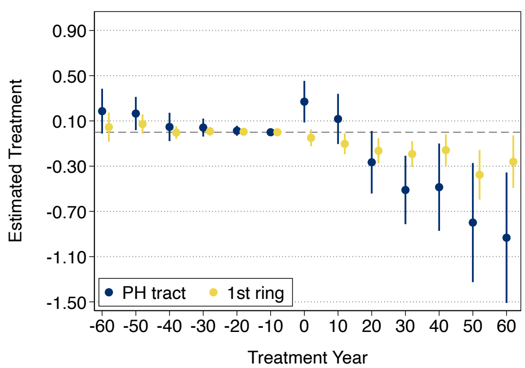
Figure 2: Effect on demographics



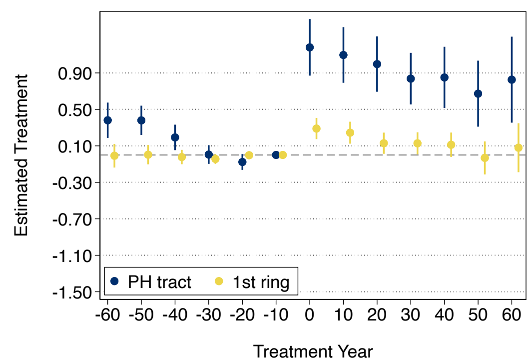
(a) log(Population)



(b) log(Priv. population)



(c) log(White)



(d) log(Black)

Note: The figure plots report coefficients $\hat{\beta}_{\tau,r}$ in Equation 1 for each treated tracts and rings around a project; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals; the omitted category consists of tracts within a second ring. Panel a and d use weighted unit counts from the US census; estimates have been weighted by frequency by ring; the sample includes 2162 time-consistent census tracts in New York City.

are small as compared to the pre-1970 period (Panel 30a). Similarly, the effect on the overall white and black population as reported in Panel 30e to 30h exhibit a similar pattern. While the white population declines gradually, the effect on the black population stabilizes around 30 years after construction. In summary, Figure 30 reveals that the long-run effects in Figure 2 are entirely driven by public housing projects constructed before 1970 and can therefore be attributed to the “Tower in Park” style of housing.

5 Mechanism

In this section, I investigate how public housing affects the differential decline of white population in treated and adjacent tracts. I focus on two potential channels. The first channel relates to the effect of public housing by replacing the existing housing stock and altering the built-up area and urban layout of those places. Urban theorist Jane Jacobs blamed the 1950s and 1960s construction type called "Tower in the Park" – slim high-rises of different layouts on a common plot and with wide green open spaces in between - for generating crime-driven and unlively places. That is because these buildings offer large, un-policeable indoor and outdoor spaces that lack the potential care of residents and shop owners (Jacobs, 1992). The architect Oscar Newman linked "Tower in the Park" with crime in his theory of defensible space and argued that the difference in design accounted for much of the difference in crime (Newman, 1997). Thus, project design might provide a disamenity or abolish intact neighborhoods. Second, public housing projects influence sorting through their residents. These effects can arise either because individuals directly have preferences over the racial composition of project residents or because public housing residents indirectly affect local public goods, such as schools or crime. In both cases, given a preference structure over public housing residents and the building's layout, white population will avoid the immediate vicinity of public housing projects. I use a rich set of public housing characteristics to disentangle these effects.

5.1 Building Design

A challenge to test for building design following the argument in Jacob lies in the lack of a clear definition of a "Tower in the Park". However, following Jacobs, it must have two main criteria: it must be of sufficient height with a sufficiently low ground coverage. To determine a height threshold, I use the requirements of the New York Department of Buildings, which states that a building with more than 75 feet is considered a high-rise building.[15] Given a legally minimum required ceiling height of 7'6 feet, a tower would have at least 9.87 stories.[16] This is slightly below the average public housing building height of 11 levels. To determine a threshold for ground coverage, I use the average of 23% across public housing projects. However, it might be that some tower buildings are too small, meaning that they only consist of a single high-rise building, which would be easily integrated into the city environment and not make any significant alterations to the broader area. Importantly, Jacobs is arguably thinking of an ensemble of buildings that removed cross streets and is not integrated into the city's fabric (Jacobs, 1992). Moreover, as mentioned before, many early buildings were of high quality and thus might be relatively easy to accept by private sector residents. Therefore, I amend the above definition of a "Tower in the Park". I add the area used for

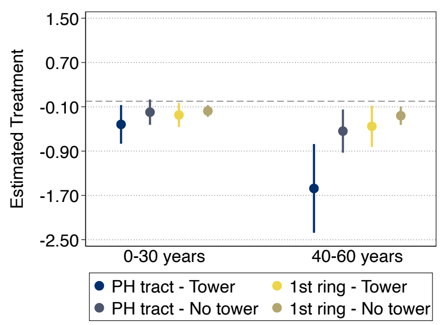
[15] Key Project Terms: Educational and Institutional

[16] Design Professional Requirements: Creation and Alteration of Habitable Apartments In Basements or Cellars of 1 and 2-Family Buildings

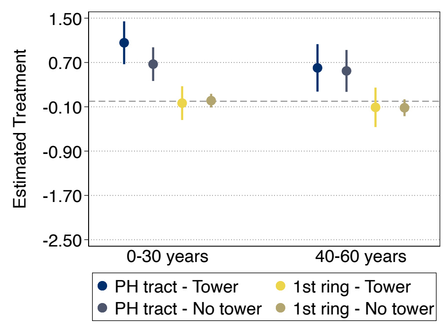
public housing construction as a share of the total tract area and construction costs as additional criteria. I use the average area used for public housing construction as a share of the total tract area (20%) and average construction costs ($17868) to derive an adjusted classification of a "Tower in the Park", which gives 36 Tower and 189 non-tower tracts. I estimate the following equation:

$$y_{m,p,t} = \left(\theta_{0r} Post_{p,t}^{0-30} + \theta_{1r} Post_{p,t}^{40-60}\right) \times (Tower + No\ tower) + \delta' \mathbf{X_{m,p,t}} + \rho_{p,t} + \zeta_{p,r(m,p),c} + u_{m,p,t} \quad (3)$$

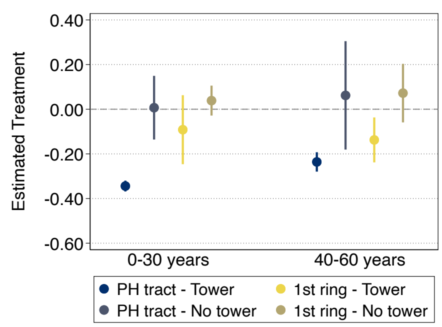
Figure 3: Effect of "Tower in Park"



(a) Log(White)



(b) Log(Black)



(c) log(Rent) - 250m rings

Note. The figure reports point estimates for coefficients θ_{0r} and θ_{1r} in Equation 3; all coefficent have been interacted with adjusted Tower dummies; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals. Panel a to b report differences for treated tracts and tracts in the first ring compared to a second neighbour ring; Panel c compares properties within a treated tract and in the second tract ring around projects to those within a third ring.

This estimation is similar to Equation 2, where *Tower* and *No tower* are dummies for tracts having towers in the park-like projects and not. I report event study results in Appendix D.3. I show pooled estimates in Figure 3.[17]

[17] In Appendix D.1 Figure 31 I relax the assumptions on area share and construction costs and just rely on heigt

Point estimates for white population in treated tracts with a "Tower"-style project are more pronounced (-34% (0-30 years) and -79% (40-60 years)), with stronger spillover effects (-22% (0-30 years) and -36% (40-60 years)). The effects of non-tower buildings are only slightly smaller, with the long-run decline of the white population of 42% and 23% in treated and adjacent tracts (Figure 3a). The effects for black population are very similar in pattern and magnitude for "Towers".

Rent prices fall within public housing tracts with "Towers" by around 30% (0-30 years)) and by 21% (40-60 years). Though not significant, point estimates in the second ring around "Towers" are negative (-13%, 0-30 years) and fall by 16% in the long run (40-60 years). Estimates for non-tower tracts are close to zero in short run (0-30 years). Only long run estimates ar slightly positive though insignificant (Figure 3c). This indicates negative demand effects to living near "Tower" buildings.

5.2 Public Housing Residents

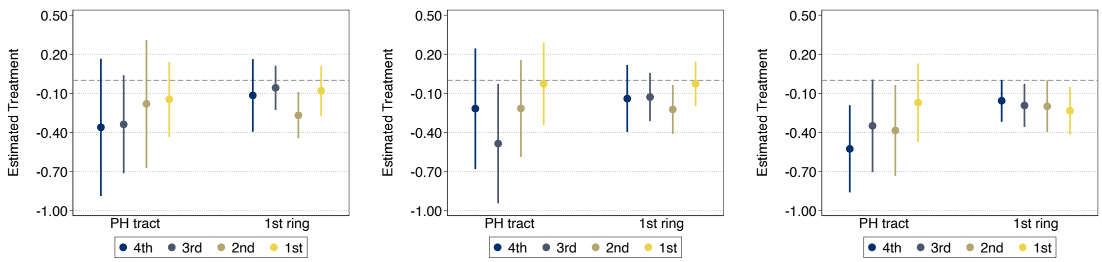
I test for potential neighborhood effects using information about the ethnic composition of public housing residents. Since projects witnessed substantial changes over time, I am using the number of black public housing residents as of December 1971 and the change in black residents from the initial opening date to December 1971. Moreover, I am using public housing units' total public housing population to test for attitudes towards residents in general. I estimate a version of Equation 2 by interacting the ring dummies with quartiles of the respective public housing characteristic:

$$y_{m,p,t} = \sum_{q \in Q} (\gamma_{0q} PH\ tract_{p,t} + \gamma_{1q} 1st\ ring_{p,t}) \times \mathbb{1}(q = q(m,p)) \times age_p + \delta' \mathbf{X_{m,p,t}} + \rho_{p,t} + \zeta_{p,r(m,p),c} + u_{m,p,t} \tag{4}$$

where $\mathbb{1}(q = q(m,p))$ is an indicator if a project's p characteristic in tract m lies in the respective quartile $Q = \{1,2,3,4\}$ and $\beta_{0,q}$ and $\beta_{1,q}$ can be interpreted as the average effect on units in ring $r \in \{0,1\}$ in quartile q.

and groun coverage as criteria.

Figure 4: Effect on log(white)

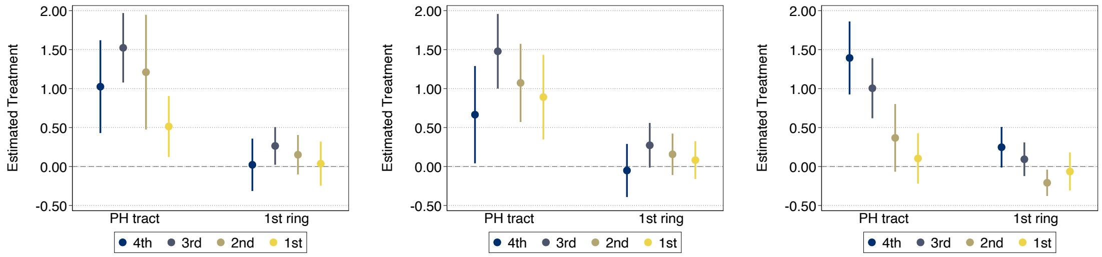


(a) Change in black residents (b) Black residents Dec. 1971 (c) Public housing resident

Note. Figure 4 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; both coefficients have interacted with quartiles indicators of the distributions of the change public housing residents from initial occupancy to Dec. 1971, the black resident population as of Dec. 1971 and the average total public housing residents within a treated tract; the vertical lines show the estimated 95% confidence intervals. Panel a to c report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; outcome variables are obtained from the US census.

Results are shown in Figure 4 to 6. Importantly, there are no significant effects of the black population and the change in black residents on the white population neither in treated nor in adjacent tracts (Figure 4a and **??**). However, point estimates are large, ranging from 14% to 30% in the first and fourth quarters. Point estimates in adjacent tracts are small, with about 8% (q1) and 11% (q4). Effect sizes for the distribution of black residents are similar, with the strongest effect in the third quarter in treated tracts (-39%). In contrast, the effects of total public housing residents on the white population ranged from -16% in the first to -41% in the fourth quartile with a public housing tract. In adjacent tracts, white population declines around all quarters of the public housing resident distribution on average by 18% across all quarters (Figure 4c).

Figure 5: Effect on black population

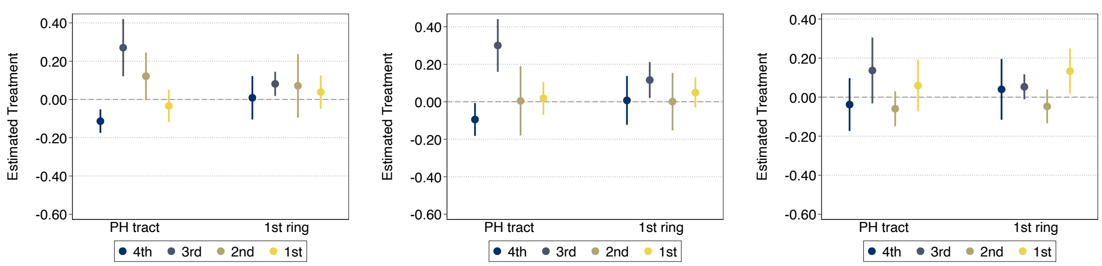


(a) Change in black residents (b) Black residents Dec. 1971 (c) Public housing resident

Note. Figure 5 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; both coefficients have interacted with quartiles indicators of the distributions of the change public housing residents from initial occupancy to Dec. 1971, the black resident population as of Dec. 1971 and the average total public housing residents within a treated tract; the vertical lines show the estimated 95% confidence intervals. Panel a to c report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; outcome variables are obtained from the US census.

The effect of the change in public housing residents reveals that black residents increase from 67% (q1) to 179% (q4), though the effect is strongest in the third quarter (359%) (Figure 5a). The effects of total public housing residents on black population show that most of the increase in black reported in Figure 2 stems from black public housing residents, that is, treated tracts witness an increase of black population ranging from 11% in the first to 303% in the fourth quartile of the total public housing resident distribution. On average, there are no significant spillover effects besides a 19% decline in black residents around tracts in the second quartile of the public housing resident distribution (Figure 5c).

Figure 6: Effect on rent



(a) Change in black residents (b) Black residents Dec. 1971 (c) Public housing resident

Note. Figure 6 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; both coefficients have interacted with quartiles indicators of the distributions of the change public housing residents from initial occupancy to Dec. 1971, the black resident population as of Dec. 1971 and the average total public housing residents across all project; the vertical lines show the estimated 95% confidence intervals. Panel a to c uses property level rent data comparing rents in a first ring (0m-350m) and a second ring (350m-700m) to properties 700m-1050m away; rental ask prices have been obtained from the New York Times.

Effects on rent prices show no consistent pattern related to black and total public housing residents (Figure 6). There are significant spikes in the first ring around a project in the third and fourth quartile of the distribution of changes in black public housing residents of 31% and -11% respectively (Figure 6a). However, there are no significant spillover effects. Moreover, there is only a positive effect of total public housing residents in the lowest quartile in the second ring of 14% (Figure 6c).

These results suggest that effects on the white population, in particular, are not driven by the black population in public housing residents. The lack of significant effects in tracts adjacent to public housing tracts, as well as nonmonotonic relationships regarding the black population, suggest only a minor role of tipping effects. This is also reflected in smaller effects compared to "Tower" in the park effects in Figure 3. However, the effects of the total public housing population suggest that the overall public housing population can account for negative effects on the white population. These effects confirm that rises in the black population are likely to be driven by increases in black public housing residents.

5.3 Discussion

As housing affordability becomes a growing issue, this result has implications for building affordable housing. As shown in Blanco and Neri (2023), public housing as mixed-income housing built by private developers can mitigate adverse effects from existing patterns of poverty, such as crime, by improving school quality and nutrition of children through the same. Low-income housing can, when built by private developers, create amenable space as compared to those places before (Diamond and McQuade, 2019). This paper, however, is concerned with governmentally constructed and operated buildings. While previous studies take those units as generally flawed, I argue that buildings that are integrated into the urban fabric of a city can provide low-income housing while not affecting the neighborhood in an unintended way. Nevertheless, the question is what design implies. The building type driving the effects are large-scale projects with low ground coverage, often turned on themselves away from the street. Thus, as argued in Newman (1997), those buildings shave less "defensible space" – space that residents can control – and might attract more crime. In order to test this hypothesis, I perform a cross-sectional analysis using incarceration rates IR_m in tract m as an outcome. First, I run a version of Equation 2, which adjusts the panel set-up to a crossectional setup:

$$IR_{m,p} = (\eta_{0r} PH\ tract + \eta_{1r} 1st\ ring) \times (Tower + No\ tower) + \delta' \mathbf{X_m} + \xi_{p,n} + u_{m,p} \qquad (5)$$

Here, $\xi_{p,n}$ are project-by-neighbohood fixed effects. I compare tracts with a public housing project and adjacent tracts to a second ring further away. The vector $\mathbf{X_m}$ contains the log of the black and white population, total owners, number of college-educated, population density, and median contract rent. I use baseline controls to make sure that variables are not affected by the treatment.

Results from running Equation 5 are shown in Table 1. Columns (1) and (2) confirm that "Tower in the Park" tracts have 239% to 246% higher incarceration rates than tracts in the second tract ring. Nevertheless, non-tower tracts still have 165% higher incarceration rates after adding controls. In both cases, there is no evidence of spillover effects. This can be considered mild evidence for the hypothesis that "Towers in the Park" are more crime-ridden. However, since incarceration rates give the location of criminals, it does not indicate where these crimes have been committed. Next, I want to test if higher crime rates in "Tower" tracts can account for push factors for the white population. Therefore, I match the crime rate of treated tracts to the first ring around them and interact "Tower" dummies with project incarceration rates. Columns (3) to (6) show results from this exercise. A one percent increase in the incarceration rate around "Tower" decreased the white population by .27% and by .12% in adjacent tracts. Using controls in (2) renders these effects insignificant besides the effect of "Towers" with .21%.

This set of results suggests that the "Tower in the Park" building facilitates crime, which hints towards a negative demand effect around "Towers". It can be considered as mild evidence for the arguments by Jacobs (1992) and Newman (1997) that "Towers" are more likely to be crime-ridden. However, non-tower tracts exhibit larger crime rates than the control group and are not statistically different from Towers. Moreover, there is mixed evidence that higher crime rates in "Tower in the Park" buildings explain spillovers on the white population. However, while not spilling over into the wider neighborhood, localized incarceration rates could stigmatize the wider area, making it less attractive for the white population. While these effects are indicative that crime can be seen as a potential channel, a problem could be that incarceration rates do not reflect actual incidents. Finally, while public housing is considered to be exogenous in this crossectional regression, it is unclear if criminals sort themselves into public units or if public housing is incentivizing residents to commit crimes, for example, through stigma or the lack of opportunity to find employment.

Besides crime as a driver of sorting, another channel could be the removal of amenable space. "Towers in the Park" often required the remodeling of entire city blocks, which entailed decreasing space for restaurants, offices, or, more general, mixed-use developments that have the potential of providing service in close proximity. Finally, the distinct urban form makes the project visible from a distance. Thus, projects might shape surrounding areas, neighborhood reputations, property values, and residential decisions simply through the stigma associated with public housing (Tach and Emory, 2017). The above results are only able to disentangle those arguments partially. Changing the structures of towers, i.e., by decreasing height and increasing ground coverage, would not likely mitigate crime. Moreover, incarceration rates in public housing tracts do not significantly affect the white population in nearby tracts, which suggests that the stigma of large and, therefore, visible

Table 1: Public housing and crime

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variables:	log(IR)		log(White)		log(Black)	
PH tract x Tower	1.22***	1.24***				
	(0.146)	(0.159)				
PH tract x No tower	1.04***	0.976***				
	(0.090)	(0.083)				
Ring 1 x Tower	-0.059	-0.067				
	(0.128)	(0.135)				
Ring 1 x No tower	0.075	0.050				
	(0.046)	(0.043)				
PH tract x Tower x IR_p			-0.276***	-0.208***	0.257***	0.307***
			(0.075)	(0.077)	(0.041)	(0.046)
PH tract x No tower x IR_p			-0.104***	-0.057	0.270***	0.258***
			(0.038)	(0.040)	(0.028)	(0.028)
Ring 1 x Tower x IR_p			-0.122*	-0.075	0.024	0.044
			(0.065)	(0.064)	(0.031)	(0.030)
Ring 1 x No tower x IR_p			-0.013	-0.007	0.041***	0.040***
			(0.017)	(0.018)	(0.016)	(0.015)
Controls	✗	✓	✗	✓	✗	✓
Project-NTA FE	✓	✓	✓	✓	✓	✓
Fit statistics						
Observations	2,785	2,695	2,762	2,672	2,811	2,722
R^2	0.71207	0.71543	0.86192	0.86290	0.81181	0.81102
Within R^2	0.03821	0.04408	0.00876	0.01970	0.02061	0.02624

Note. Table 1 Reports point estimates for coefficients η_{0r} and η_{1r} in Equation 5; all coefficients have interacted with Tower dummies; standard errors are clustered at the project level; the dependent variable in columns (1) and (2) is the log of the incarceration rate; in columns (3)-(4) and (5)-(6) the dependent variable is the log of white and black population respectively; tower dummies in columns (3)-(6) have been interacted with the log of the incarceration rate of the treated public housing tract; as tract level control variables I use the log of white and black population, median contract rent, population density, total owners and number of college-educated at baseline. Standard errors have.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

projects or the lack of amenable space potentially can also account for drivers of sorting. Finally, since public housing became more tailored towards lower-income households, it could entail a decline in school quality and other local public goods.

The other concern related to the quasi-experimental setting. There are many moving parts in the city and beyond. For instance, one would need to disentangle the role of suburban pull factors, the reason different areas grow differently, whether there is something inherently different about growth in one area versus another, what accounts for intergenerational transfers, etc. Each of these channels would require a different natural experiment. This is in addition to channels such as replacing amenable space, school quality, or crime, which are important but beyond the scope of this paper.

6 Residential sorting model

This section develops a model of equilibrium sorting by combining a discrete choice model of residential demand according to Bayer et al. (2007) with a model of housing supply to further study the welfare implications of public housing and "Towers in the Park" in particular. It follows the estimation procedure proposed by Almagro et al. (2023). The model directly accounts for spillover effects by following the empirical Equation 2 closely.

6.1 A Model of neighborhood Demand and Housing Supply

The following set-up consists of utility maximizing Indirect utility for a households n of ethnic group $g \in \{b, w\}$ which chooses her tract location m at time t is given by:

$$V^g_{nmt} = \varphi^g_{nmt} + \epsilon_{mt} \tag{6}$$

where φ^g_{nmt} is the component of indirect utility for census tract m that is common to all households of group g - called mean indirect utility hereafter - , and ϵ_{mt} is an idiosyncratic shock which are drawn from an Extreme Value Type I distribution. The common component of indirect utility is:

$$\begin{aligned}\varphi^g_{nmt} = \beta^g_{1t} s^w_{mtP} + \beta^g_{2t} s^b_{mtP} + \beta^g_{3t} \mathbb{1}(r=1)_{mtPH} + \beta^g_{4t} \mathbb{1}(r=2)_{mtPH} \\ + \beta^g_{5t} \mathbb{1}(r=3)_{mtPH} + \beta^g_{6t} log(r_{mt}) + \beta^g_{7t} log(hu_{mt}) + \beta^g_{8t} log(w_{mt}) + \xi_{mt}\end{aligned} \tag{7}$$

The effect of public housing is modeled by β^g_{3mt} switches to one if a tract has public housing unit or lies in the first or second ring around public housing. Thus, the dummies will capture any effect in adjacent areas caused by public housing. I use the following census variables to capture tract characteristics, where s^w_{mtP} and s^b_{mtP} are the shares of households that are white or black. Rent, r_{mt}, is measured as the medium contract rent within a tract m in year t, hu_{mt} measure housing units in tract m and w_{mt} is the median household income in the same tract. Finally, ξ_{mt} is a vector of exogenous un–observable neighborhood characteristics.

The vector $\boldsymbol{\beta^g_t} = (\beta^g_{1t}, \beta^g_{2t}, \beta^g_{3t}, \beta^g_{4t}, \beta^g_{5t}, \beta^g_{6t}, \beta^g_{7t}, \beta^g_{8t})$ contains preference parameters and may differ arbitrarily across groups as well as neighborhood unobserved quality, ξ_{mt}. I use vectors (e.g., $\mathbf{r}$, $\mathbf{s^w}$, and $\mathbf{s^b}$) to represent aggregates across the set of M − many neighborhoods. I assume that home prices are equal to the present discounted value of rents, and therefore homeowners face the same optimisation problem as renters. Given the distributional assumption on ϵ_{mt}, the probability that a household of group g chooses to live in tract m is:

$$\pi^g_{mt} = \frac{exp(\varphi^g_{mt})}{\sum^M exp(\varphi^g_{mt})} \tag{8}$$

The demand for living in neighborhood m equals the total number of households, across all groups, that want to live in m, assuming each household occupies one housing unit. Taking total population of group g, N^g_t , in the City of New York City exogenous yields the following housing demand equation:

$$D_{mt} = \sum_g \pi^g_{mt} N^g_t \tag{9}$$

As in Almagro et al. (2023) the model is closed by assuming an isoelastic supply function such that the number of housing units in tract m is given by:

$$S_{mt} = \delta_{mt} r^{\phi}_{mt} \tag{10}$$

where δ_{mt} is a supply shifter and ϕ is the supply elasticity.

Assuming exogenous city population and public housing population, the model describes an equilibrium when prices and tract demographics characteristics fulfil the following market clearing conditions:

$$D_{mt}(\mathbf{r}^*, \mathbf{s}^{\mathbf{w}^*}, \mathbf{s}^{\mathbf{b}^*}; \beta) = S_{mt}(r^*_{mt}) \qquad \forall\ m \tag{11}$$

$$\frac{D^b_{mt}(\mathbf{r}^*, \mathbf{s}^{\mathbf{w}*}, \mathbf{s}^{\mathbf{b}^*}, \beta)}{D_{mt}(\mathbf{r}^*, \mathbf{s}^{\mathbf{w}^*}, \mathbf{s}^{\mathbf{b}^*}; \beta)} = s^{b^*}_{mt} \qquad \forall\ m \tag{12}$$

$$\frac{D^w_{mt}(\mathbf{r}^*, \mathbf{s}^{\mathbf{w}*}, \mathbf{s}^{\mathbf{b}^*}, \beta)}{D_{mt}(\mathbf{r}^*, \mathbf{s}^{\mathbf{w}^*}, \mathbf{s}^{\mathbf{b}^*}; \beta)} = s^{w^*}_{mt} \qquad \forall\ m \tag{13}$$

A fixed point of the system of Equations 11 to 13 can be found using a non-linear optimisation procedure. In that case, I use Newton's method to solve for the equilibrium vectors ($\mathbf{r}$, $\mathbf{s^w}$, and $\mathbf{s^b}$) given the preference parameters $\boldsymbol{\beta_t^g}$, supply elasticity ϕ and supply shifter δ setting the tolerance criteria to e^{-10}. This is described in greater detail in section 7.

6.2 Quantification of the model

To study the consequences of public housing demolitions using our model, a necessary step is to obtain estimates of the household preference parameters β, supply elasticity ϕ and supply shifter δ. The modelsś outside option can be normalised to zero $\varphi_{0t}^g = 0$ as is standard in the literature and the preference parameters can be identified by the following equation which is implied by Equation 8:

$$\log\left(\frac{\pi_{mt}^g}{\pi_{0t}^g}\right) = \beta_{1t}^g s_{mtP}^w + \beta_{2t}^g s_{mtP}^b + \beta_{3t}^g \mathbb{1}(r=1)_{mtPH} + \beta_{4t}^g \mathbb{1}(r=2)_{mtPH} + \beta_{5t}^g \mathrm{r}_{mtPH} + \beta_{6t}^g log(hu_{mt}) + \beta_{7t}^g log(w_{mt}) + \mu_m + \theta_t + u_{mt} \tag{14}$$

In order to estimate preference parameters, I distinguish between population living in public housing and private dwellings. This is important in order to disentangle the effect of public housing population and private sector residents. Thus, s_{mtP}^w and s_{mtP}^b are white and black population shares. The coefficients s_{mtPH}^{b3} to s_{mtPH}^{b5} represent dummies which switch to one given the distance relationship of the tract to the nearest public housing project. The third ring is the omitted group. Finally I collect neighborhood effects ξ_{mt} into the fixed effects μ_m and use θ_t census tract and year fixed effects.

Since I consider the choice to settle in a given distance in relationship to public housing as defined by neighbour rings around public housing tracts, the outside option is to live in anywhere else in New York City. Equation 14 can then be estimated using maximum likelihood. $\mathbb{1}(r = r(m,p))$ is a dummy equal to one if a tract lied in the respective ring and s_{mtPH}^b is the number of public housing residents in the closest project of the number of residents of in tract m. To model a social interaction effect I interact the ring dummies with the share of the closest of public housing population population. I define the choice probabilities using the share of households of group g that reside in each tract as:

$$\hat{\pi}_{mt}^g = \frac{\#\ residents\ of\ group\ g\ in\ tract\ m}{\#\ residents\ of\ group\ g\ in\ New\ York\ City} \tag{15}$$

For estimation, I addresses two main threats for credible identification of the preference parameters of the model of residential choice. First, I include a series of fixed effect terms by estimating the model using year and tract fixed effects. Second, since rent prices are potnetially correlated with neighbohood unobservables, I instrument all variables besides public housing dummies following the arguments in Berry (1994) and Bayer et al. (2007). The argument is that prices, housing stock and demograohics for any particular tract will be affected not only by its own attributes but also by the availability of tracts that are close substitutes for it. That is, two tracts with identical characetritics may have very different prices, depending on how they are situated relative to other locations within New York City. I construct a set of instruments based on tract characeteristics 1.5 to 2.5 miles around each tract used in the analysis to account for this pattern of substitution and isolate exogenous variation in public housing. I use the average development inentisty, or the number of housing units devided by the total tract area, $avg.\ develop.\ intensity_{1.5-2.5}$, the average share of white and black population, $avg.\ share\ white_{1.5-2.5}$ and $avg.\ share\ black_{1.5-2.5}$, the average public park area share, $avg.\ share\ park_{1.5-2.5}$ and the average population density $avg.\ pop.\ dens._{1.5-2.5}$.

Thus, I obtain $\boldsymbol{\beta^g}$ by an IV regression of the vector of mean indirect utility where rent prices, housing units, income and demographics are instrumented with tract chracteristics further away. As argued under section 4, conditional on controls and fixed effects the location of public housing is random, therefore the effect of public housing as modelled can be interpreted as causal. Both fixed effects vary arbitrarily by ethnic group. Instead of using a stacked design as described in 3 I use a panel version. If a tract is a neighbour to two project it becomes activated as neighbour of the nearest first treated public housing project. Figure 13 shows the spatial layout of the panel data. In order to estimate the preference parameters I am interest in a world with public housing. Thus, for each census year I estimate Equation 15 only for the time after treatment for treated tracts and their neighbours to build a meaningful counterfactual.

One main caveat for the interpretation of the estimated coefficients in Table 2 is that as reduced–form parameters they reflect the combined impact of additional preferences that are not explicitly modeled. For example, white households might prefer to live in neighborhoods with a higher White population share because of racial animus, preferences for public goods that are associated with demographic composition, or preferences for particular types of consumption amenities. However, I treat the intake of public housing residents as exogenous conditional on having a public housing or not. Table 2 displays results from estimating Equation 15 for white and black population.

Table 2: Instrumental Variable Estimates of Neighborhood Preference Parameters

Model:	(White)	(Black)	(White)	(Black)
log(med. rent)	-1.920**	-1.494***	-2.021**	-1.534***
	(0.8164)	(0.5443)	(0.7734)	(0.5740)
log(Own)	0.1703	-0.1100	0.1607	-0.0725
	(0.5088)	(0.4209)	(0.4922)	(0.4292)
log(HU)	0.2393	0.8574*	0.3069	0.9058*
	(0.8049)	(0.5116)	(0.7283)	(0.4704)
Share white	0.0233	-0.0389	0.0293	-0.0356
	(0.0328)	(0.0290)	(0.0317)	(0.0283)
Share black	-0.0287*	0.0121	-0.0224	0.0163
	(0.0150)	(0.0174)	(0.0138)	(0.0157)
log(Income)	1.419	1.026*	1.255	0.9178*
	(0.9040)	(0.5412)	(0.7762)	(0.4797)
PH tract	-0.4211	-0.8713***		
	(0.3267)	(0.2677)		
Ring 1	-0.2876	-0.2411		
	(0.1910)	(0.1479)		
Ring 1 x Tower			-0.5345	-1.063**
			(0.4018)	(0.4733)
Ring 1 x no Tower			-0.4275	-0.8796***
			(0.3771)	(0.3191)
Ring 2 x Tower			-0.3361	-0.3694
			(0.4911)	(0.3320)
Ring 2 x no Tower			-0.2811	-0.2382
			(0.2002)	(0.1588)
Year FE	✓	✓	✓	✓
Tract FE	✓	✓	✓	✓
Fit statistics				
R^2	0.46317	0.74255	0.48515	0.75024
Observations	6,508	6,460	6,666	6,618
F-test	27.338	30.359	24.501	27.622
1st Stage F	39.0	43.2	42.9	48.1

Note. Table 2 presents regression results of preference parameters for a static logit location choice model using Equation 14; I use population counts across census tracts for a set of tracts from 1950 to 2020. I estimate preference parameters separately by race/ethnicity. Log median rent, Black and White population share, and log median income are instrumented following Bayer et al. (2007), where I take public housing construction as exogenous variables. Columns 1 and 2 report results using simple treatment dummies switching in after a public housing project opened. Columns 3 and 4 interact ring dummies with dummies for having a "Tower in the Park" as defined in Section5.1. The instrumental variables in this specification are based on weighted averages of tract characteristics that are within a 1.5-2.5 miles ring for each census tract. I am using $avg.\ develop.\ intensity_{1.5-2.5}$, $avg.\ share\ white_{1.5-2.5}$, $avg.\ share\ black_{1.5-2.5}$, $avg.\ share\ park_{1.5-2.5}$, $avg.\ pop.\ dens._{1.5-2.5}$. Standard errors are clustered at the neighborhood level.
Signif. Codes. ***: 0.01, **: 0.05, *: 0.1.

Conditional on a neighborhood's fixed effects and costs of living, white households prefer to live in neighborhoods where with a higher concentration of other white households. black households when making their location decision. White population living in private dwellings in a tract does not play a role for either ethnic groups when making their location decision with estimates close to zero while only marginally reject the concentration of black population. In contrast, black residents not only prefer the presence of other black residents but also have stronger preferences not being close to white population. For the purpose of the following analysis, the public housing estimates behave in the expected way. The difference in probability to live in a public housing tract as compared to the third ring is larger for blacks than for white population. Similarly for the second ring white population is around 6% more likely to settle in there as black population is about 12% more likely to live close by. This could hint the fact that black residents have a stronger preference for public housing residency as compared to white population. These results closely reflect the result from estimating Equation 2 which shows negative spillover effects for white population.

Finally both white population and black population prefer places with more apartments. A one percent incase in rents decreases the probability to live in a tract by 8% for black population and insignificantly for white population by 1.8%. All households have a higher probability to live in the tracts comprised by this analysis as compared to other places in New York. This results does not result from the fact that ethnicities overall does not prefer lower rents but rather from the fact that individuals might be willing to pay more living far away from public housing. These results are confirmed using hedonic rent estimates of ask prices. While preference parameters of white and black racial animus stay stable, hedonic rents are positively associated with the probability living outside the tract of observation for black population.

Next, I calibrate the supply shifter using the housing market clearing condition (Equation 9) yields:

$$\delta_{mt} = \frac{D_{mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta)}{r_{mt}^{\phi}} \tag{16}$$

Using the full set of $\boldsymbol{\beta_t^g}$ I claibrate the supply shifter for each tract for each year t. I set the medium term housing supply elasticity $\phi = .65$ following estimates by Saiz (2008) for the years 1970 to 2000. There are no estimates of housing supply elasticties for earlier years for New York City to the knowledge of the author. While later estimates by Baum Snow suggest a lower elasticity in the year 2010 this drop seems drastic and might be due to the use of different nts and levels of aggregation.

7 Welfare Impacts of Public Housing Construction

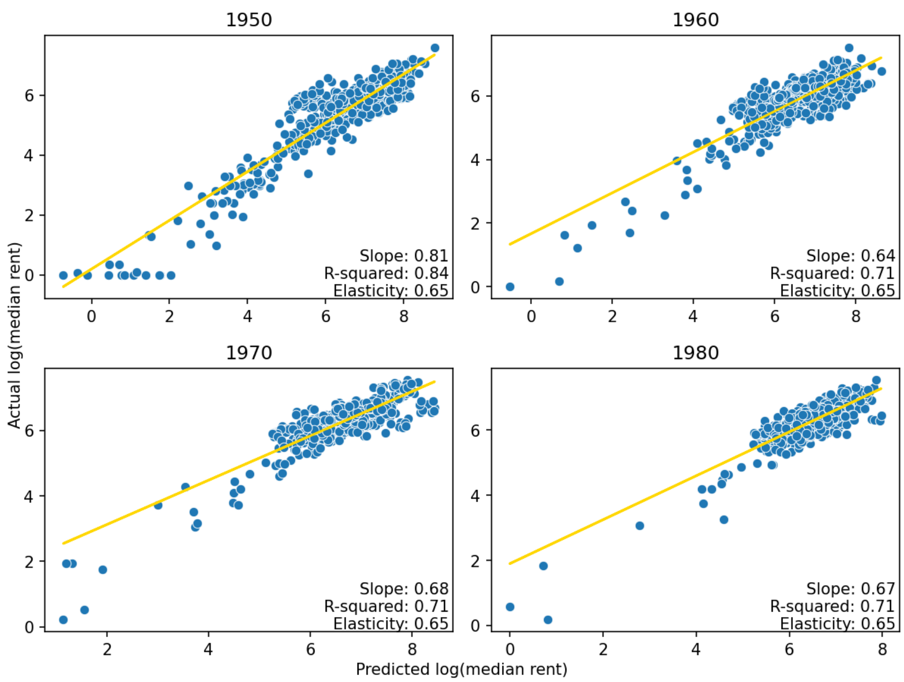
7.1 Model fit

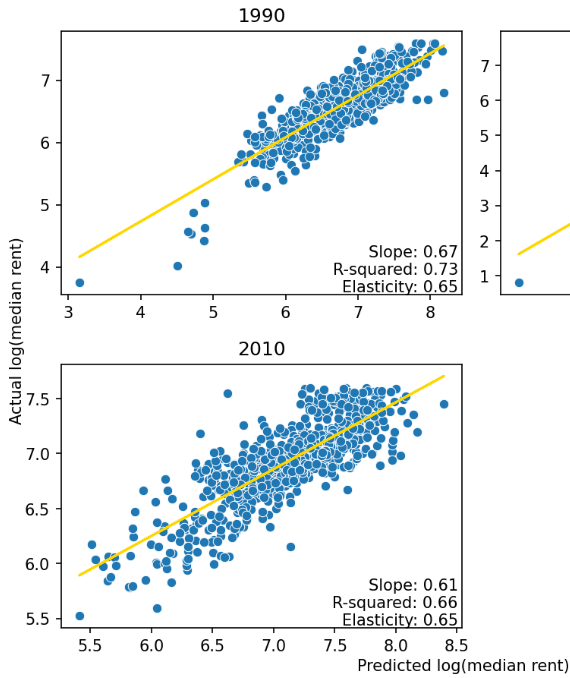
The final aim of model is to assess the welfare consequences of public housing over the long run. I solve the model by finding a fixed point that solves the system of $3xM$ Equation 11 to 13. Details on the equilibrium solver I report in Appendix D.6. Before describing the welfare estimates and the counterfactual, I perform a validation exercise using the equilibrium rental prices. I ignore the racial share estimates because they depend on both the demand and supply components of the model.

Figure 7 plots actual log rents in census tracts against predicted equilibrium rents log rents that are implied by the associated model equilibrium. In this exercise I include the models unobservables. The fit of predicted rent and actual rent varies quite considerable by year. While the model has a reasonable fit for the first three decades it performs poorly for the years 1980 to 2010.

A main result from this exercise is that differences between the actual and simulated data can arise because of the elasticity. Higher elasticities lead better fits though, the model is bounded from above and below for specific elasticities, yielding now solution for values above and below.

Figure 7: In-Sample Fit of Structural Model Using Rent Dat





Note. Figure 7 plots actual log rents in census tracts against log rents that are implied by the model estimates where unobservable components of neighborhood quality are included. The number of housing units supplied is set to equal the number of housing units implied by the demand system.

7.2 Welfare

Using the estimated preference parameters, a specified set of neighborhood characteristics $(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b})$ and the assumption on the distribution of the ideosyncrtic shock ϵ_{mt}, the consumer surplus for group g in closed-form solution associated with a set of alternatives is given in the standard log–sum–exp form:[18]

$$CS_t^g = \ln\left(\sum_m \exp(v_{mt}^g(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}))\right) \tag{17}$$

Where v_{mt}^g is indirect utility as defined in Equation 6. To asses the welfare consequences of public housing I perform two counterfactual exercises. First, I remove public housing entirely from a tract. I do this by setting the dummies in the utility function to zero, thereby setting the preferences parameters over public housing to zero. This counterfactual informs about how a world without public housing would have looked liked, in which agents never exposed to these buildings.

[18]By definition, the consumer surplus is the utility, in money terms, that a household receives in the choice situation. The household n chooses the alternative that provides the greatest utility. Therefore, $CS_n = max_j(U_{nj} = (V_{nj} + \epsilon_{ij},\ \forall\ j)$. If each ϵ_{ij} is iid and Type 1 Extreme Value distributed it $\mathbb{E}(CS_n)$ becomes: $ln(\sum_j exp(V_{nj}))$.

The second counterfactual deals with a change in spatial extend of the projects. Changing the area share of public housing projects can to lead to sizeable equilibrium effects as households might resort across the entire city.

While the usual welfare analysis computation would require an expenditure function, I rely on the notion of a rent equivalent to compute renter welfare changes from a counterfactual world $(\mathbf{r}^1, \mathbf{s^w}^1, \mathbf{s^b}^1)$ relative to a baseline scenario $(\mathbf{r}^0, \mathbf{s^w}^0, \mathbf{s^b}^0)$ in monetary terms (Almagro et al., 2023). Thus, the group-specific rent equivalent, RE^g, is the increase in rent that is necessary to leave the household indifferent with respect to the baseline values as follows:

$$\Delta CS_t^g = \ln\left(\sum_m \exp(v_{mt}^g(\mathbf{r}^1 + RE^g, \mathbf{s^w}^1, \mathbf{s^b}^1))\right) - \ln\left(\sum_m \exp(v_{mt}^g(\mathbf{r}^0, \mathbf{s^w}^0, \mathbf{s^b}^0))\right) \tag{18}$$

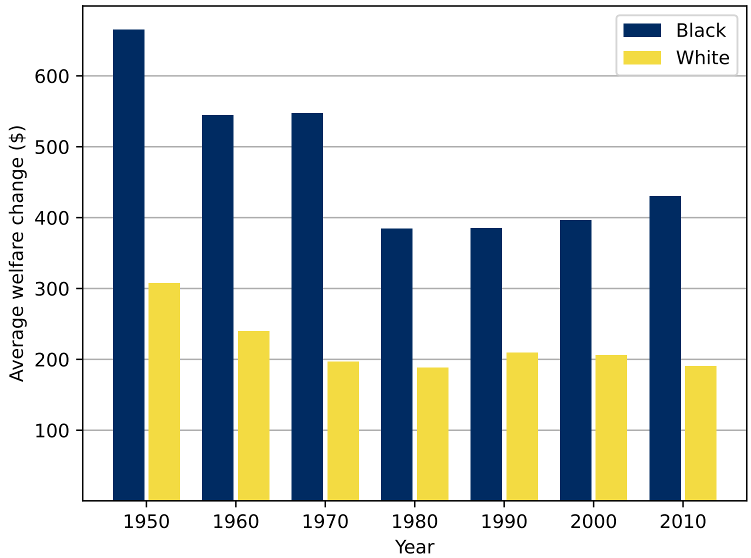
Figure 8 shows the rent equivalent (RE) averaged for black and white households by year from the first counterfactual exercise removing all public housing from the city. These results show that welfare is positive on average for both for white and balck population in all census years. The positive effect for blacks is mostly twice as high as for white population throughout all years. In 1950 the RE for Whites is \$307 and \$664 for Blacks. This value averages for whites around \$200 in years after 1960. In contrast, Black's RE is averageing around \$400 in ther years 1980 to 2010.

These results complement welfare estimates from Almagro et al. (2023) showing that in a world without public housing construction welfare for non public housing residents would have been higher. However, welfare gains are differently distributed. In Almagro et al. (2023), whites gain more than Blacks. In particular, non-poor white population gains \$230 which cloesely reflaect average welfare of white of \$200, non-poor black population gains \$39. Average welfafe is about 50% smaller. Furthermore, my results are in line with the empirical literature on public housing showing that in particular in the US context public housing is an important driver of neighborhood through a disamenity channel.

These positive gains can be explained by two mechanisms. First, blacks have a stronger aversion of living within public housing tracts than white population (see Table 2). Therfore, removing projects removes this disutilty. Second, both white and black population have an aversion of high rents. The disutility from higher rents is larger for whites than blacks. Average rent prices are lower across census tracts by removing all public housing projects from the city's stock. That is the counterfactual rent distribution is shifted towerds left with a lower mean (see Apendix D.6, Figure 37).

The largest changes in rents are observed in the third ring around public housing projects. Rent differentials in a public housing tract and the first ring are considerable lower and fall to \$60 and \$85 respectively in the period 1980 to 2000 from a peak of \$433 and \$432 in 1950 (see Figure 38). Which contribute to lowering welfare gains.

Figure 8: Summary of Welfare Consequences of Public Housing Demolitions

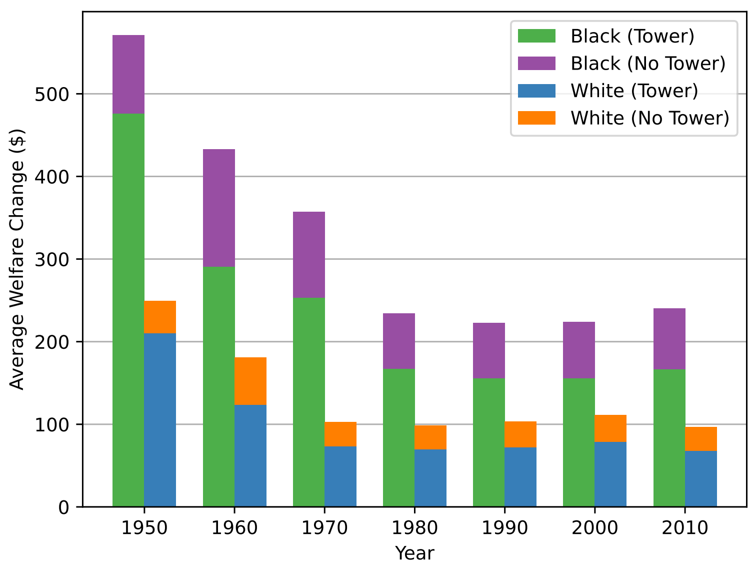


Note. Figure 8 reports the average rent equivalent due to public housing construction for black (blue) and white (yellow) population for each census year. I compare welfare under the actual state - with public housing - to a counterfactual scenario in wich all public housing projects have been removed. Welfare is expressed as the change in rents that would make households indifferent between the counterfactual and actual states of the world as expressed by Equation 18. A positive value implies that demolitions lead to higher welfare; unobservable components of neighborhood quality are included.

Rent equivalents follow the trends in rent differentials in the second and first ring. However, rent equivalents for both whites and blacks within public housing tracts are increasing not decrasing (see Figure 38). This reveals the importance of two counterbalancing mechanisms. First, lower rent prices in the counterfactual szenario drive welfare gains in areas further away from public housing, where preference are over public housing are considerable lower. In contrast, rents in public housing tracts are similar in the counterfactual szenario while welfare is increaisng for both white and black population. In particular, in the periods from 1980 to 2010 REs increase from $288 to $494 for whites (Figure 38c) and from $484 to $780 for blacks (Figure 38b), therby outperforming any gains from lower rents in previous preiods. This reflects strong aversion to live very close to public housing projects and confirms falling rents in public housing tracts (see Section 5.1, Figure 3c).

In the second counterfactural szenario I explore welfare changes due to the removal of “Tower in the Park” style public housing and non-tower buildings. As argued in Section 5 these building type is an important component driving spillover effects of public housing. I estimate the model by removing either “Towers” or non-towers while keeping the respective structures in place. Teh model is recalibrated using estimates from Table 2 columns (3) and (4). Figure 9 gives rent equivalents (RE) from the removal of the other building type. First, welfare gains from removing "Towers" outperforms removing welfare from non towers. Moreover, though preference aramters have been restimated, total welafre gains are nearly identical to the removal of all public housing projects, which allows a direct comparison to the total welfare gain. For example, for black population around 72% of total welfare can be attributed to the removal of "Towers" and 69% for Whites. Welfare gains are also strictly larger for black population than for Whites which is reflected in the differential valuation of living close to public hosing projects. Blacks devalue living close to "Towers" more than whites at all distance (see Table 2). Removing them would increase welfare by up tp $238 in 1950 for Blacks on average while this value stabilizes at around $161 after the 1970s. For Whites REs are stable after 1960 around $72. These gains are large compared to removing all non-tower projects. Non-tower REs for Whites range from $29 to $57 and for Blacks range from $67 to $142.

Figure 9: Summary of Welfare Consequences of Public Housing Types Demolitions



Note. Figure 9 reports the average change in each groups welfare due to public housing construction. I compare welfare under the actual state - with public housing - to two counterfactual scenarios; in the first scenario, only "Tower in the park" style buildings have been removed (Tower); in the second scenario, only non-tower buildings have been removed (No Tower). Welfare is expressed as the change in rents that would make households indifferent between the counterfactual and actual states of the world as expressed by Equation 18. A positive value implies that demolitions lead to higher welfare; unobservable components of neighborhood quality are included. Welfare estimates have been weighted using shares of "Tower in the Park"projects and non-tower projects as of total public housing projects in census year t.

This results informs about the welfare effects of racial sorting induced by public hosuing. One way to think about different mechanisms through which public housing works is to return to the original estimates from reduced form estimation (Figure 2). White population falls continuously 10 years after construction indicating that the initial externality shock accumulates over time. The fact that welfare gains stabilize after a certain time indicates further that there are adjustment costs to price public housing efficiently. The result further highlights potential welfare returns to remodeling public housing. The provision of affordable housing can entail welfare gains to its residents which are not factored into the results in Figure 8 and Figure 9 suggesting these results to be an upper bound. As suggested by Almagro et al. (2023) to distinguish between welfare for race-by-income groups, there are considerable welfare losses from removing public housing for poor white and black households while overall welfare gains are driven by gains for rather upper income households. In order to avoide potential losses due to the removal of affordable housing, remodelling of public housing could provide an alternative to demolition. Since welfare gains are driven by the demlition of "Towers in the Park" redeveloping projects and project areas by filling in open space with additional private units or integrating existing projects into a retail or mixed use enviornemnt could be explored as potential options.

8 Conclusion

In this paper, I ask how public housing construction shaped neighborhoods in New York City from 1930 to 2010. Specifically, I study how a particular building type called "Tower in the Park" affect the location decision of white and black population. Over an 80-year period, I estimate that public housing construction increased the concentration of the black population in treated tracts while at the same time decreasing the concentration of the white population in the immediate and wider vicinity of the new projects. These effects are driven by "Tower in the Park"- style projects, while non-tower projects have significantly lower effects. The spatial pattern of net price effects is consistent with negative demand effects of white population where public housing units are large concerning the previous stock. Overall, I identify the "Tower in the Park" style projects as those that increase segregation between white and black populations. I use a structural approach to quantify how these changes shaped welfare and study distributional considerations across racial and income groups. Demolition of public housing in the model generated large welfare improvements for white and black households. The effects of demolitions arise from lower average rents and less segregated neighborhoods. This could indicate that subsequent resorting generates large gains for white households, bidding less for certain areas, thereby improving rents for all households. My findings highlight that scale matters. Welfare gains increase for white households with reductions in the area share of public housing. However, the rent equivalent does not change with reductions in the area share for back population. This highlights the disparate impacts on welfare and hints at the limitations of policies that aim to revitalize neighborhoods and benefit lower-income households. Nevertheless, a key policy implication of our results is that redevelopment can potentially play a key role in shaping the welfare impacts of urban renewal programs such as public housing demolition. While governmentally run public housing has often been blamed as inefficient, this paper argues that public housing, which is integrated into the urban fabric, can provide low-income housing while not affecting the neighborhood in an unintended way. Thus, this paper corroborates existing findings by Blanco and Neri (2023). While concerned with private regenerations of public housing, My findings highlight that mixed-race developments and higher-quality buildings mitigate the negative effects of public housing and can favor the wider area. Moreover, those regenerations are tailored to the private market in their design and generate an urban layout that suits the city structure. In particular, when conversion is costly, efforts to fill large empty green spaces between towers could be made by an approach to make places more convenient to live in for different income groups, which might have similar effects as in Blanco and Neri (2023).

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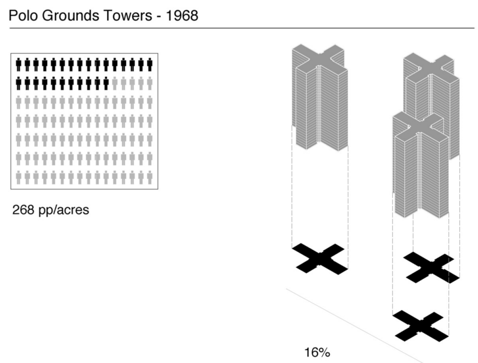
9 Appendix

A Additional Material

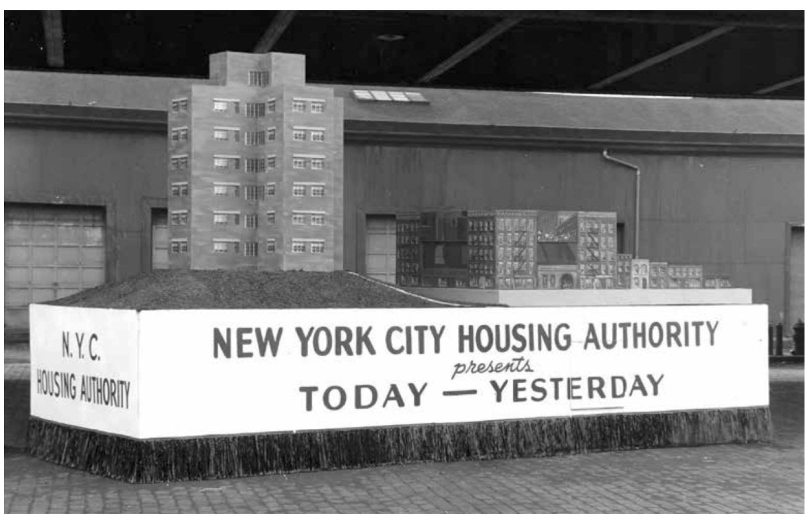
Figure 10

Figure 11: Tower in the Park

(a) Polo Ground Towers



(b) Polo Ground Towers - Floor-plan

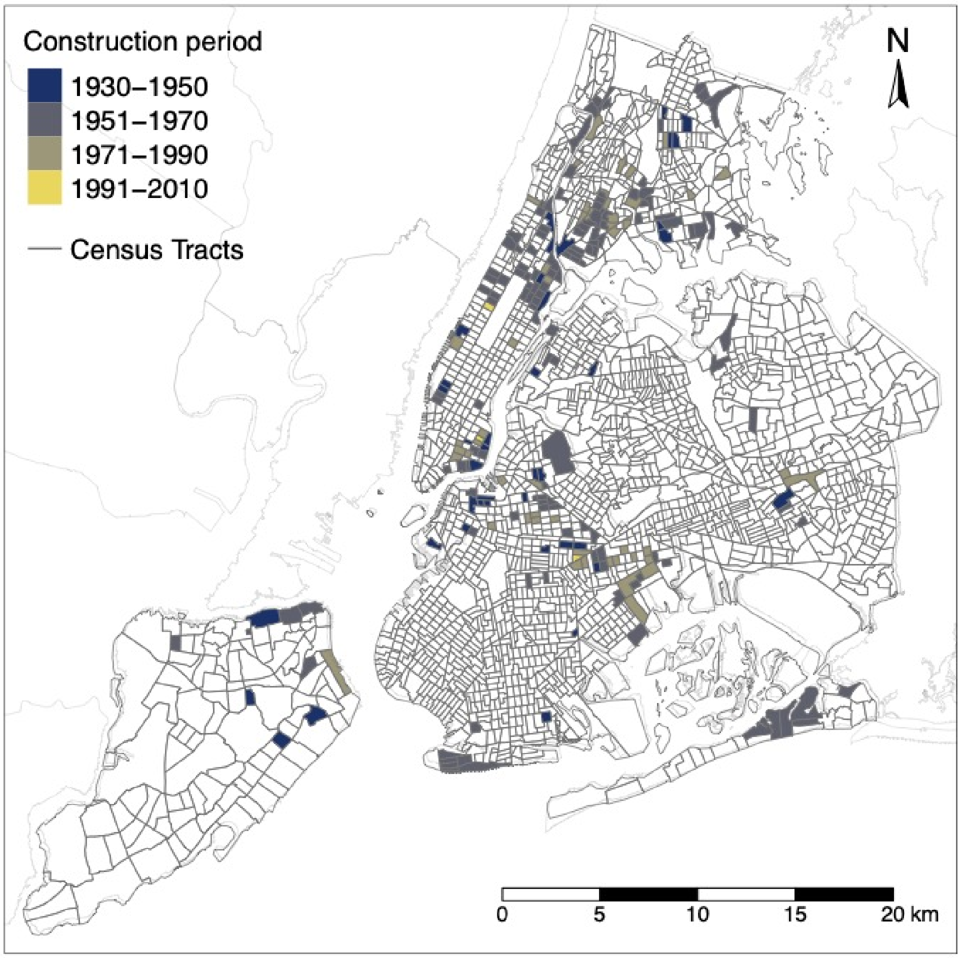


(c) "Today - Yesterday", 1948

Source. Panel a: La Guardia and Wagner Archives, NYCHA Collection, LAGCC, CUNY; Panel b: https://skyscraper.org/housing-density/history/; Panel c: Bloom et al. (2016).

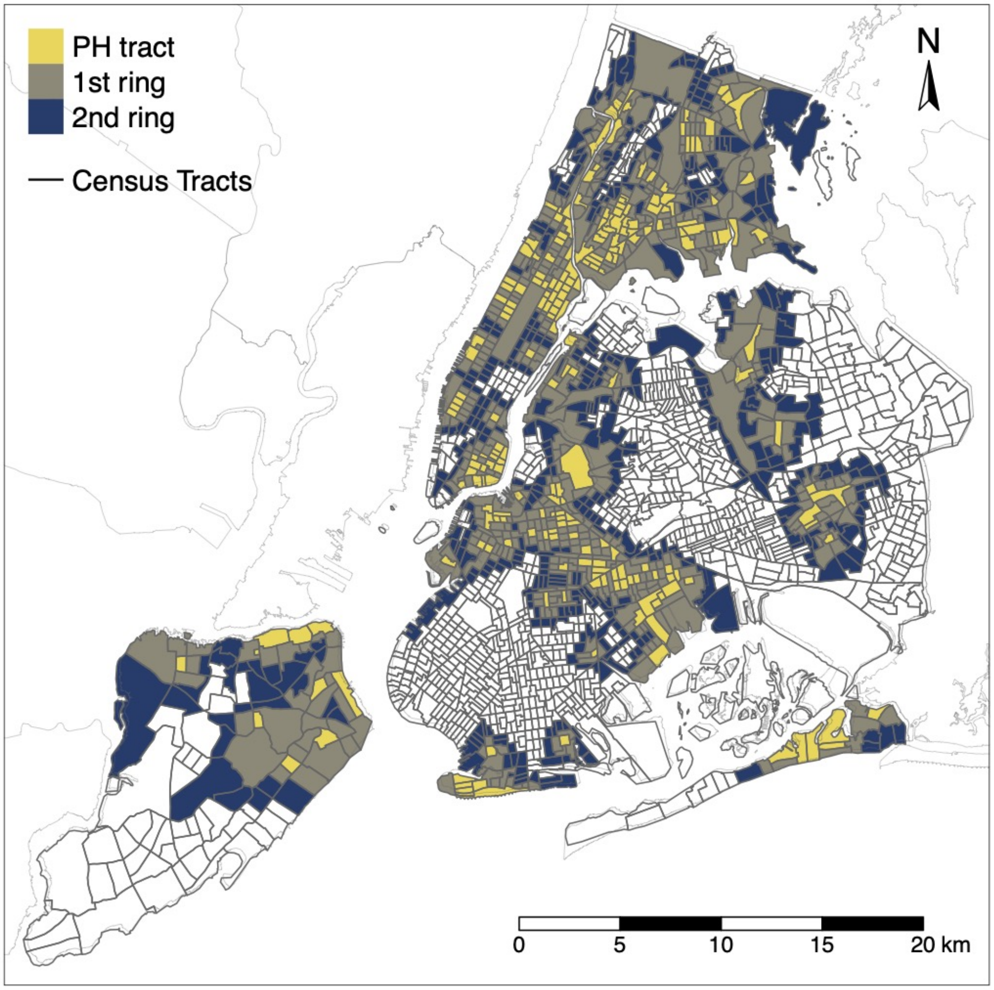
B Additional Maps

Figure 12: Evolution of public housing by construction period



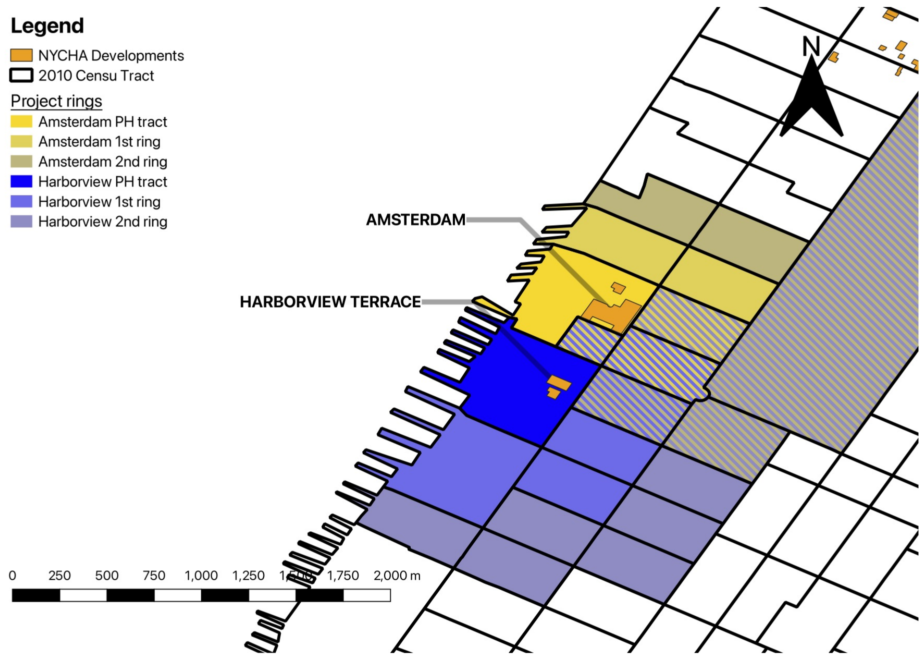
Note: Figure 12 displays 2010 census tracts. Tracts highlighted in color contained at least one public housing project. Some tracts have more than one project. Public housing tracts have been grouped in construction periods based on the completion date of the first project.
Source. La Guardia and Wagner Archives, NYCHA development data book. Details on the construction of data the data set can be found in subsection 2.2.

Figure 13: Tracts by distance relationship to public housing

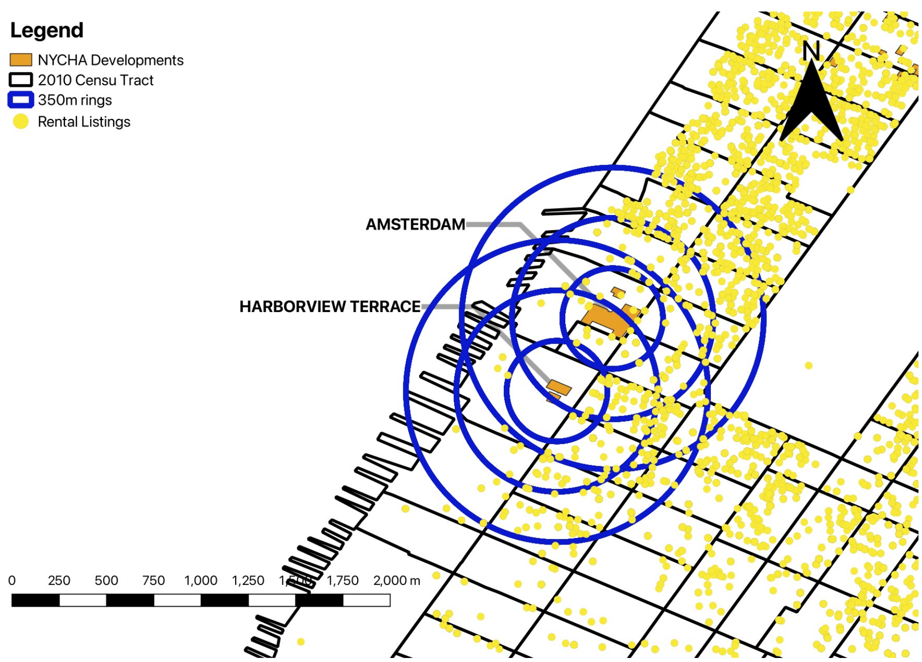


Note. Tracts by distance relationship as used in the analysis in panel setup.

Figure 14: Treatment construction



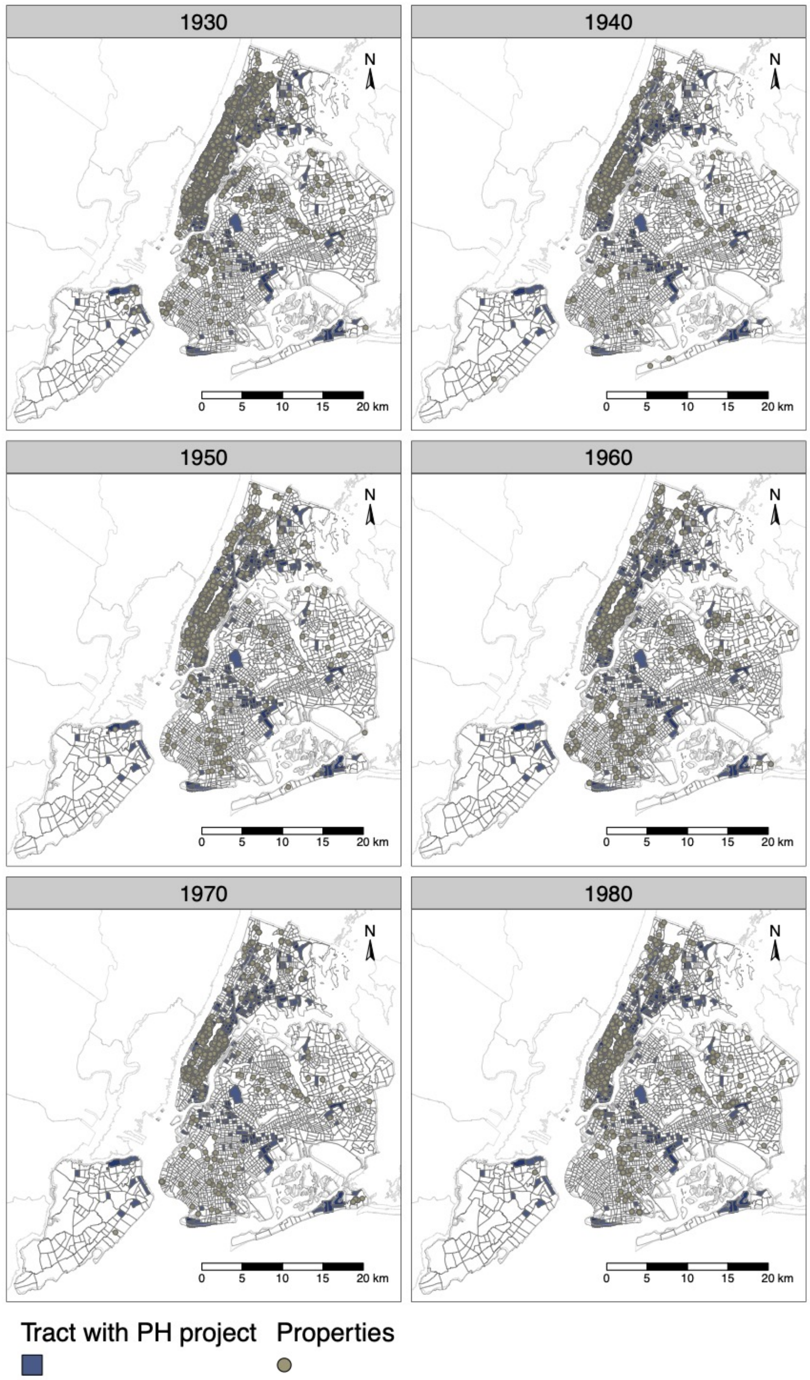
(a) Neighbour rings

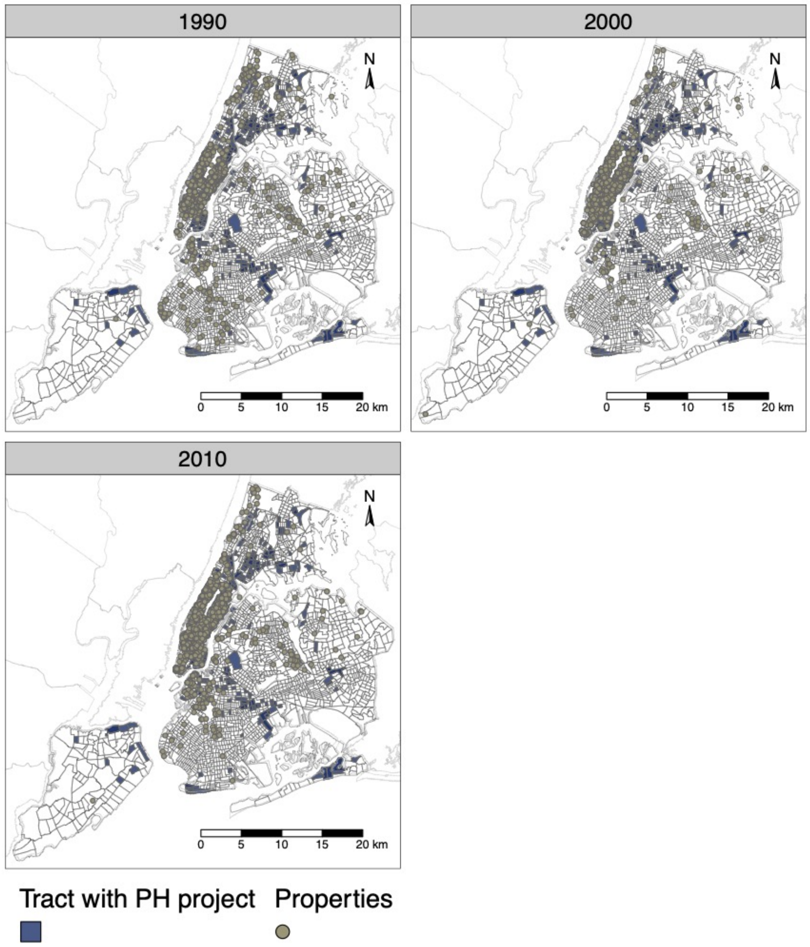


(b) Distance rings

Note. Panels a and b provide an illustrative example of overlapping neighborhood/distance rings for two public housing projects: Harborview Terrace and Amsterdam Houses. In Panel a, the concept of neighborhood rings is depicted, with blue and yellow hatched census tracts representing the areas that belong to the respective public housing tracts and are located within their respective rings. It is important to note that these tracts may appear multiple times in the dataset. If a public housing tracts was lying within a neighborhood ring to another public housing tracts, it was excluded from the respective ring such that no treated tract appears in the control group.
Panel b demonstrates flexible distance rings with a radius of 250m. Similar to Panel a, properties (represented by yellow dots) that lie within both rings will be classified as belonging to the respective project-ring, potentially appearing multiple times in the dataset.

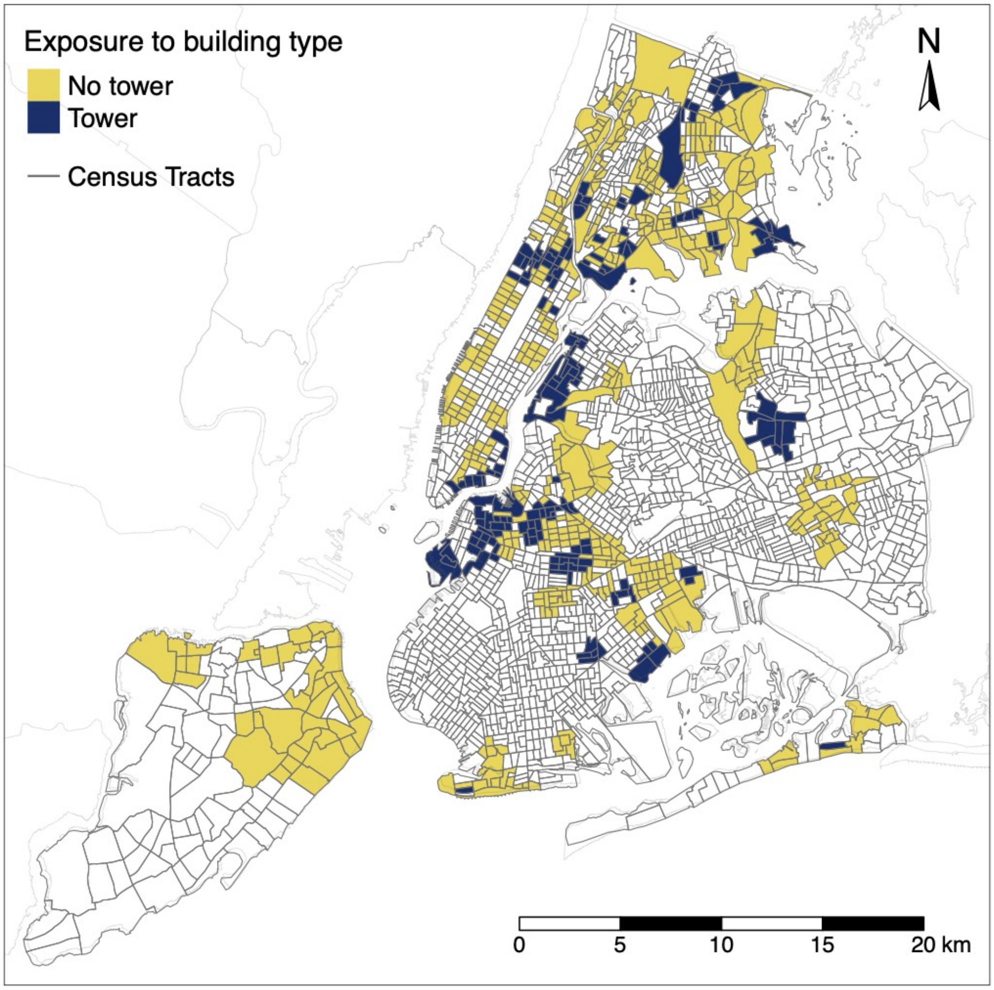
Figure 15: Spatial extent of Rental Data





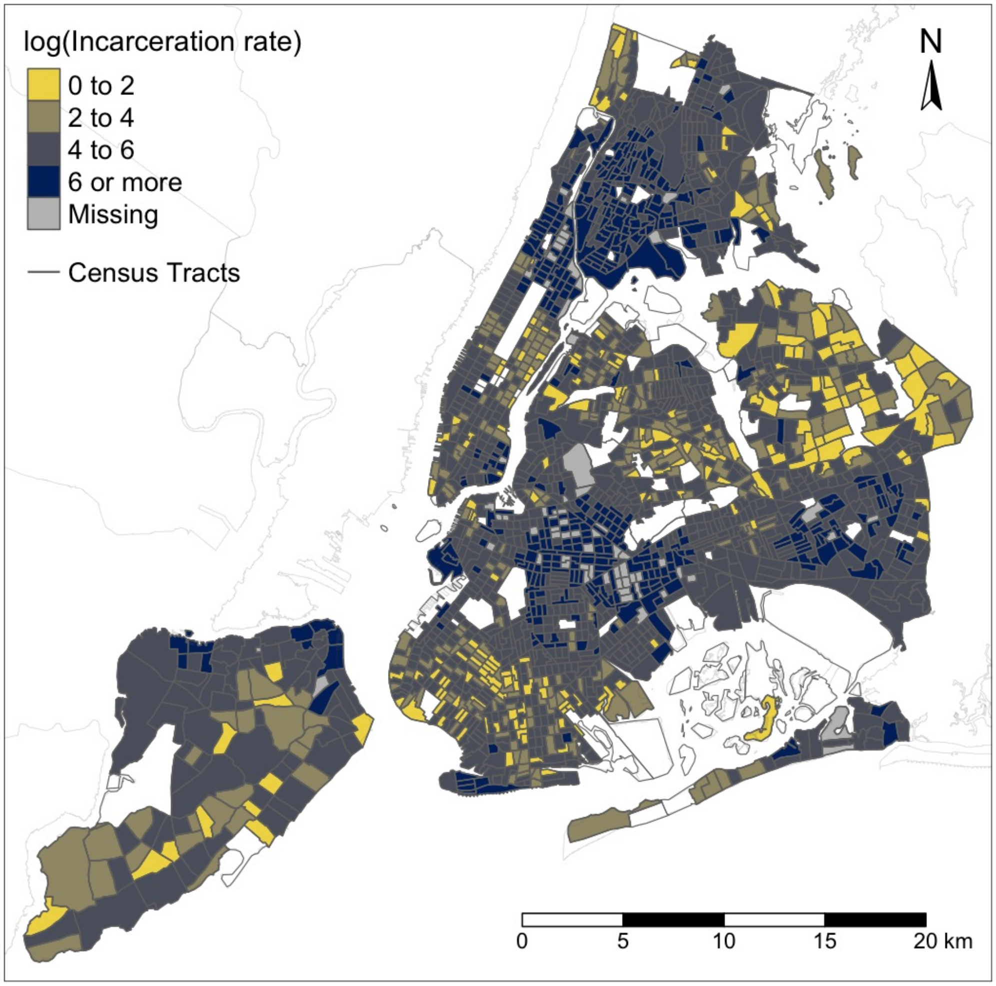
Note: Geocoded rental data fro each given census year are shown as red dots. All census tracts which have had a public housing unit ever during the observation period are colored in green.

Figure 16: Impact areas by treatment



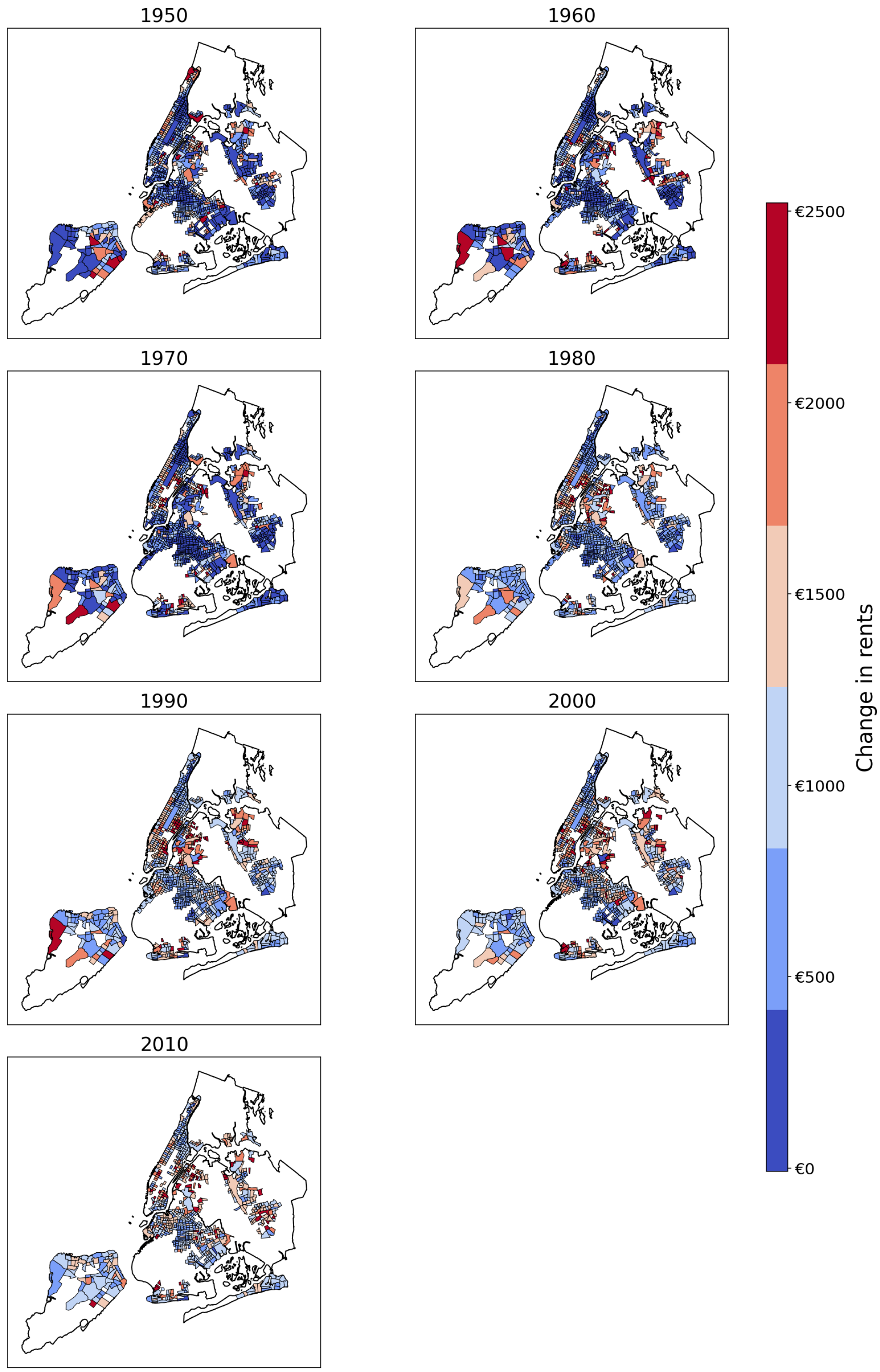
Note. Figure 16 shows impact areas for towers in the park

Figure 17: Incarceration rate



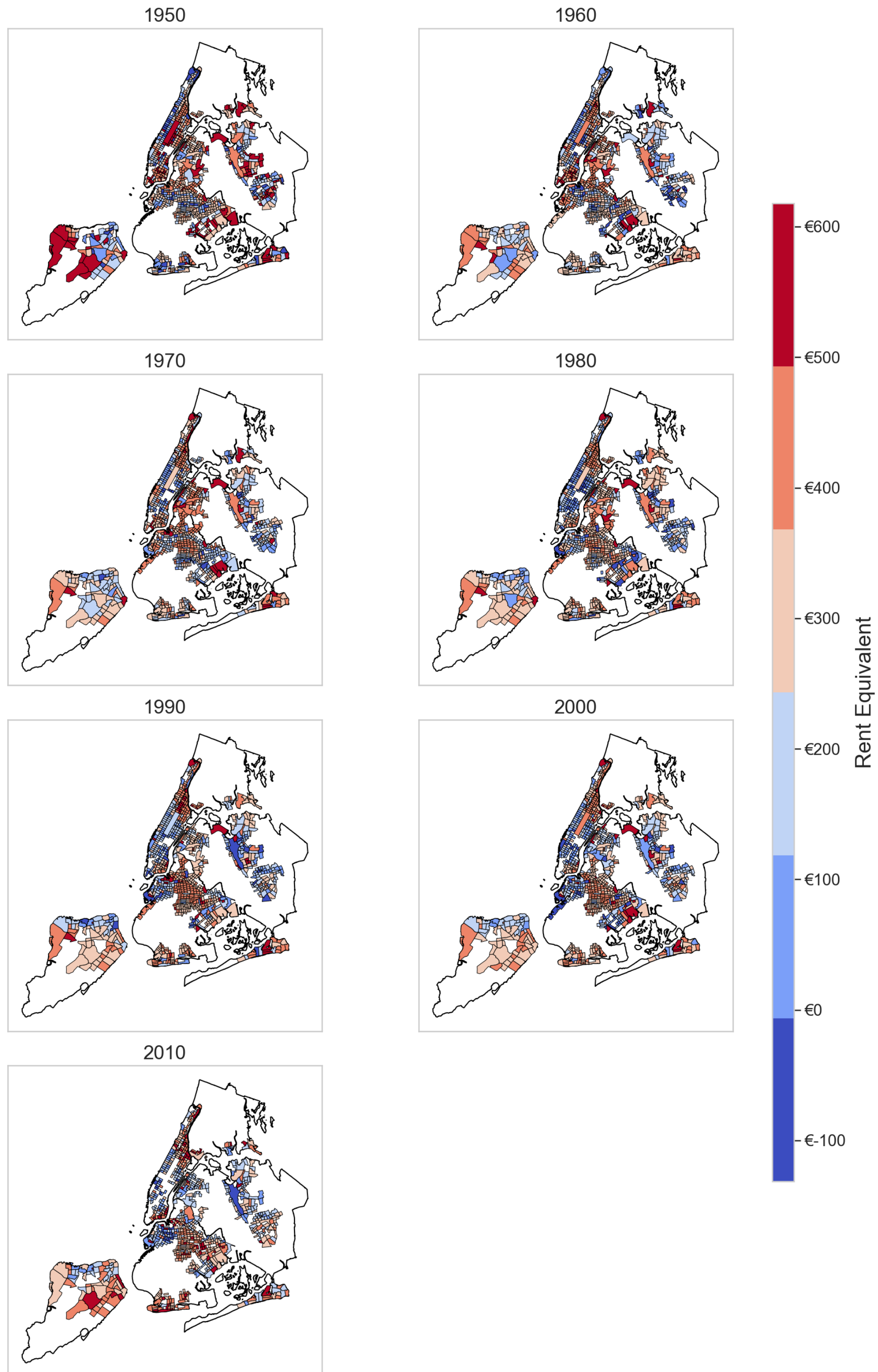
Note. Figure 17 shows the log of the incaration rate by tract

Figure 18: Rent Differentials from Simulated Public Housing Removal



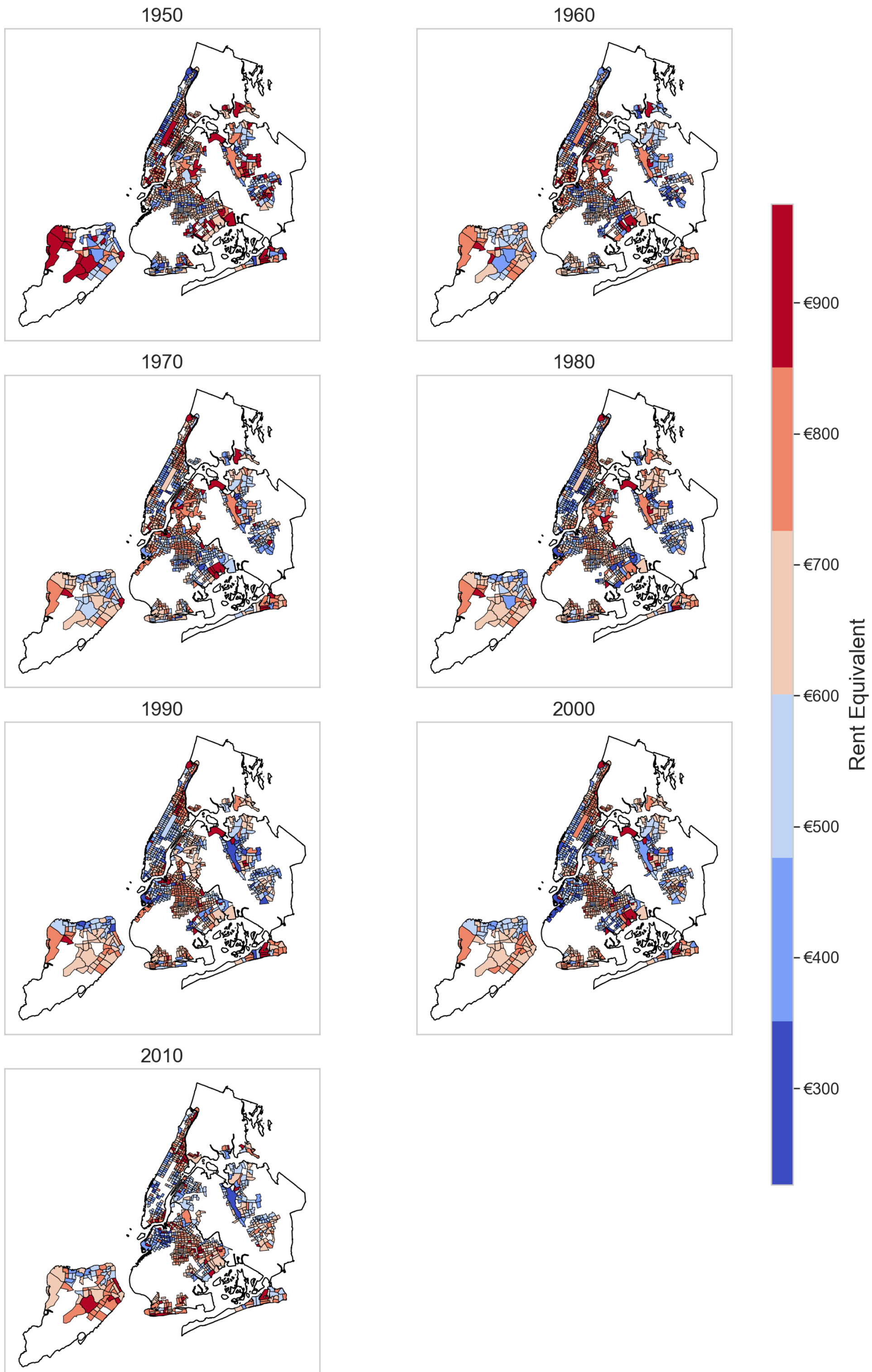
Note. Figure 18 shows rent differentials by tract; I take the difference between the actual predicted rent and the counterfactua rent; the counterfactural szenario corresponds to removing all public housing projects and letting the housing stock become private. Rent differentials are plotted by census year and within 2010 census tract boundaries; positive rent differential imply lower counterfactual rents; unobservable components of neighborhood quality are included.

Figure 19: Rent Equivalent for Whites



Note. Figure 19 shows change equivalents (RE) for *white* populations - that is, the rent differential that would make households indifferent between the counterfactual and actual states of the world as expressed by Equation 18; REs are plotted by census year and within 2010 census tract boundaries. A positive value implies that demolitions lead to higher welfare; unobservable components of neighborhood quality are included.

Figure 20: Rent Equivalent for Blacks



Note. Figure 20 shows change equivalents (RE) for *black* populations - that is, the rent differential that would make households indifferent between the counterfactual and actual states of the world as expressed by Equation 18; REs are plotted by census year and within 2010 census tract boundaries. A positive value implies that demolitions lead to higher welfare; unobservable components of neighborhood quality are included.

C Data

Table 3: Summary statistics

Variable	Mean	sd	Min	Max
Control				
Population	3245	2403	0	50449
Net Population	3245	2403	0	50449.00
Pop. Density	16700	14483	0	192780.00
Median Rent	582	478	0	17020
Hedonic Rent	613	877	0	12685
Income	21398	25034	0	326228
Owners	935	854	0	14268
Commercial Area	851736	2362728	150	27794145
Res. Units	1479	1120	1	11148
Buildings	442	360	1	3427
Tot Units	1597	1445	1	48255
Treatment				
Population	5618	3366	0	27096
Net Population	4745	3517	0	27096
Pop. Density	29171	19986	0	159814
Median Rent	461	282	0	2850
Hedonic Rent	771	1029	1	8228
Income	13794	14259	0	108164
Owners	496	615	0	6282
Commercial Area	686033	925061	375	6694034
Res. Units	1527	1686	1	23614
Buildings	221	201	1	1199
Tot Units	1567	1767	1	23868

Note. Construction variables are only available for the period from 2000 to 2010.

Table 4: Balance Tests: Stacked dataset

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variables:			$\mathbb{1}(r = PHtract)$			
log(Pop)	0.1332***			0.0877		
	(0.0319)			(0.0753)		
log(White)		0.0899			0.0203	
		(0.0560)			(0.0674)	
log(Black)			0.3360***			0.3151***
			(0.0479)			(0.0649)
Projct-Year FE	✓	✓	✓	✓	✓	✓
Project-Borough-CD FE	✗	✗	✗	✓	✓	✓
Fit statistics						
Observations	13,556	9,673	9,673	5,798	5,798	5,798
Pseudo R^2	0.03780	0.05531	0.07949	0.06473	0.06387	0.08163
BIC	26,551.8	15,235.6	15,080.3	14,801.6	14,806.1	14,714.4

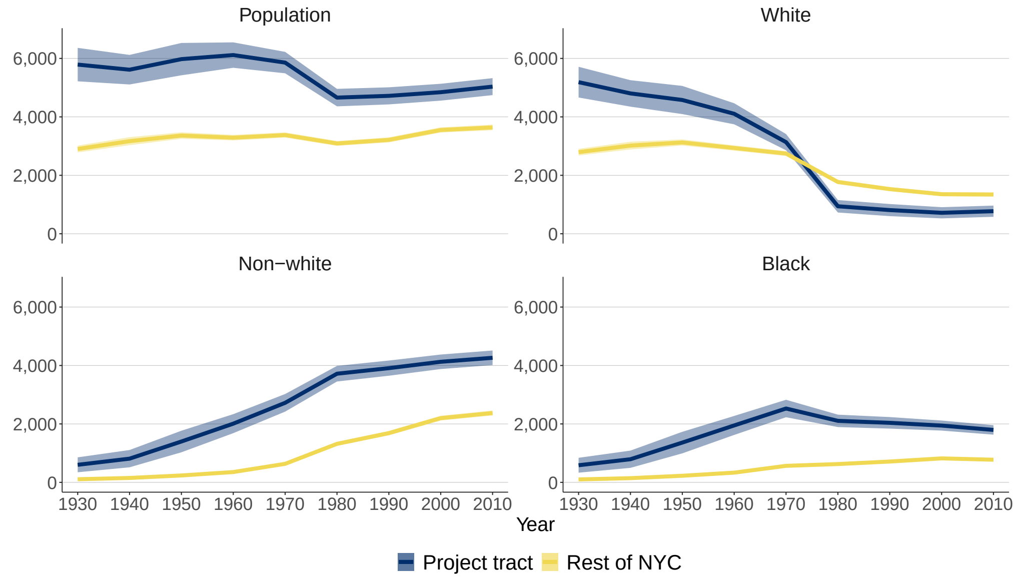
Note. Table 4 shows estimates from a logistic regression using a binaty variable equal to one if a census tract is treated and to zero if the treat is within the second ring as dependent variable. I use the stacked sample implying all fixed effects had to be interacted with project fixed effects; the sample only contains control and treatment before treament. The 1st ring around treated tracts has been excluded. Standard errors are clustred at the project level (level at which that data have been stacked).
Signif. Codes. ***: 0.01, **: 0.05, *: 0.1.

Table 5: Balance Tests: Panel dataset

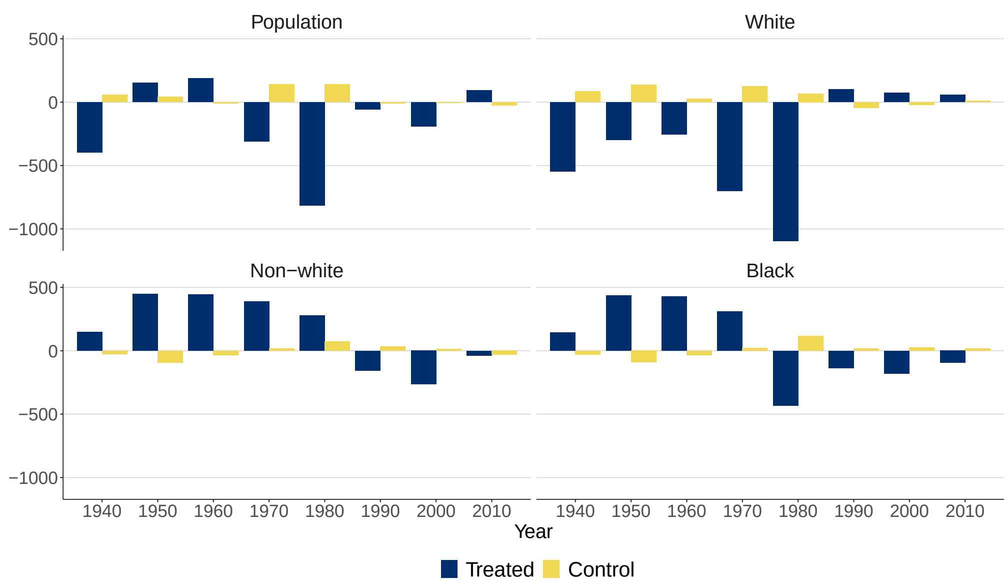
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variables:			$\mathbb{1}(r = PHtract))$			
log(Pop)	0.3634***			0.0660		
	(0.1062)			(0.0784)		
log(White)		0.2139***			0.0132	
		(0.0669)			(0.0738)	
log(Black)			0.4506***			0.4544***
			(0.0530)			(0.0808)
Year FE	✗	✗	✗	✓	✓	✓
NTA FE	✗	✗	✗	✓	✓	✓
Fit statistics						
Observations	3,199	3,199	2,809	1,478	1,478	1,478
Pseudo R^2	0.04723	0.02292	0.16209	0.19754	0.19667	0.24121
BIC	3,867.4	3,965.7	2,572.4	2,061.1	2,062.9	1,974.8

Note. Table 5 shows estimates from a logistic regression using a binaty variable equal to one if a census tract is treated and to zero if the treat is within the second ring as dependent variable. I use the panel (unstacked) sample; the sample only contains control and treatment before treament. The 1st ring around treated tracts has been excluded. Standard errors are clustred at the neighbohood level.
Signif. Codes. ***: 0.01, **: 0.05, *: 0.1.

Figure 21: Demografic trends



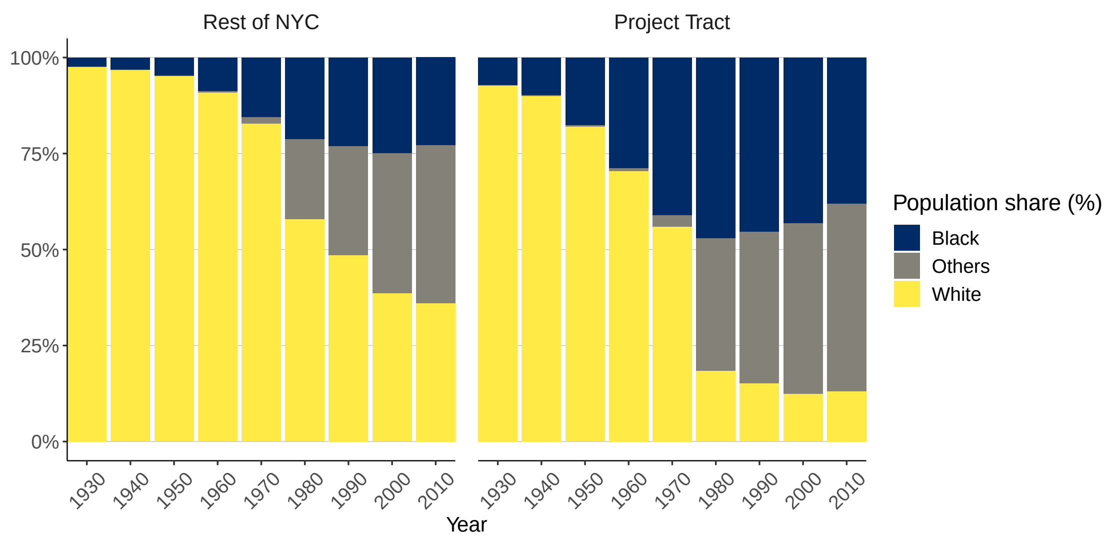
(a) Demografic trends



(b) Deviation from average city tract

Note. Figure 21 reports trends of the main outcome variables. Panel a shows yearly averages for demographic variables: total population, white, black and neiter black nor white population; I compute averages for all tracts which ever had a public housing unit within its boundaries (Project Tract) and all remaining tracts in New York City (Rest of NYC).
Panel b reports the deviation of the average treated and control tract as defined in Section 3 from the average tract in the rest of new york city.
Source. US Decennial Census, NYCHA development data book. Details on construction of the data set can be found in subsection 2.2.

Figure 22: Racial composition of PH Tracts and within the Res of New York



Note: Figure 22 reports the racial composition of census tracts with a public housing project (Project Tract) and all other tracts in New York City (Rest of NYC); I compute the average of the respective race as a share of the total tract population. Averages for all tracts which ever had a public housing unit within its boundaries (Project Tract) and all remaining tracts in New York City (Rest of NYC).
Source. US Decennial Census, NYCHA development data book. Details on construction of the data set can be found in subsection 2.2.

C.1 Public housing statistics

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
1010 EAST 178TH ST.	BRONX	21	5 %	17 %	0	✓	✗
104-14 TAPSCOTT ST.	KINGS	4	0 %	70 %	16637.53	✗	✗
131 ST. NICHOLAS AVE.	NEW YORK	17	2 %	20 %	16910.39	✓	✗
154 WEST 84TH ST.	NEW YORK	7	1 %	60 %	32218.57	✗	✗
303 VERNON AVE.	KINGS	24	9 %	10 %	15148.98	✓	✗
335 EAST 111TH ST.	NEW YORK	6	5 %	45 %	25263.52	✗	✗
344 EAST 28TH ST.	NEW YORK	26	5 %	18 %	9297.16	✓	✗
45 ALLEN ST.	NEW YORK	14	2 %	20 %	20295.78	✓	✗
572 WARREN ST.	KINGS	6	2 %	35 %	17808.76	✗	✗
830 AMSTERDAM AVE.	NEW YORK	20	1 %	27 %	16887.63	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
ADAMS	BRONX	18	19 %	14 %	14020.04	✓	✗
ALBANY	KINGS	14	22 %	15 %	17836.12	✓	✓
ALBANY II	KINGS	13.5	12 %	12 %	13431.83	✓	✗
AMSTERDAM	NEW YORK	9.5	11 %	22 %	13873.75	✗	✗
AMSTERDAM ADDITION	NEW YORK	27	1 %	49 %	23014.35	✗	✗
ARMSTRONG I	KINGS	3.5	13 %	38 %	13475.52	✗	✗
ARMSTRONG II	KINGS	4	20 %	83 %	30749.86	✗	✗
ASTORIA	QUEENS	6.5	41 %	12 %	12453.88	✗	✗
ATLANTIC TERMINAL SITE 4B	KINGS	31	5 %	17 %	21354	✓	✗
AUDUBON	NEW YORK	20	1 %	33 %	14472.17	✗	✗
AVERNE	QUEENS	7	6 %	0 %	16824.61	✗	✗
BAILEY AVE.-WEST 193RD ST.	BRONX	20	2 %	14 %	15174.28	✓	✗
BAISLEY PARK	QUEENS	8	17 %	17 %	12998.43	✗	✗
BARUCH	NEW YORK	11.3	55 %	13 %	13434.51	✓	✓
BARUCH HOUSES ADDITION	NEW YORK	23	1 %	13 %	17377.17	✓	✗
BAY VIEW	KINGS	8	20 %	15 %	15364.28	✗	✗
BAYCHESTER	BRONX	6	12 %	19 %	18574.35	✗	✗
BEACH 41ST ST.-BEACH CHANNEL DRIVE	QUEENS	13	5 %	12 %	14654.91	✓	✗
BELMONT-SUTTER AREA	KINGS	3	5 %	30 %	24441.07	✗	✗
BERRY	RICHMOND	6	9 %	13 %	20630.31	✗	✗
BERRY ST.-SOUTH 9TH ST.	KINGS	4.5	9 %	31 %	27313.67	✗	✗
BETANCES I	BRONX	9.8	41 %	30 %	11453.87	✗	✗
BETANCES II	BRONX	9.8	2 %	41 %	15741.18	✗	✗
BETANCES II, 13	BRONX	6	12 %	36 %	15734.7	✗	✗
BETANCES II, 18	BRONX	5	12 %	37 %	15737.79	✗	✗
BETANCES II, 9A	BRONX	4	5 %	56 %	15734.73	✗	✗
BETANCES IV	BRONX	4.3	41 %	39 %	17287.91	✗	✗
BETHUNE GARDENS	NEW YORK	22	9 %	12 %	15015.38	✓	✗
BLAND	QUEENS	10	5 %	16 %	15183.6	✓	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
BORINQUEN PLAZA I	KINGS	7	22 %	77 %	30424.79	✗	✗
BORINQUEN PLAZA II	KINGS	7	8 %	33 %	17560.14	✗	✗
BOSTON ROAD PLAZA	BRONX	20	4 %	18 %	16631.39	✓	✗
BOSTON SECOR	BRONX	15.5	6 %	6 %	15310.29	✓	✗
BOULEVARD	KINGS	10	77 %	15 %	13601.39	✓	✓
BRACETTI PLAZA	NEW YORK	7	4 %	42 %	20072.08	✗	✗
BREUKELEN	KINGS	5	77 %	13 %	14195.23	✗	✗
BREVOORT	KINGS	7	29 %	16 %	13959.72	✗	✗
BRONX RIVER	BRONX	14	44 %	28 %	26518.79	✓	✓
BRONX RIVER ADDITION	BRONX	10	7 %	39 %	52448.5	✓	✗
BROWN	KINGS	6	4 %	30 %	30133.76	✗	✗
BROWNSVILLE	KINGS	5.3	41 %	23 %	12804.4	✗	✗
BRYANT AVE.-EAST 174TH ST.	BRONX	6	1 %	44 %	18901.81	✗	✗
BUSHWICK	KINGS	16.5	65 %	11 %	17540.86	✓	✓
BUSHWICK II (GROUPS A & C)	KINGS	3	65 %	25 %	843.32	✗	✗
BUSHWICK II (GROUPS B & D)	KINGS	3	65 %	23 %	21588.4	✗	✗
BUSHWICK II CDA (GROUP E)	KINGS	3	65 %	28 %	26107.98	✗	✗
BUTLER	BRONX	21	82 %	32 %	26818.67	✓	✓
CAMPOS PLAZA II	NEW YORK	13	4 %	31 %	22819.79	✗	✗
CAREY GARDENS	KINGS	16	11 %	16 %	17386.52	✓	✗
CARLETON MANOR	QUEENS	11	2 %	10 %	14827.95	✓	✗
CARVER	NEW YORK	10.5	27 %	15 %	14005.12	✓	✓
CASSIDY-LAFAYETTE	RICHMOND	6	3 %	24 %	13342.19	✗	✗
CASTLE HILL	BRONX	16	103 %	20 %	35120.17	✓	✓
CHELSEA	NEW YORK	21	4 %	25 %	15640.2	✗	✗
CHELSEA ADDITION	NEW YORK	14	2 %	32 %	34215.94	✗	✗
CLAREMONT PARKWAY-FRANKLIN AVE.	BRONX	5	22 %	52 %	53262.25	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
CLASON POINT GARDENS	BRONX	2	68 %	42 %	13861.86	✗	✗
CLINTON	NEW YORK	13.5	25 %	43 %	31372.86	✓	✗
COLLEGE AVE.-EAST 165TH ST.	BRONX	6	1 %	45 %	20124.29	✗	✗
CONEY ISLAND	KINGS	14	17 %	13 %	15360.66	✓	✗
CONEY ISLAND I (SITE 1B)	KINGS	18	3 %	15 %	18386.64	✓	✗
CONEY ISLAND I (SITE 8)	KINGS	14	3 %	19 %	5727.49	✓	✗
CONEY ISLAND I (SITES 4 & 5)	KINGS	17	8 %	21 %	19571.76	✓	✗
CONLON LIHFE TOWER	QUEENS	13	1 %	22 %	20199.68	✓	✗
COOPER PARK	KINGS	7	2 %	16 %	13091.13	✗	✗
CORSI HOUSES	NEW YORK	16	2 %	64 %	22120.14	✗	✗
CYPRESS HILLS	KINGS	7	72 %	18 %	12854.85	✗	✗
DAVIDSON	BRONX	8	3 %	30 %	20786.38	✗	✗
DE HOSTOS APT.	NEW YORK	22	1 %	32 %	16002.53	✗	✗
DOUGLASS	NEW YORK	13.5	18 %	15 %	15141.11	✓	✗
DOUGLASS ADDITION	NEW YORK	16	1 %	37 %	19795.55	✗	✗
DOUGLASS I	NEW YORK	12.6	18 %	18 %	15142.1	✓	✗
DOUGLASS II	NEW YORK	15.2	12 %	11 %	15141.59	✓	✗
DREW-HAMILTON	NEW YORK	21	31 %	48 %	29486.64	✗	✗
DYCKMAN	NEW YORK	14	9 %	13 %	13553.34	✓	✗
EAGLE AVE.-EAST 163RD ST.	BRONX	6	1 %	35 %	15503.08	✗	✗
EAST 152ND ST.-COURTLANDT AVE.	BRONX	12.5	3 %	34 %	21195.34	✗	✗
EAST 165TH ST.-BRYANT AVE.	BRONX	3	34 %	60 %	43071.61	✗	✗
EAST 173RD ST.-VYSE AVE.	BRONX	3	6 %	28 %	25806.78	✗	✗
EAST 180TH ST.-MONTEREY AVE.	BRONX	10	3 %	39 %	16529.67	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
EAST NEW YORK CITY LINE	KINGS	3	11 %	96 %	47424.71	✗	✗
EAST RIVER	NEW YORK	9	14 %	22 %	5973.44	✗	✗
EASTCHESTER GARDENS	BRONX	7.5	14 %	18 %	17223.14	✗	✗
EDENWALD	BRONX	8.5	89 %	16 %	13967.39	✗	✗
EDGEMERE	QUEENS	8	9 %	0 %	15053.85	✗	✗
EDWIN MARKHAM HOUSES	RICHMOND	2	5 %	0 %	9481.87	✗	✗
ELLIOTT	NEW YORK	11.5	17 %	44 %	22440.92	✓	✗
FARRAGUT	KINGS	14	37 %	14 %	11169.27	✓	✓
FENIMORE-LEFFERTS	KINGS	2	4 %	121 %	37661.6	✗	✗
FIORENTINO PLAZA	KINGS	4	5 %	44 %	14991.69	✗	✗
FIRST HOUSES	NEW YORK	4.5	6 %	46 %	47867.36	✗	✗
FOREST	BRONX	11	86 %	32 %	27020.62	✓	✓
FOREST HILLS COOP (108TH ST.-62ND DRIVE)	QUEENS	12	86 %	30 %	58367.75	✓	✗
FORT INDEPENDENCE ST.-HEATH AVE.	BRONX	21	8 %	17 %	17291.81	✓	✗
FULTON	NEW YORK	15.5	30 %	52 %	32442.47	✗	✗
GARVEY (GROUP A)	KINGS	10	7 %	29 %	16208.85	✗	✗
GLEBE AVE.-WESTCHESTER AVE.	BRONX	6	3 %	40 %	19328.03	✗	✗
GLENMORE PLAZA	KINGS	17.3	15 %	27 %	47487.95	✓	✗
GLENWOOD	KINGS	6	80 %	19 %	18248.75	✗	✗
GOMPERS	NEW YORK	20	9 %	15 %	14358.73	✓	✗
GOWANUS	KINGS	9.2	27 %	19 %	15437.86	✗	✗
GRANT	NEW YORK	17	71 %	31 %	26710.01	✓	✓
GRAVESEND	KINGS	7	15 %	17 %	12687.7	✗	✗
GUN HILL	BRONX	14	18 %	16 %	18451.54	✓	✗
HABER	KINGS	14	1 %	18 %	20365.75	✓	✗
HAMMEL	QUEENS	7	7 %	17 %	12922.82	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
HARBORVIEW TERRACE	NEW YORK	14.5	3 %	19 %	27215.66	✓	✗
HARLEM RIVER	NEW YORK	4.5	10 %	32 %	22725.13	✗	✗
HARLEM RIVER II	NEW YORK	15	1 %	25 %	14497.91	✗	✗
HERNANDEZ	NEW YORK	17	4 %	29 %	8810.02	✗	✗
HIGHBRIDGE GARDENS	BRONX	13.5	19 %	10 %	12394.14	✓	✗
HOE AVE. EAST 173RD ST.	BRONX	6	1 %	42 %	30813.29	✗	✗
HOLMES TOWERS	NEW YORK	25	5 %	16 %	16185.85	✓	✗
HOPE GARDENS	KINGS	10.5	14 %	20 %	20201.41	✓	✗
HOWARD	KINGS	10	29 %	13 %	14880.77	✓	✓
HOWARD AVE.	KINGS	3	5 %	38 %	23616.34	✗	✗
HOWARD AVE.-PARK PLACE	KINGS	3	21 %	56 %	48106.24	✗	✗
HUGHES APT.	KINGS	22	11 %	10 %	15380.36	✓	✗
HYLAN	KINGS	19	7 %	15 %	20581.19	✓	✗
INDEPENDENCE	KINGS	21	8 %	19 %	16316.17	✓	✗
INGERSOLL	KINGS	8.5	166 %	53 %	25352.68	✗	✗
INTERNATIONAL TOWER	QUEENS	10	2 %	30 %	31318.89	✗	✗
ISAACS	NEW YORK	24	7 %	21 %	16975.43	✓	✗
JACKSON	BRONX	16	17 %	17 %	13916.31	✓	✗
JEFFERSON	NEW YORK	11.3	33 %	20 %	15258.23	✓	✓
JOHNSON	NEW YORK	14	24 %	19 %	13620.08	✓	✓
KING TOWERS	NEW YORK	13.5	102 %	49 %	37018.38	✓	✓
KINGSBOROUGH	KINGS	6	50 %	37 %	12617.82	✗	✗
KINGSBOROUGH EXTENSION	KINGS	25	2 %	11 %	18363.91	✓	✗
LA GUARDIA	NEW YORK	16	65 %	27 %	25240.97	✓	✓
LA GUARDIA ADDITION	NEW YORK	16	1 %	22 %	20199.31	✓	✗
LAFAYETTE	KINGS	16	18 %	18 %	13035.17	✓	✗
LATIMER GARDENS	QUEENS	10	3 %	24 %	19955.1	✗	✗
LEAVITT ST.-34TH AVE.	QUEENS	6	0 %	42 %	23245.3	✗	✗
LEHMAN VILLAGE	NEW YORK	20	16 %	16 %	14090.79	✓	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
LEXINGTON	NEW YORK	14	8 %	23 %	13861.49	✗	✗
LINCOLN	NEW YORK	10	22 %	19 %	13509.25	✓	✓
LINDEN	KINGS	11	66 %	13 %	16237.47	✓	✓
LOW HOUSES	KINGS	17.5	8 %	18 %	13935.44	✓	✗
LOWER EAST SIDE I INFILL	NEW YORK	6.5	12 %	86 %	60025.64	✗	✗
LOWER EAST SIDE II	NEW YORK	3	15 %	36 %	26772.4	✗	✗
LOWER EAST SIDE III	NEW YORK	4	4 %	53 %	26611.44	✗	✗
MANHATTANKVILLE	NEW YORK	20	17 %	16 %	15399.38	✓	✗
MARBLE HILL	BRONX	14.5	87 %	46 %	37699.72	✓	✓
MARCY	KINGS	6	72 %	19 %	14923.66	✗	✗
MARCY AVE.-GREENE AVE. SITE A	KINGS	3	72 %	32 %	25611.67	✗	✗
MARCY AVE.-GREENE AVE. SITE B	KINGS	3	72 %	27 %	0	✗	✗
MARINER'S HARBOR	RICHMOND	4.5	23 %	13 %	16112.7	✗	✗
MARLBORO	KINGS	11.5	233 %	53 %	327238.76	✓	✓
MARSHALL PLAZA	NEW YORK	13	1 %	52 %	31013.13	✗	✗
MCKINLEY	BRONX	16	23 %	28 %	25059.92	✓	✗
MELROSE	BRONX	14	23 %	13 %	11037.43	✓	✓
MELTZER TOWER	NEW YORK	20	6 %	14 %	11166.56	✓	✗
METRO NORTH PLAZA	NEW YORK	8.7	5 %	35 %	975.58	✗	✗
MIDDLETOWN PLAZA	BRONX	15	2 %	20 %	19961.87	✓	✗
MILL BROOK	BRONX	16	87 %	28 %	31966.06	✓	✓
MILL BROOK EXTENSION	BRONX	16	2 %	38 %	14380.71	✗	✗
MITCHEL	BRONX	18.7	60 %	14 %	14516.47	✓	✓
MONROE	BRONX	12.3	16 %	15 %	12511.6	✓	✗
MOORE	BRONX	20	14 %	37 %	28596.78	✓	✗
MORRIS I	BRONX	18	28 %	16 %	13930.7	✓	✓
MORRIS II	BRONX	18	29 %	14 %	13931.53	✓	✓
MORRISANIA	BRONX	16	3 %	21 %	14337.98	✓	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
MORRISANIA AIR RIGHTS	BRONX	23.7	46 %	70 %	50069.13	✗	✗
MOTT HAVEN	BRONX	21	41 %	38 %	31529.41	✓	✓
MURPHY	BRONX	20	72 %	18 %	16129.52	✓	✓
NEW LANE AREA	RICHMOND	10	1 %	24 %	29977.41	✗	✗
NOSTRAND	KINGS	6	41 %	17 %	19600.79	✗	✗
OCEAN BAY APT. (BAYSIDE)	QUEENS	8	16 %	31 %	0	✗	✗
OCEAN BAY APT. (OCEANSIDE)	QUEENS	6	16 %	37 %	0	✗	✗
OCEAN HILL APT.	KINGS	14	5 %	15 %	15419.18	✓	✗
ODWYER GARDENS	KINGS	15.5	12 %	12 %	23581.7	✓	✗
PALMETTO GARDENS	KINGS	6	11 %	46 %	25734.41	✗	✗
PARK AVE.-EAST 122ND, 123RD ST.S	NEW YORK	6	1 %	45 %	26105.94	✗	✗
PARKSIDE	BRONX	10.5	23 %	20 %	15240.84	✓	✓
PATTERSON	BRONX	9.5	13 %	22 %	15299.06	✗	✗
PELHAM PARKWAY	BRONX	6	78 %	36 %	39522.81	✗	✗
PENNSYLVANIA AVE.-WORTMAN AVE.	KINGS	12	3 %	17 %	15379.9	✓	✗
PINK	KINGS	8	74 %	14 %	16615.78	✗	✗
POLO GROUNDS TOWERS	NEW YORK	30	27 %	13 %	13747.57	✓	✓
POMONOK	QUEENS	6	43 %	17 %	15151.29	✗	✗
PROSPECT PLAZA	KINGS	13.5	6 %	0 %	18891.93		✗
PSS GRANDPARENT FAMILY APT.	BRONX	6	71 %	0 %	0	✗	✗
QUEENSBRIDGE NORTH	QUEENS	6	33 %	22 %	11577.49	✗	✗
QUEENSBRIDGE SOUTH	QUEENS	6	46 %	16 %	11600.84	✗	✗
RANDALL AVE.-BALCOM AVE.	BRONX	6	6 %	21 %	27045.02	✗	✗
RANGEL	NEW YORK	14	19 %	15 %	12890.05	✓	✗
RAVENSWOOD	QUEENS	6.5	161 %	42 %	26140.9	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
RED HOOK EAST	KINGS	4	33 %	22 %	0	✗	✗
RED HOOK I	KINGS	4	33 %	22 %	12854.93	✗	✗
RED HOOK II	KINGS	7.7	31 %	14 %	13387.07	✗	✗
RED HOOK WEST	KINGS	7.7	33 %	20 %	0	✗	✗
REDFERN	QUEENS	6.5	17 %	12 %	17873.97	✗	✗
REID APT.	KINGS	20	5 %	19 %	20357.44	✓	✗
RICHMOND TERRACE	RICHMOND	8	12 %	25 %	29558	✗	✗
RIIS	NEW YORK	11	26 %	20 %	14500.36	✓	✓
RIIS II	NEW YORK	11	13 %	17 %	13341.15	✓	✗
ROBBINS PLAZA	NEW YORK	20	1 %	54 %	18921.89	✗	✗
ROBINSON	NEW YORK	8	2 %	35 %	17790.85	✗	✗
ROOSEVELT I	KINGS	15.7	39 %	31 %	30201.79	✓	✗
ROOSEVELT II	KINGS	14.5	9 %	16 %	13709.41	✓	✗
RUTGERS	NEW YORK	20	8 %	17 %	14012.34	✓	✗
ST. MARY PARK	BRONX	21	59 %	19 %	33509.2	✓	✓
ST. NICHOLAS	NEW YORK	14	30 %	15 %	12541.12	✓	✓
SARATOGA VILLAGE	KINGS	16	3 %	13 %	14019.08	✓	✗
SEDGWICK	BRONX	14.5	11 %	19 %	14277.67	✓	✗
SEWARD PARK EXTENSION	NEW YORK	23	12 %	53 %	26753.18	✗	✗
SHEEPSHEAD BAY	KINGS	6	42 %	15 %	18941.84	✗	✗
SMITH	NEW YORK	17	56 %	13 %	14525.32	✓	✓
SOTOMAYOR HOUSES	BRONX	7	47 %	14 %	12920.44	✗	✗
SOUNDVIEW	BRONX	7	22 %	14 %	12564.55	✗	✗
SOUTH BEACH	RICHMOND	6	8 %	10 %	68082.69	✗	✗
SOUTH BRONX AREA (SITE 402)	BRONX	3	6 %	28 %	21476.23	✗	✗
SOUTH JAMAICA I	QUEENS	3.5	6 %	21 %	12927.68	✗	✗
SOUTH JAMAICA II	QUEENS	3.5	39 %	40 %	29680.7	✗	✗
STANTON ST.	NEW YORK	6	0 %	72 %	0	✗	✗
STAPLETON	RICHMOND	8	11 %	10 %	15069.18	✗	✗
STEBBINS AVE.-HEWITT PLACE	BRONX	3	5 %	34 %	25587.74	✗	✗
STRAUS	NEW YORK	19.5	2 %	27 %	16753.55	✗	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
STUYVESANT GARDENS I	KINGS	4	12 %	46 %	14969.67	✗	✗
STUYVESANT GARDENS II	KINGS	7	4 %	23 %	30034.63	✗	✗
SUMNER	KINGS	9.5	69 %	14 %	15479.16	✗	✗
SURFSIDE GARDENS	KINGS	14.5	27 %	23 %	34936.28	✓	✗
TAFT	NEW YORK	19	28 %	20 %	14323.72	✓	✓
TAYLOR ST.-WYTHE AVE.	KINGS	11	10 %	31 %	20174.57	✗	✗
TELLER AVE.-EAST 166TH ST.	BRONX	6	2 %	45 %	16156.75	✗	✗
THOMAS APT.	NEW YORK	11	1 %	71 %	39981.83	✗	✗
THROGGS NECK	BRONX	5	34 %	16 %	15282.2	✗	✗
THROGGS NECK ADDITION	BRONX	9.5	8 %	10 %	9815.11	✗	✗
TILDEN	KINGS	16	26 %	14 %	12180.43	✓	✓
TODT HILL	RICHMOND	6	15 %	14 %	26611.28	✗	✗
TOMPKINS	KINGS	12	80 %	18 %	13770.27	✓	✓
TWIN PARKS EAST (SITE 9)	BRONX	14	3 %	16 %	19885.95	✓	✗
TWIN PARKS WEST (SITES 1 & 2)	BRONX	16	3 %	18 %	19334.52	✓	✗
TWO BRIDGES URA (SITE 7)	NEW YORK	26	3 %	42 %	21310.83	✗	✗
UNION AVE.-EAST 163RD ST.	BRONX	9	5 %	16 %	27612.33	✗	✗
UNION AVE.-EAST 166TH ST.	BRONX	3	4 %	39 %	25823.16	✗	✗
UNITY PLAZA (SITES 17,24,25A)	KINGS	6	5 %	34 %	13930.23	✗	✗
UNITY PLAZA (SITES 4-27)	KINGS	6	29 %	72 %	34603.65	✗	✗
UPACA (SITE 5)	NEW YORK	11	3 %	23 %	30326.73	✓	✗
UPACA (SITE 6)	NEW YORK	12	2 %	23 %	30999.35	✓	✗
VAN DYKE I	KINGS	14	41 %	17 %	13235.53	✓	✓
VAN DYKE II	KINGS	14	2 %	22 %	21619.03	✓	✗
VANDALIA AVE.	KINGS	10	2 %	13 %	31286.39	✓	✗

Table 6: NYCHA developments

Development	County	Avg. stories	Area share	Coverage	Const. cost	"Tower"	"Adj. Tower"
VLADECK	NEW YORK	6	18 %	30 %	12607.42	✗	✗
VLADECK II	NEW YORK	6	3 %	30 %	11751.67	✗	✗
WAGNER	NEW YORK	11.5	139 %	39 %	40743.13	✓	✓
WALD	NEW YORK	12.5	53 %	19 %	14293.26	✓	✓
WASHINGTON	NEW YORK	13	120 %	28 %	25360.98	✓	✓
WATSON AVE.	BRONX	6	2 %	33 %	31211.63	✗	✗
WEBSTER	BRONX	21	10 %	16 %	15162.8	✓	✗
WEEKSVILLE GARDENS	KINGS	4.5	12 %	45 %	14861.46	✗	✗
WEST BRIGHTON I	RICHMOND	8	47 %	18 %	15249.15	✗	✗
WEST BRIGHTON II	RICHMOND	1	27 %	37 %	19274.24	✗	✗
WEST TREMONT AVE.-SEDGWICK AVE. AREA	BRONX	12	3 %	26 %	21791.24	✗	✗
WHITE	NEW YORK	20	2 %	66 %	23161.6	✗	✗
WHITMAN	KINGS	10	140 %	39 %	16899.42	✓	✓
WILLIAMS PLAZA	KINGS	17.5	101 %	33 %	31076.56	✓	✓
WILLIAMSBURG	KINGS	4	101 %	64 %	47371.67	✗	✗
WILSON	NEW YORK	20	4 %	17 %	11827.57	✓	✗
WISE TOWERS	NEW YORK	19	102 %	104 %	57254.33	✗	✗
WOODSIDE	QUEENS	6	41 %	19 %	25029.05	✗	✗
WOODSON	KINGS	17.5	6 %	17 %	19755.5	✓	✗
WSUR (SITE A) 120 WEST 94TH ST.	NEW YORK	9	1 %	30 %	17976.39	✗	✗
WSUR (SITE B) 74 WEST 92ND ST.	NEW YORK	22	1 %	52 %	42289.45	✗	✗
WSUR (SITE C) 589 AMSTERDAM AVE.	NEW YORK	18	1 %	31 %	45047.46	✗	✗
WYCKOFF GARDENS	KINGS	21	14 %	12 %	14477.15	✓	✗

Note. Table 6 shows all NYACHA developments used in the analysis. The list only includes newly built projects. Additionally, I report the average by project if projects since projects consist of several buildings, the area share - that is, the total ground area relative to the total 2010 census tract area, the ground coverage - that is, the total ground floor area of the building footprints of a development, divided by a development's total area and construction costs per room (in 2010 constant prices). The last two columns indicate weather a project has been classified as a "Tower" or "Adjusted Tower" following the definition given in Section 5.1.
Source. NYCHA development data book.

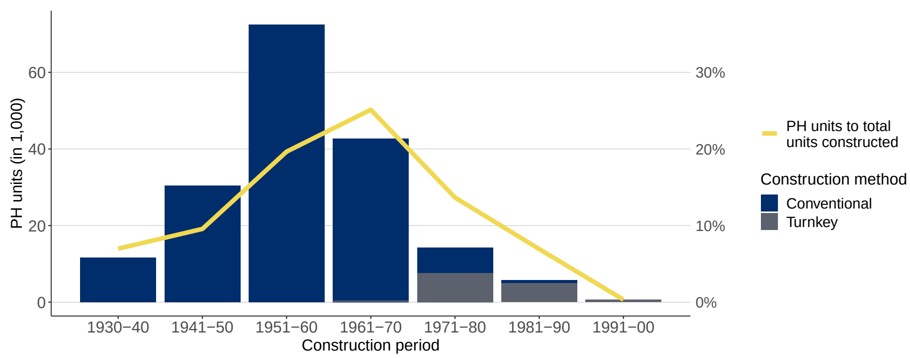
Table 7: Public housing characteristics by construction decade

	1930-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
	Total counts						
Projects	10.00	28.00	60.00	77.00	60.00	26.00	9.00
Units	10955	25432	63006	37662	13115	5335	587
	Median characteristics						
Units	1171	967	1040	407	208	184	48
Height (stry)	4.50	8.00	11.17	17.33	9.75	6.25	4.50
Ground coverage	26%	19%	15%	17%	34%	28%	43%
Area share	25%	23%	30%	9%	04%	05%	9%
Construction cost	$12,854.93	$14,712.01	$13,963.55	$15,345.32	$17,287.91	$25,965.57	$26,962.55

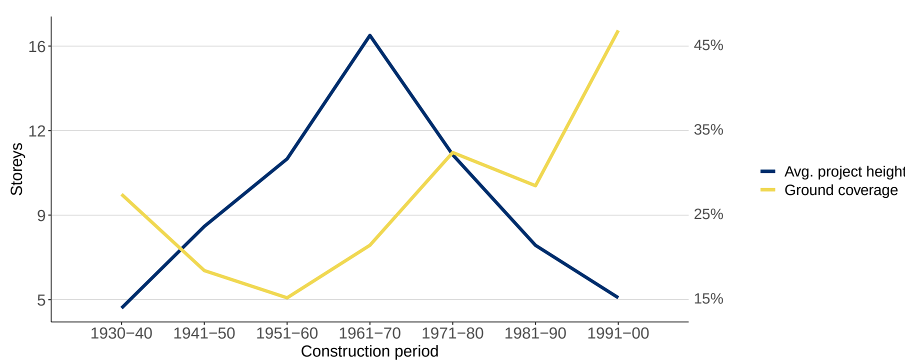
Note. Projects were grouped into construction period cohorts based on their opening date. The first two rows report total counts by construction decade. Row three to six shows median public housing characteristics by construction decade. Area share refers to tract area occupied by public housing projects. Ground coverage refers to the build-up share of public housing land. Average height is given in storeys by project. Construction cost per room are deflated by 2010 Dollars.
Source. NYCHA Development Data Book. Details on construction of the data set can be found in subsection 2.2.

Figure 23: Public Housing in New York City

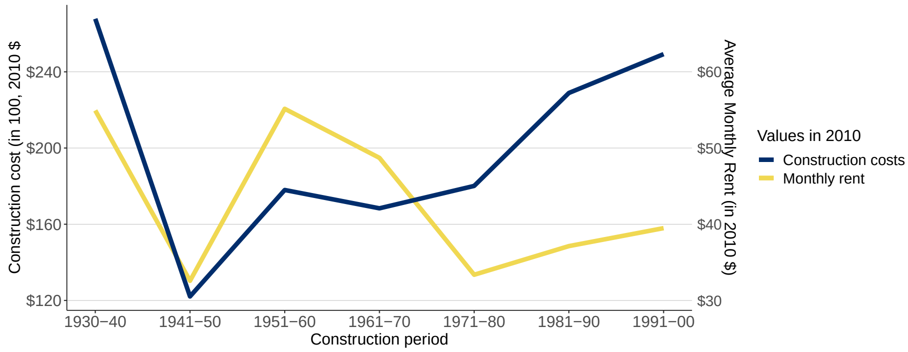
(a) Construction by Decade



(b) Height and Ground Coverage



(c) Rent and Construction Costs



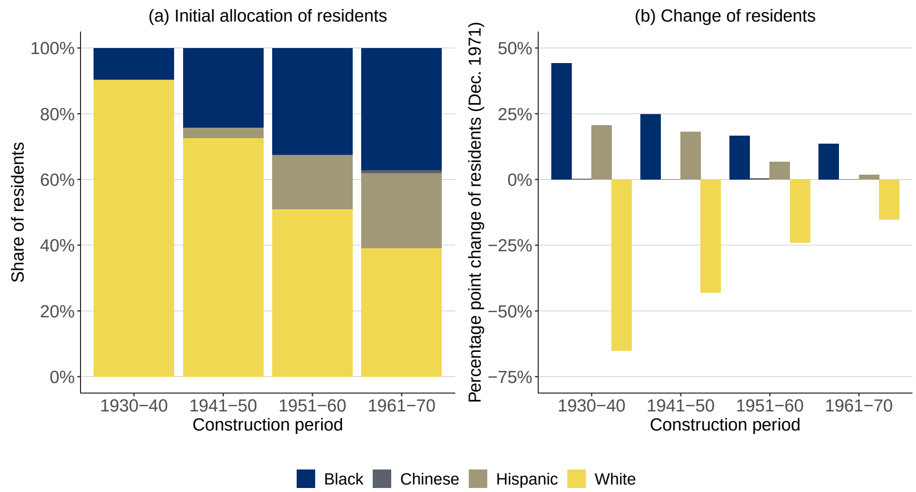
Note. Figure 23 reports trends of public housing by construction decade. Projects have been grouped in constriction periods by their completion date. Panel a shows the total number of units within a decade. There are two acquisition methods. Under the *Conventional Method*, the authority acquires the land and contracts for General Construction, Heating and Ventilation, Elevators, Electrical, and Plumbing work. Under the *Turnkey Method*, the developer buys the land, constructs the Development, and sells it to the Authority under the terms of a pre-agreed contract. The yellow line shows the total number of public units as a share of total units constructed in New York City within the decade. Panel b shows the average height and ground coverage ratio - this is the total ground floor area of the building footprints of a development, divided by a development's total area. The average was taken across all public housing projects constructed within a decade. Panel c reports ask real rent at opening date in a public housing project average by construction cohort and the average cohort real construction costs; both variables have been defalated using 2010 CPI.
Source. NYCHA development data book. Details on the construction of data the data set can be found in subsection 2.2.

C.2 Rent data collection

Rent data were collected from the real estate section of the New York Times (NYT). This was undertaken in context for the HIstorical Prices in HOusing Project (HiPHoP) project at Trinity College Dublin. Figure 25 Panel b gives an example of a typical listing page in the NYT. For each census year, the standard approach was to choose 12 sets of listings, one per month collected on the last Sundays. Sundays were chosen as the day with by far the largest set of real estate listings. This was true for the vast majority of years; where another day of the week had the largest set of listings, this was used instead. Within each set of listings, targets were set for valid rental ads: 1500 rental listings.

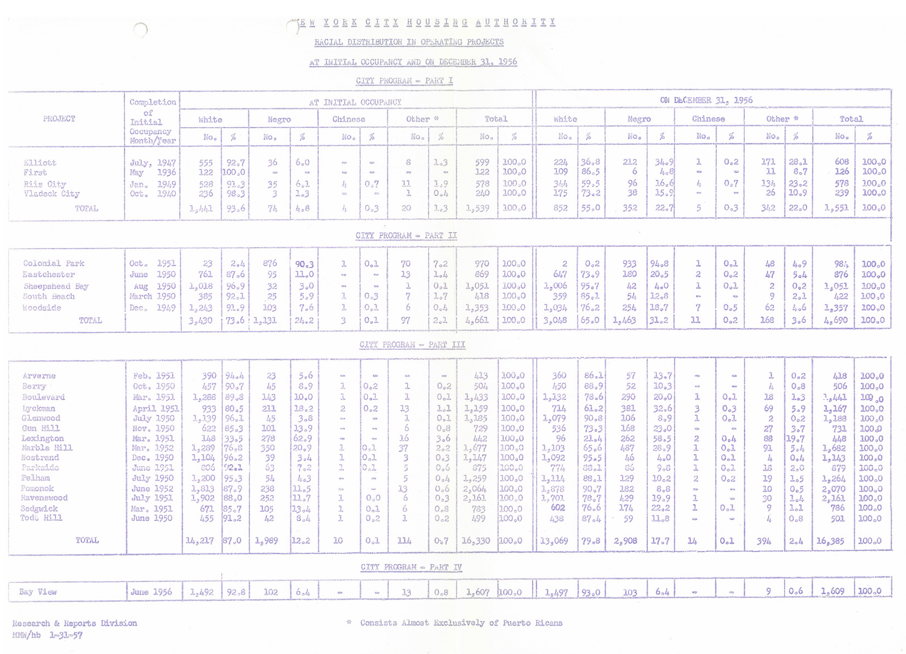
The final listings which were used depended on the fact of having the correct address. For this to have either cross street or street number was required to be available, to ensure the correct location. In a next step the Google Geocode API was used to geocode the addresses. If an address matched main and cross street or with the exact street number the rental listing was included. If not it was kicked out. This procedure yields the final sample of rental listings shown in Table 8. The years 1930 and 1940 has more observations than the following years since existing data from HiPHoP had been added.

Figure 24: Racial composition by construction decade



Note. Figure 24 displays the ethnic composition of NYCHA projects based on their construction decade. Projects have been grouped in constriction periods by their completion date. Panel (a) presents the resident shares by ethnicity at the time of initial occupancy. Panel (b) illustrates change for each ethnic group from the project's start date to December 1971 in percentage points.
Source. La Guardia and Wagner Archives, NYCHA development data book. Details on the construction of the data set can be found in subsection 2.2.

Figure 25: Example of data used



NEW YORK CITY HOUSING AUTHORITY

RACIAL DISTRIBUTION IN OPERATING PROJECTS

AT INITIAL OCCUPANCY AND ON DECEMBER 31, 1956

PROJECT	Completion of Initial Occupancy Month/Year	AT INITIAL OCCUPANCY										ON DECEMBER 31, 1956									
		White		Negro		Chinese		Other *		Total		White		Negro		Chinese		Other *		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
CITY PROGRAM - PART I																					
Elliott	July, 1947	555	92.7	36	6.0	-	-	8	1.3	599	100.0	224	36.8	212	34.9	1	0.2	171	28.1	608	100.0
First	May 1936	122	100.0	-	-	-	-	-	-	122	100.0	109	86.5	6	4.8	-	-	11	8.7	126	100.0
Riis City	Jan. 1949	528	91.3	35	6.1	4	0.7	11	1.9	578	100.0	344	59.5	96	16.6	4	0.7	134	23.2	578	100.0
Vladeck City	Oct. 1940	236	98.3	3	1.3	-	-	1	0.4	240	100.0	175	73.2	38	15.9	-	-	26	10.9	239	100.0
TOTAL		1,441	93.6	74	4.8	4	0.3	20	1.3	1,539	100.0	852	55.0	352	22.7	5	0.3	342	22.0	1,551	100.0
CITY PROGRAM - PART II																					
Colonial Park	Oct. 1951	23	2.4	876	90.3	1	0.1	70	7.2	970	100.0	2	0.2	933	94.8	1	0.1	48	4.9	984	100.0
Eastchester	June 1950	761	87.6	95	11.0	-	-	13	1.4	869	100.0	647	73.9	180	20.5	2	0.2	47	5.4	876	100.0
Sheepshead Bay	Aug 1950	1,018	96.9	32	3.0	-	-	1	0.1	1,051	100.0	1,006	95.7	42	4.0	1	0.1	2	0.2	1,051	100.0
South Beach	March 1950	385	92.1	25	5.9	1	0.3	7	1.7	418	100.0	359	85.1	54	12.8	-	-	9	2.1	422	100.0
Woodside	Dec. 1949	1,243	91.9	103	7.6	1	0.1	6	0.4	1,353	100.0	1,034	76.2	254	18.7	7	0.5	62	4.6	1,357	100.0
TOTAL		3,430	73.6	1,131	24.2	3	0.1	97	2.1	4,661	100.0	3,048	65.0	1,463	31.2	11	0.2	168	3.6	4,690	100.0
CITY PROGRAM - PART III																					
Arverne	Feb. 1951	390	94.4	23	5.6	-	-	-	-	413	100.0	360	86.1	57	13.7	-	-	1	0.2	418	100.0
Berry	Oct. 1950	457	90.7	45	8.9	1	0.2	1	0.2	504	100.0	450	88.9	52	10.3	-	-	4	0.8	506	100.0
Boulevard	Mar. 1951	1,288	89.8	143	10.0	1	0.1	1	0.1	1,433	100.0	1,132	78.6	290	20.0	1	0.1	18	1.3	1,441	100.0
Dyckman	April 1951	933	80.5	211	18.2	2	0.2	13	1.1	1,159	100.0	714	61.2	381	32.6	3	0.3	69	5.9	1,167	100.0
Glenwood	July 1950	1,139	96.1	45	3.8	-	-	1	0.1	1,185	100.0	1,079	90.8	106	8.9	1	0.1	2	0.2	1,188	100.0
Gun Hill	Nov. 1950	622	85.3	101	13.9	-	-	6	0.8	729	100.0	536	73.3	168	23.0	-	-	27	3.7	731	100.0
Lexington	Mar. 1951	148	33.5	278	62.9	-	-	16	3.6	442	100.0	96	21.4	262	58.5	2	0.4	88	19.7	448	100.0
Marble Hill	Mar. 1952	1,289	76.8	350	20.9	1	0.1	37	2.2	1,677	100.0	1,103	65.6	487	28.9	1	0.1	91	5.4	1,682	100.0
Nostrand	Dec. 1950	1,104	96.2	39	3.4	1	0.1	3	0.3	1,147	100.0	1,092	95.5	46	4.0	1	0.1	4	0.4	1,143	100.0
Parkside	June 1951	806	92.1	63	7.2	1	0.1	5	0.6	875	100.0	774	88.1	86	9.8	1	0.1	18	2.0	879	100.0
Pelham	July 1950	1,200	95.3	54	4.3	-	-	5	0.4	1,259	100.0	1,114	88.1	129	10.2	2	0.2	19	1.5	1,264	100.0
Pomonok	June 1952	1,813	87.9	238	11.5	-	-	13	0.6	2,064	100.0	1,878	90.7	182	8.8	-	-	10	0.5	2,070	100.0
Ravenswood	July 1951	1,902	88.0	252	11.7	1	0.0	6	0.3	2,161	100.0	1,701	78.7	429	19.9	1	-	30	1.4	2,161	100.0
Sedgwick	Mar. 1951	671	85.7	105	13.4	1	0.1	6	0.8	783	100.0	602	76.6	174	22.2	1	0.1	9	1.1	786	100.0
Todt Hill	June 1950	455	91.2	42	8.4	1	0.2	1	0.2	499	100.0	438	87.4	59	11.8	-	-	4	0.8	501	100.0
TOTAL		14,217	87.0	1,989	12.2	10	0.1	114	0.7	16,330	100.0	13,069	79.8	2,908	17.7	14	0.1	394	2.4	16,385	100.0
CITY PROGRAM - PART IV																					
Bay View	June 1956	1,492	92.8	102	6.4	-	-	13	0.8	1,607	100.0	1,497	93.0	103	6.4	-	-	9	0.6	1,609	100.0

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* Consists Almost Exclusively of Puerto Ricans

(a) Racial distribution in projects

Table 8: Summary rent statistics

Year	Obs	Avg. rent	Avg. rent pr	Avg rooms
1930	8027	2034.31	773.87	4
		(1832.05)	(732.06)	(3)
1940	1890	1234.11	415.8	4
		(2154.22)	(978.84)	(3)
1950	1361	1213.67	511.5	3
		(815.71)	(357.64)	(4)
1960	1507	1183.12	365.95	4
		(860.66)	(223.77)	(2)
1970	1404	1856.95	589.76	3
		(1313.91)	(446.65)	(2)
1980	1285	1331.02	459.89	2
		(1576.09)	(556.38)	(3)
1990	1456	1415.23	606.08	2
		(1523.01)	(654.5)	(3)
2000	972	1661.08	481.33	3
		(2665.49)	(812.81)	(3)
2010	800	1548.88	328.54	3
		(4689.02)	(708.17)	(3)

Note. Table 8 shows all listings used in the corresponding analysis by year. Column "Avg. rent" refers to the average monthly rent, column "Avg. rent pr" is the average rent per room per year and "Avg. room" is the mean of rooms across properties; standard deviations are given in parentheses.
Source. New York Times.

C.3 Tract Harmonisation

A major difficulty in making use of census tract-level data for this longitudinal analysis is that the tract boundaries change considerably across time, making it challenging to have a time consistent panel dataset. I tackle this problem by taking reweighing observation based on overlapping areas weights (AW) using 2010 census tract boundaries as target areas. Let S be the set of all overlapping land areas in target tract t then weighted estimates for target tract t are defined as $\hat{y_t} = \sum^S \frac{A_s}{A_t} * y_s$. However, this procedure is susceptible to error because it requires to assume a uniform spatial distribution of geographic information. For example, allocating half of tract Z's residents in 2000 to tract A and the other half to tract B in 2010. In that case, both affluent and poor residents of tract Z would be evenly split between the two 2010 tracts. However, poverty is likely not spatially evenly distributed.

Figure 26: Deviation due to boundary harmonization

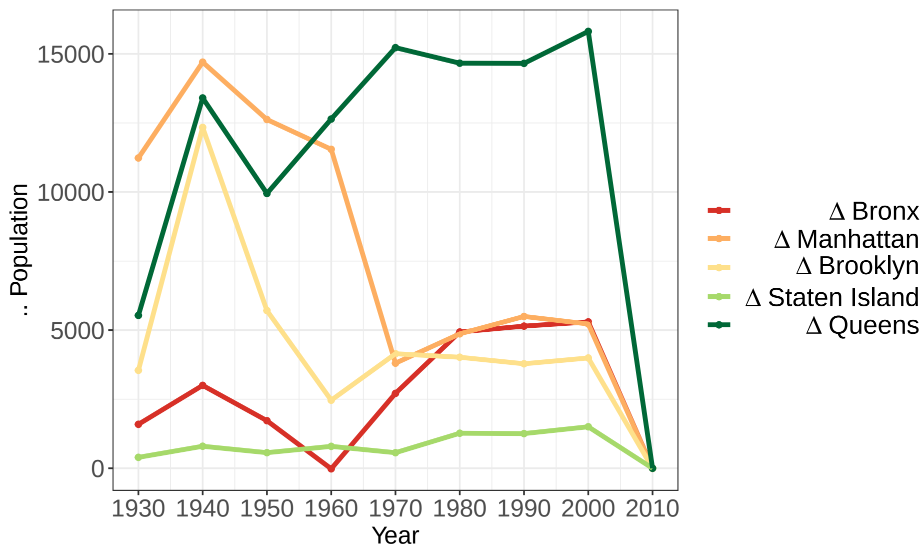
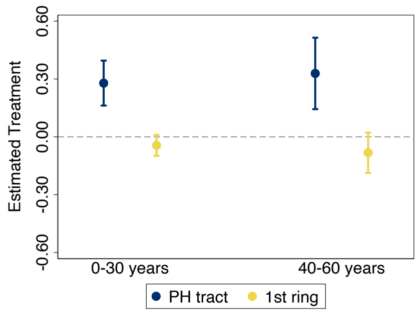


Figure 26 compares the reweighed series for New York City Boroughs with the original series, both aggregated in borough level. Using AW weights created some deviation of the original population series especially until 1960. This deviation is highest for Queens throughout the observation period while being lowest for Staten Island. Nevertheless, the degree of error depends on how tract boundaries change: consolidations, splits, and complex changes. The error would be expected to be larger for the latter two changes as discussed in Logan et al. (2021).

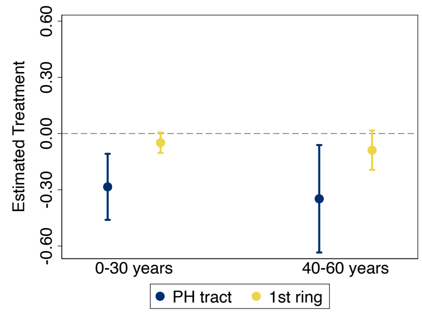
D Additional results

D.1 Pooled estimates

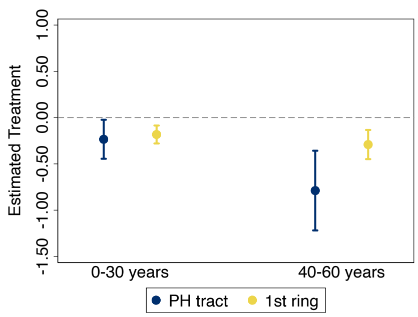
Figure 27: Pooled results - baseline



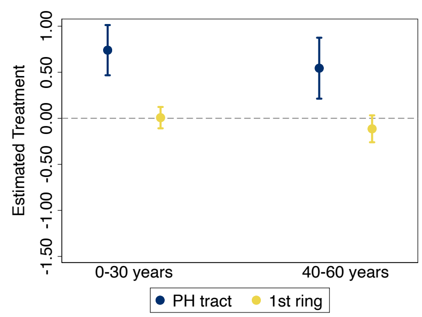
(a) Log(Population)



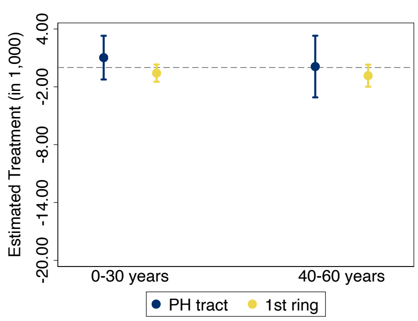
(b) log(Priv. population)



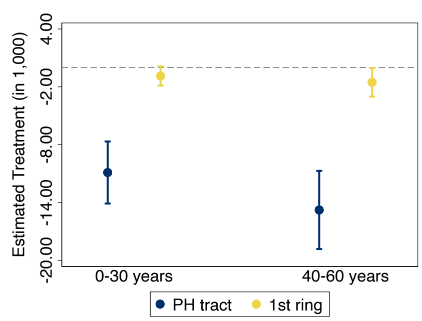
(c) Log(White)



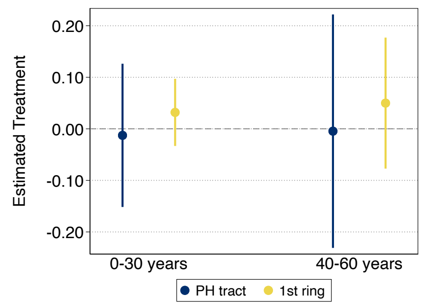
(d) log(Black)



(e) Housing units



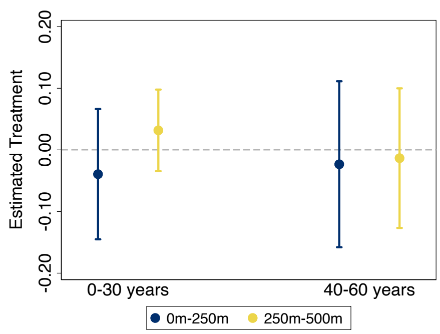
(f) Priv. housing units



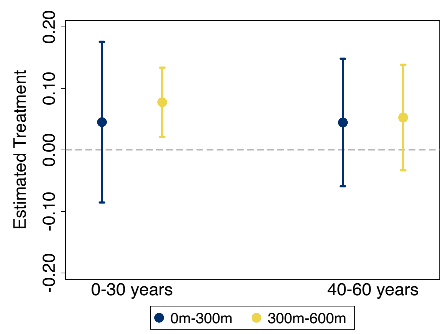
(g) Log rent

Note. Figure 27 reports point estimates for coefficients θ_{0r} and θ_{1r} in Equation 2; both coefficients have been interacted with ring dummies; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals. Panel a to f report differences for treated tracts and tracts in the first ring compared to a second neighbour ring; outcome variables are obtained from the US census. Panel f shows point estimates using property level rent data. The omitted group are tracts and properties within th 2nd ring.

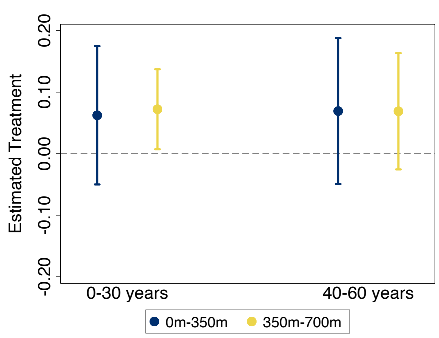
Figure 28: Pooled results - rents



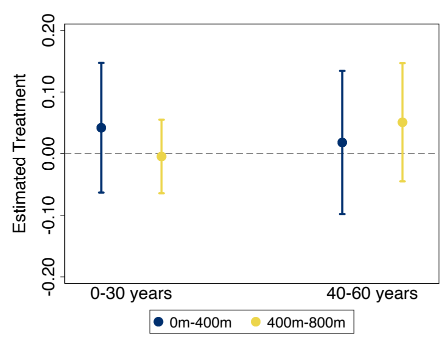
(a) 250m rings



(b) 300m rings



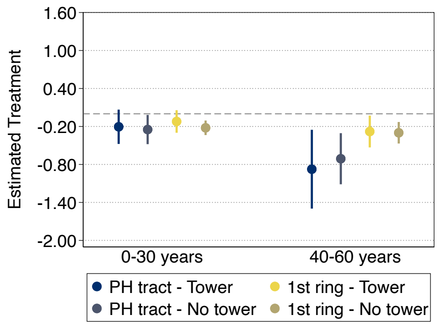
(c) 350m rings



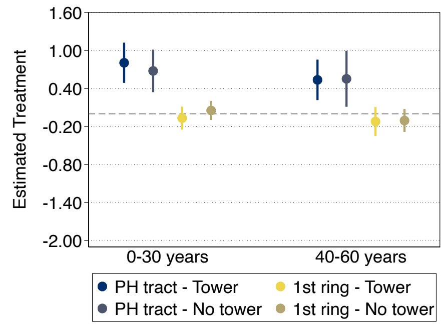
(d) 400m rings

Note. Figure 28 reports point estimates coefficients θ_{0r} and θ_{1r} in Equation Equation 2; both coefficients have been interacted with ring dummies; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals. Panel a to d uses property level rent data with alternative distances rings of 250m, 300m, 350m and 400m. The omitted group is within a third distance that is 500m-750m, 600m-900m, 700m-1050m and 800m-1200m respectively.

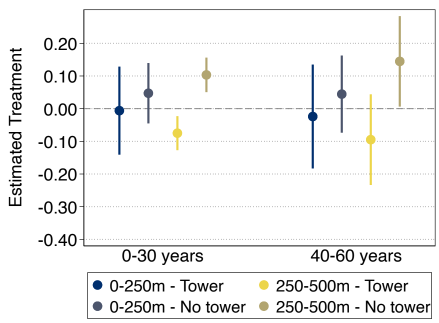
Figure 29: Effect of relaxed "Tower in Park"



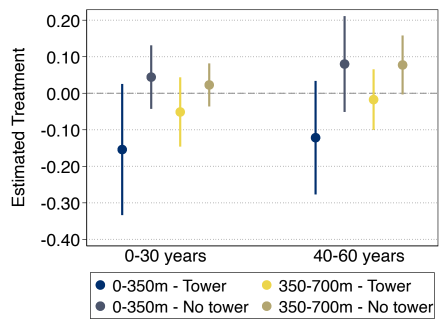
(a) Log(White)



(b) Log(Black)



(c) log(Rent) - 250m rings

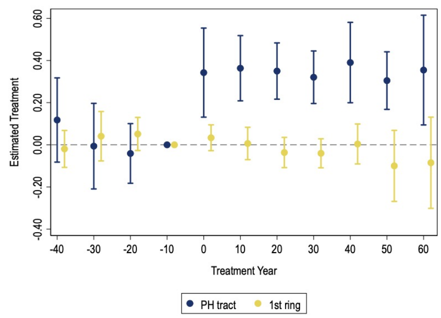


(d) log(Rent) - 350m rings

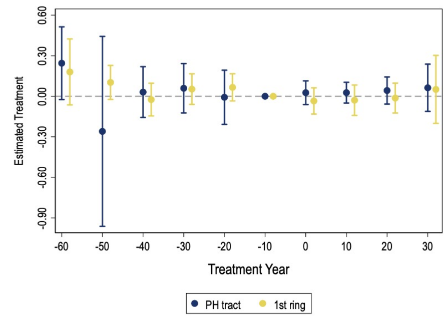
Note. Figure 29 reports point estimates for coefficients θ_{0r} and θ_{1r} in Equation 3; all coefficent have been interacted with Tower dummies; standard errors are clustered at the project level; the vertical lines show the estimated 95% confidence intervals. For this exercise two criteria described in Section 5.1 have been realxed: area share and consruction costs. Therfore a "Tower"is defined as a buildng with more than 9.87 stories and below 23% building coverage; doing so results in 89 tracts with "Tower"-style projects and 136 non-tower tracts. I estimate the following equation. Panel a to b report differences for treated tracts and tracts in the first ring compared to a second neighbour ring; panel c and d compare properties within a first (0m-250m; 0m-350m) and second distance ring (250m-500m; 350m-700m) around project tp those within a third ring (500m-750m; 700m-1050m).

D.2 Event study results - Construction Periods

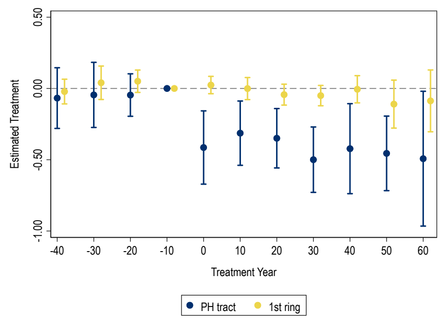
Figure 30: Construction period heterogeneity



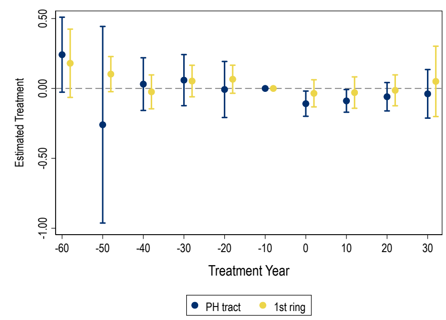
(a) Pre 1970: log(Population)



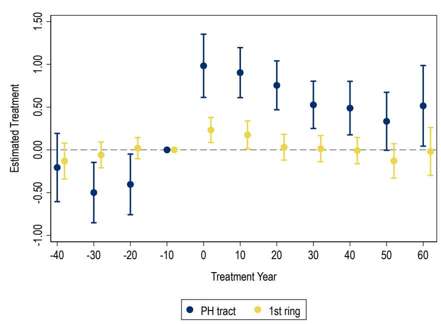
(b) Post 1970: log(Population)



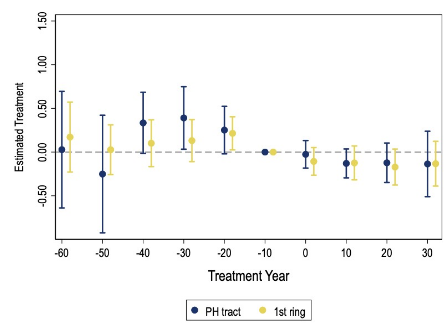
(c) Pre 1970: log(Priv. population)



(d) Post 1970: log(Priv. population)

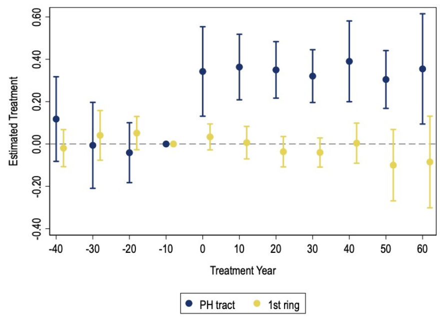


(e) Pre 1970: log(Black)

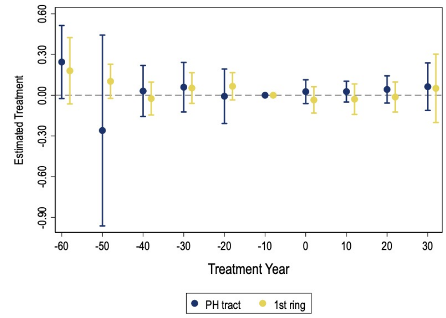


(f) Post 1970: log(Black)

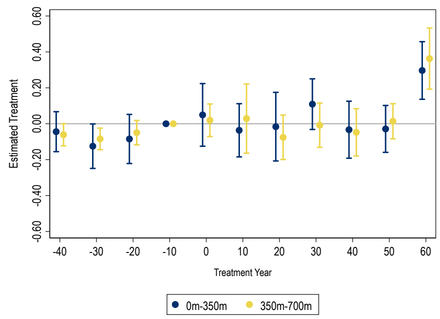
Figure 30: Construction period heterogeneity



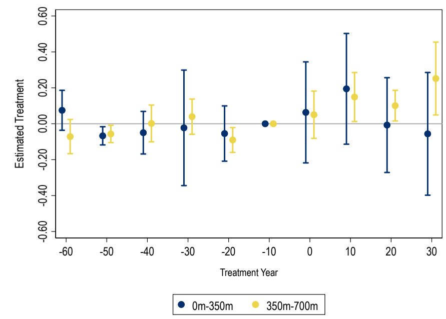
(g) Pre 1970: log(White)



(h) Post 1970: log(White)



(i) Pre 1970: log(Rent)



(j) Post 1970: log(Rent)

Note. Figure 30 plots report coefficients $\hat{\beta}_{\tau,r}$ in Equation Equation 1; the sample is split in all ring panals with projects constructed before 1970 and afterwards; the vertical lines show the estimated 95% confidence intervals; Panel a to h use weighted unit counts from the US census; the omitted category is tracts within a second ring. Panel i and j use property level rent data comparing rents in a first ring (0m-350m) and a second ring (350m-700m) to properties 700m-1050m away; rental ask prices have been obtained from the New York Times.

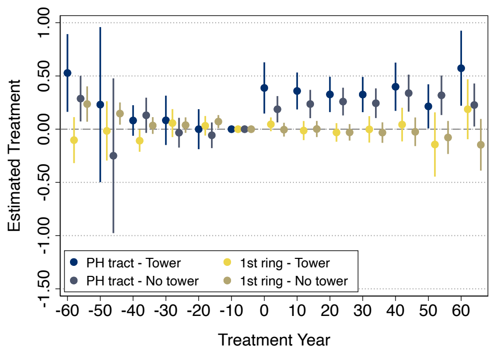
D.3 Event study results - Building Design

Using the definitions provided in Section 5.1, I defien a "Tower in the Park" as follows: a a project with a height larher than 9.87 and ground coverage below 23%. An "Adjusted Tower" is defined as public housing project with a height larher than 9.87, ground coverage below 23%, an area share above 20% and construction costs below \$17868. This takes construction quality and importance realtive to the area int account. If a project is not satisfying any of these crietria it is considered a "No Tower". I estimate the following equation:

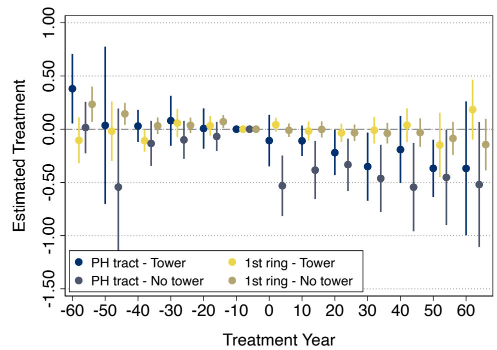
$$y_{m,p,t} = \sum_{r \in R} \sum_{\tau=-60}^{60} (Tower + No\ tower) \times \beta_{\tau,r} \left(t - Y_p, r = r(m,p)\right) + \delta' \mathbf{X_{m,p,t}} + \rho_{p,t} + \zeta_{p,r(m,p),c} + u_{m,p,t} \tag{19}$$

Thus, this estimation is similar to Equation 1, where *Tower* and *No tower* are dummies for tracts having a "Tower in the park" like projects and not. Results of estimating Equation 19 for "Tower"-style prjects are shown in Figure 31 and for "Adjusted Tower"-projects are shown in Figure 32.

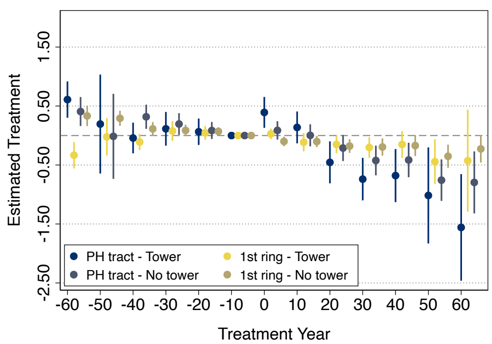
Figure 31: Event study results "Towers"



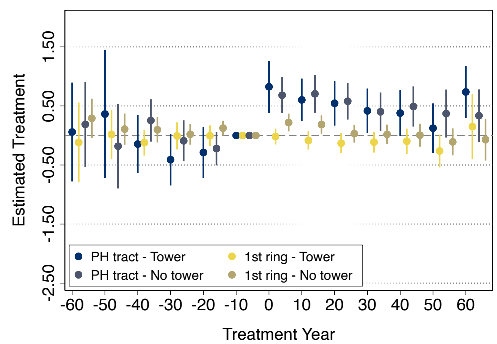
(a) log(Population)



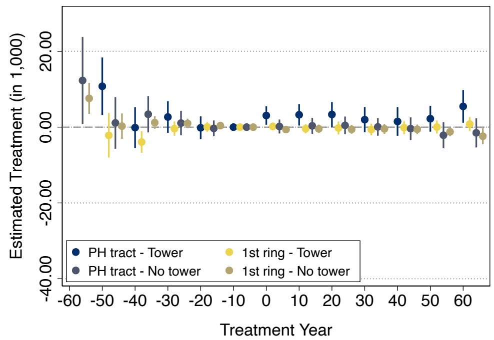
(b) log(Priv. population)



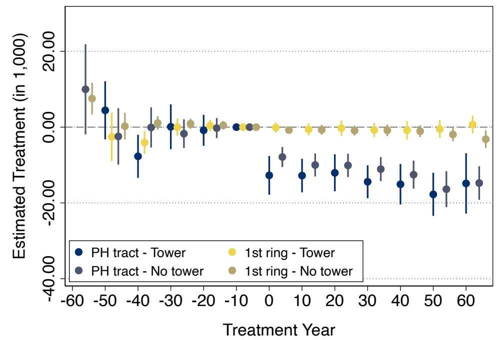
(c) log(White)



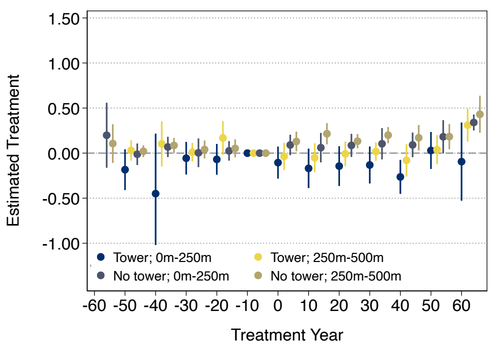
(d) log(Black)



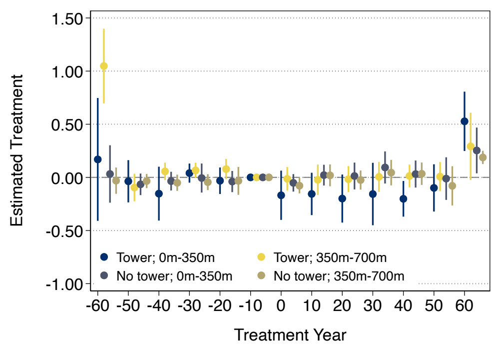
(e) Housing units



(f) Priv. housing units



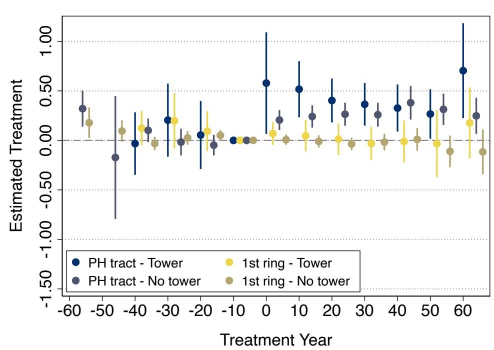
(g) log(Rent) - 250m rings



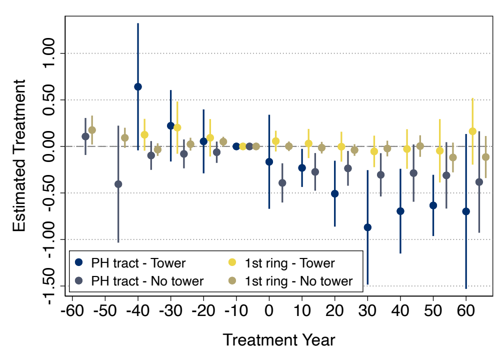
(h) log(Rent) - 350m rings

Note. Figure 31 report coefficients $\hat{\beta}_{\tau,r}$ in Equation 19; all coefficients have been interacted with "Tower" and non-tower dummies as per deintion in Section 5.1; the vertical lines show the estimated 95% confidence intervals; Panel a to f use weighted unit counts from the US census; the omitted category is tracts within a second ring. Panel g and h use property level rent data comparing rents in a first ring (0m-350m) and a second ring (350m-700m) to properties 700m-1050m away; rental ask prices have been obtained from the New York Times.

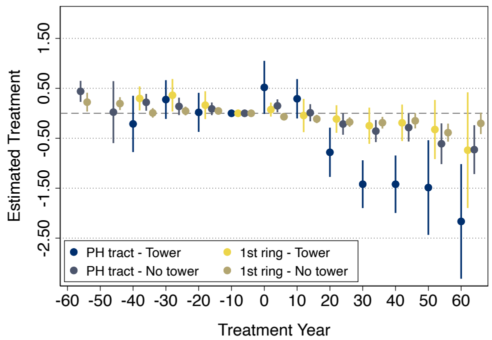
Figure 32: Event study results "Adjusted Towers"



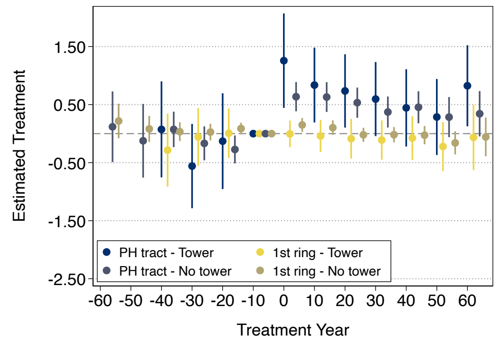
(a) log(Population)



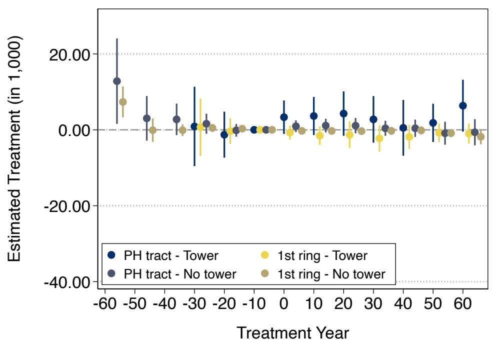
(b) log(Priv. population)



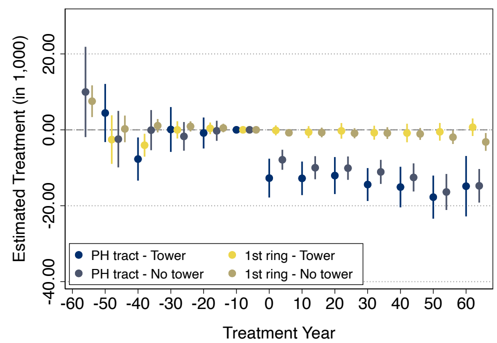
(c) log(White)



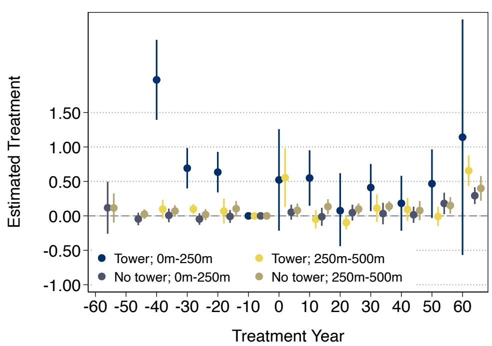
(d) log(Black)



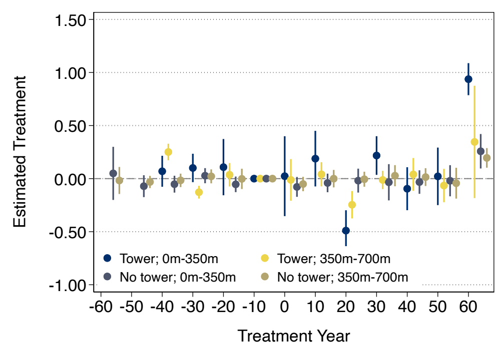
(e) Housing units



(f) Priv. housing units



(g) log(Rent) - 250m rings



(h) log(Rent) - 350m rings

Note. Figure 32 report coefficients $\hat{\beta}_{\tau,r}$ in Equation 19; all coefficients have been interacted with "Adjusted Tower" and non-tower dummies as per definition in Section 5.1; the vertical lines show the estimated 95% confidence intervals; Panel a to f use weighted unit counts from the US census; the omitted category is tracts within a second ring. Panel g and h use property level rent data comparing rents in a first ring (0m-350m) and a second ring (350m-700m) to properties 700m-1050m away; rental ask prices have been obtained from the New York Times.

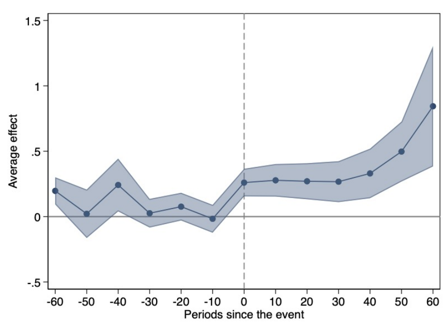
D.4 Event study results - Panel setup

In section I report event study results using a standard panel set-up. In this set up a tract is considered to be treated if it ever had a public housing within its boundaries. I compare treated tracts to tracts in an outer ring surrounding the inner ring, dropping the first tract ring around public housing in order not to violate STUVA. Figure 13 shows the spatial layout of treatment and control. The assumption of unconditional parallel differences in how public housing affects demographics in treated versus non-tracts may be implausible in light of how construction sites were choosen. As outlines in Section 3 sites with considerably low land values and high density were selected. This imposes a weaker assumption of "conditional parallel differences" in demographic responsiveness to public housing. I leverage recently developed Doubly Robust (DR) estimators, which yield consistent estimates if either the outcome regression or the propensity score is miss-specified (Sant'Anna and Zhao, 2020). I estimate the following specification:

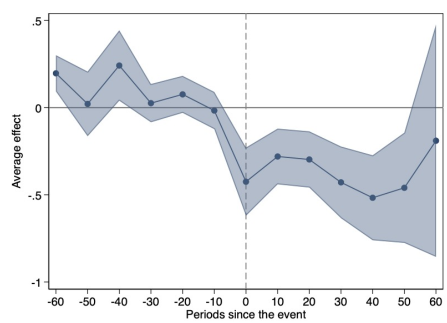
$$y_{m,t} = \sum_{\tau=-60}^{70} \beta_\tau (t - Y_p) + \delta y_{m,t}^{base} + \rho_t + \zeta_m + u_{m,t} \tag{20}$$

The parameter of interest, denoted as β_τ, captures the effect of the arrival of public housing in census year t relative to the year of construction Y_p compared to the outermost rings. I control for census year ρ_t and tract ζ_m fixed effects. Finally I control for differences of the outcome variable at baseline, $y_{m,t}^{base}$. Results from estimating Equation 20 are shown in Figure 33

Figure 33: Effect of public housing



(a) log(Population)

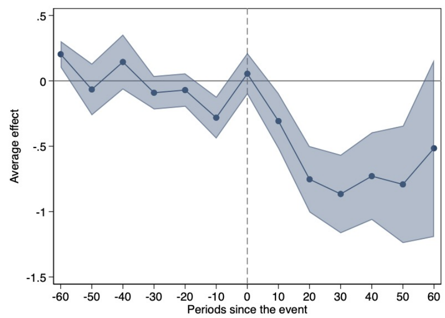


(b) log(Priv. population)

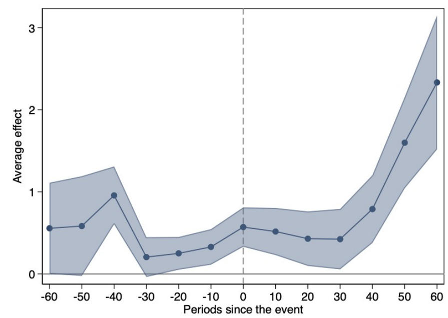
D.5 Public Housing Characteristics

In this section I test for the effects of different oublic housing characteristics on the set of outcome variables. In particular I am testing for foour buildings characetristics which are used in Section 5.1 to define a "Tower in the Park". I use test teh the effect of project size and layout, by using the average number public apartments relative to the existing housing stock[19], the average height of all project buildings within a tract

[19]Using the the stock in the respective year would mean measuring public housing units against itself. Therefore, I use the housing in the respective census year before public housing has been built and take the average over the



(c) log(White)



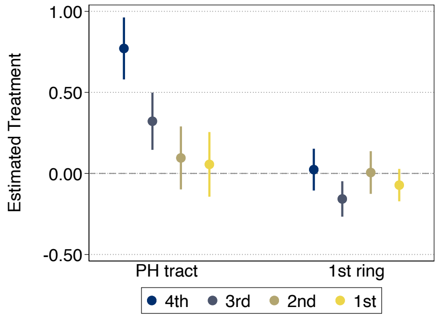
(d) og(Black)

Note. Figure 33 displays Sant'Anna and Zhao (2020) Doubly Robust (DR) coefficients $\hat{\beta}_\tau$ from estimating Equation 20; the vertical lines show the estimated 95% confidence intervals; Panel a to d show results using population, private sector population, white population and black population.Sandard errors are clustered at the neighborhood lavel (NTA).

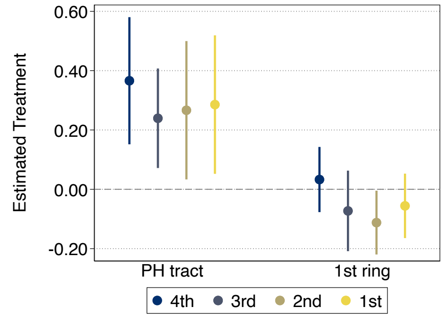
and the total area used for construction relative to the total tract area. To test for differences in buildings quality I use construction costs per room as a measure of construction quality. I estimate Equation 4 in Section 5.2 by interacting the ring dummies with quartiles of the respective public housing characteristics. Results for are given Shown by Figure 34 to Figure 36 .

decade in order to account for potential changes within the 10 years between census years.

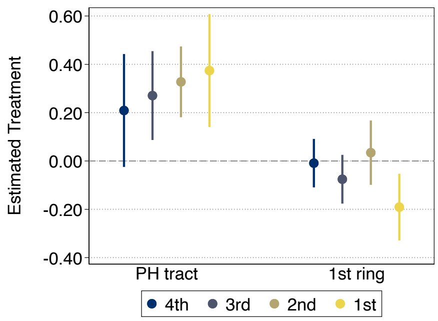
Figure 34: Effect on log(pop)



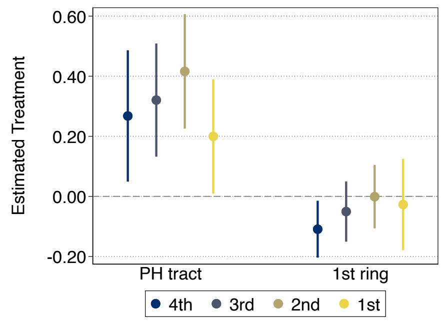
(a) PH apartments



(b) Average height



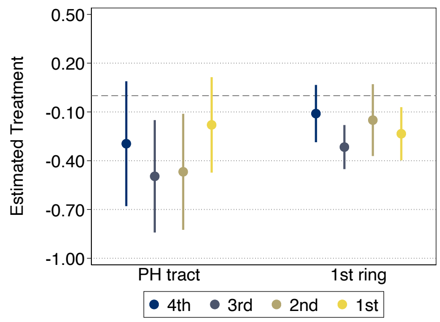
(c) Construction cost



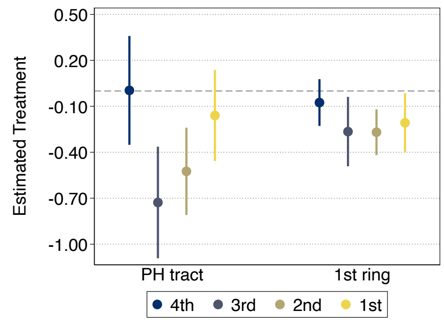
(d) Ground coverage

(e) *Note:* Figure 34 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; coefficients report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; all both coefficients have been interacted with quartiles indicators of distributions of the average number public apartments relative to the existing housing stock (Panel a), the average height of all project buildings within a tract (Panel b), construction costs per room (Panel c) and ground coverage (Panel d); the vertical lines show the estimated 95% confidence intervals; report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; outcome variables are obtained from the US census.

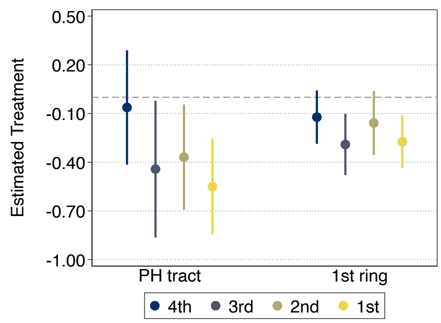
Figure 35: Effect on log(white)



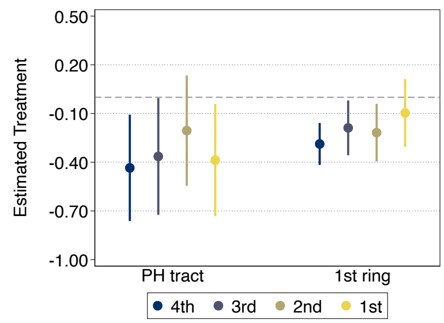
(a) PH apartments



(b) Average height



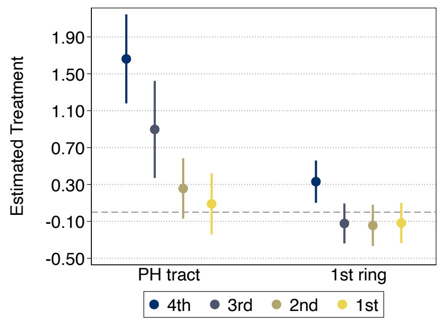
(c) Construction cost



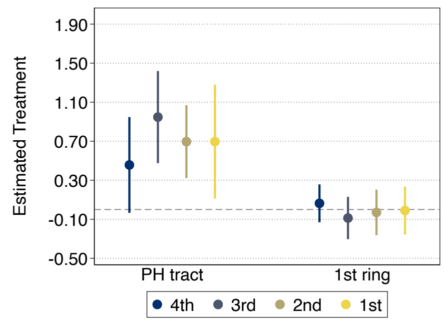
(d) Ground coverage

Note. Figure 35 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; coefficients report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; all both coefficients have been interacted with quartiles indicators of distributions of the average number public apartments relative to the existing housing stock (Panel a), the average height of all project buildings within a tract (Panel b), construction costs per room (Panel c) and ground coverage (Panel d); the vertical lines show the estimated 95% confidence intervals; report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; outcome variables are obtained from the US census.

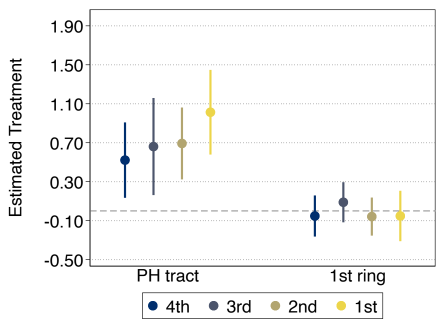
Figure 36: Effect on log(black)



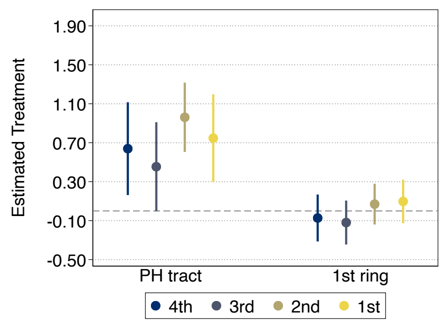
(a) PH apartments



(b) Average height



(c) Construction cost



(d) Ground coverage

Note. Figure 36 reports point estimates for coefficients γ_{0q} and γ_{1q} in Equation 4; coefficients report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; all both coefficients have been interacted with quartiles indicators of distributions of the average number public apartments relative to the existing housing stock (Panel a), the average height of all project buildings within a tract (Panel b), construction costs per room (Panel c) and ground coverage (Panel d); the vertical lines show the estimated 95% confidence intervals; report differences for treated tracts and tracts in the first ring compared to a second neighbor ring; outcome variables are obtained from the US census.

D.6 Model estimation

In this section I show how I solve the model. A solution to the system of vector values equlibrium equation, derived in Equations 11 to 13 in Section 6 can be found given values for ϕ, δ_{mt}, $\boldsymbol{\beta_t^g}$. I solve the model by finding a fixed point that solves the system of 3xM equations:

$$\begin{bmatrix} D_{1t}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta) - S_{1t}(r_{1t}) \\ \vdots \\ D_{Mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta) - S_{Mt}(r_{Mt}) \end{bmatrix} = 0$$

$$\begin{bmatrix} \frac{D^b_{1t}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}, \beta)}{D_{1t}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta)} - s^b_{1t} \\ \vdots \\ \frac{D^b_{Mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}, \beta)}{D_{Mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta)} - s^b_{Mt} \end{bmatrix} = 0$$

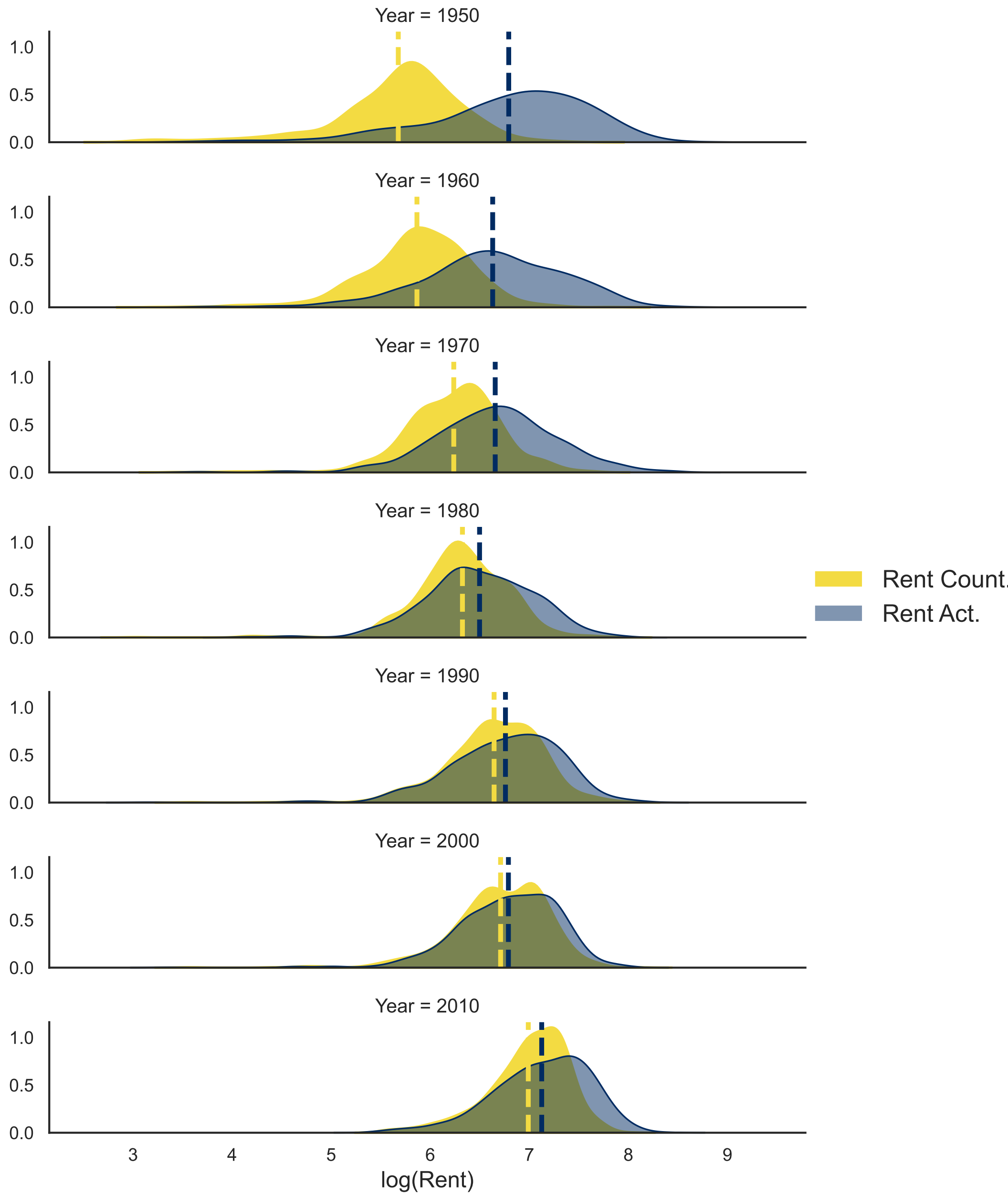
$$\begin{bmatrix} \frac{D^w_{1t}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}, \beta)}{D_{1t}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta)} - s^w_{1t} \\ \vdots \\ \frac{D^w_{Mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}, \beta)}{D_{Mt}(\mathbf{r}, \mathbf{s^w}, \mathbf{s^b}; \beta)} - s^w_{Mt} \end{bmatrix} = 0$$

I use Newton's Method to iterate over the above system of equations for an initial guess $x_0 = (\mathbf{r}^0, \mathbf{s^w}^0, \mathbf{s^b}^0)$:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \tag{21}$$

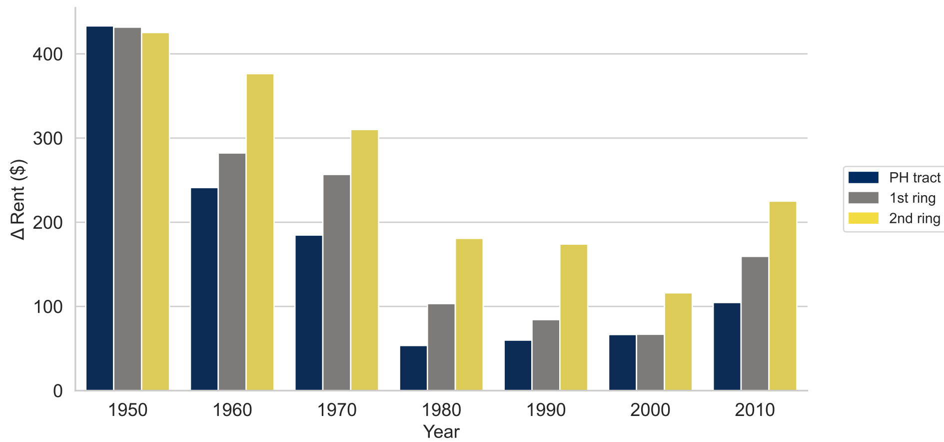
Where $f'$is the Jacobien of the equilibrium system. I use the JAX automatic differentiation package in Python to find the market clearing solutions. Newton's method trys to find a critical vector such that $f'(x^*) = 0$. Since I am only interest in finding the root of the 3xM system of equation, I do not use f'' which would check if the solution is a local maximum or minimum. I set the tolerance criteria to $\|x_{n+1} - x_n\| < e^{-10}$.

Figure 37: Equilibrium Rent Distributions

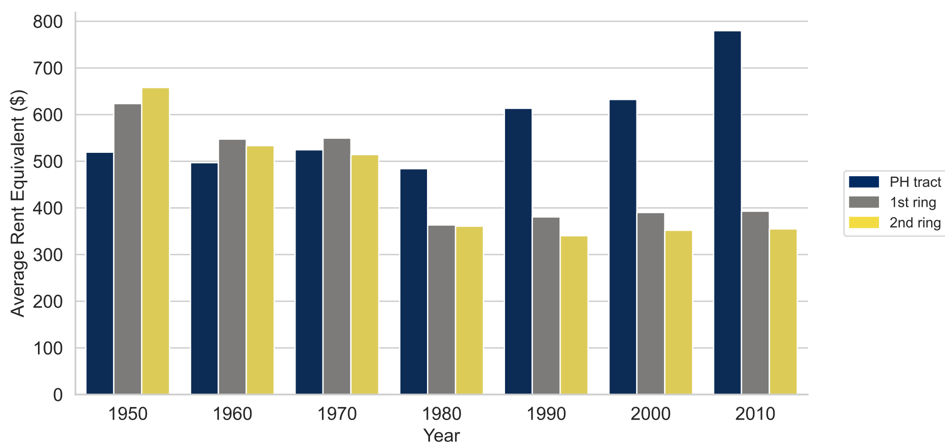


Note. Figure 37 reports distributions of the estimated equilibrium rent; estimates under the actual scenario - no public housing demolitions - are shown in blue and those under the counterfactual scenario - removing all public housing - are shown in yellow; the dotted lines give the average of each distribution. The model had been estimated for each census year.

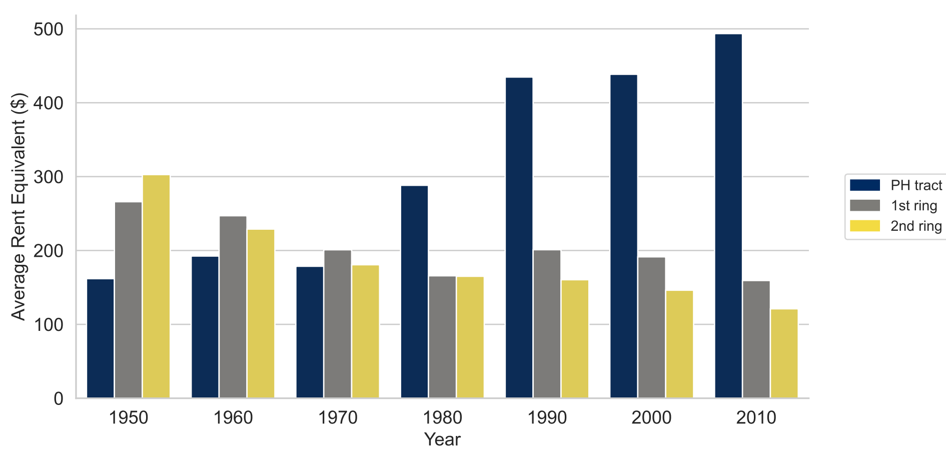
Figure 38: Equilibrium Differentials by Distance Relationship



(a) Rent Differential



(b) Rent Equivalent Blacks



(c) Rent Equivalent Whites

Note. Figure 38 reports differentials from the removal of all public housing projects in New York City and letting the stock become private. Panel a reports the average difference between predicted actual and countercultural rents by distance rings. Panel b and Panel c display the average Rent Equivalents as calculated by Equation 18 by distance ring.