ThinkBrooklyn's comparative analysis revealed that the percentage increase in *Median contract rent* from 1970-2010 in historic district census tracts (HDCTs) differed from New York City and borough increases for all census tracts over the same time period.[20] Table1 (above) presents data for all HDCTs in New York City and its boroughs[21] showing that on average, the *Median contract rent* of the 175 HDCTs increased 123.0% from 1970 to 2010, which was more than the average increase in *Median contract rent* for all census tracts in New York City (71.6%). This comparison means that the average *Median contract rent* was rising faster in historic district census tracts than for all census tracts in New York City during the 40 year time period. Likewise, for Manhattan and Brooklyn HDCTs, the average *Median contract rent* rose faster (118.3% and 162.5% respectively) than for the average in all census tracts in the borough-wide comparisons (89.4% for Manhattan and 79.7% for Brooklyn). HDCT data for The Bronx, Queens, and Staten Island (combined as "Other") had a similar (63.1%) change in average *Median contract rent* compared to all census tracts in the "Other" category (62.1%) between 1970 and 2010.

The comparative analysis showed that Brooklyn's HDCTs had the most substantial changes in *Median contract rent* of all the boroughs. The average *Median contract rent* of Brooklyn's HDCTs was lower in 1970 ($510.71) than the average for all Brooklyn census tracts ($545.35) for that same year, but forty years later in 2010, Brooklyn HDCTs had a higher average *Median contract rent* ($1,269.60) than the average for all of Brooklyn ($979.97).

The comparative statistics point to clear differences both among HDCTs at the borough level, as well as between HDCTs and all census tracts in New York City and its boroughs, and absent regression analysis, may suggest that historic districting was statistically related to increasing rental prices. However, it is very important to note that regression analysis allows for a much more mathematically nuanced assessment of the relationship between variables, and in the case of this study, it controls for multiple independent variables (*Historic district concentration, Timing of designation* and *Borough*), all of which have the possibility of correlating with the *Percentage change in median contract rent 1970-2010.* Furthermore, unlike comparative analysis, the regression model only examines change amongst census tracts that have varying degrees of concentrations of residential units in historic districts, and thus keeps the analysis targeted so as to control for myriad neighborhood variables that can impact rental prices.[22] ThinkBrooklyn's Ordinary Least Squares (OLS) multiple linear regression analysis found that *Historic district concentration* was actually *not* a statistically significant predictor of change in average *Percentage change in median contract rent 1970-2010.*

[20] Using data provided by LTDB, the comparative data were analyzed by averaging all census tracts in New York City and for each of the boroughs. Averaging medians when there are large numbers of dissimilar census tracts may result in data distortions. However, for *Median contract rent*, the only available data source for the 1970 data was at the census tract level from the LTDB, so the comparison data provided were the best available for this study. For the other two dependent variables (*Percentage point change in renter households paying 35% or more of income to housing, 1970-2010* and *Percentage change in median household income, 1970-2010*) however, city and borough (county) estimates were available that were not calculated based upon the underlying census tract level data, and so those data were used.

[21] As referenced previously, data for The Bronx, Queens and Staten Island are combined because of HDCT small sample sizes.

[22] An important goal of the study's research design was to effectively isolate the relationship between historic districting and affordability by controlling for several neighborhood characteristics that might influence affordability (i.e. distance to transportation, open space, schools, safety, shopping districts and other neighborhood amenities). The approach of analyzing only census tracts that had at least one residential unit in an historic district was therefore applied. Future research could explore whether census tracts adjacent to historic district census tracts (and with zero historic residential units) would be a useful comparison.

The first OLS multiple linear regression model was run to examine the correlation of the independent variables *Historic district concentration*, *Timing of designation*, and *Borough* for all 175 HDCTs. A second model looked at only the HDCTs in Manhattan, and a third at HDCTs in Brooklyn. Models were also run for all of the HDCTs in The Bronx, Queens and Staten Island combined, but in light of the small sample size of HDCTs in those boroughs, even collectively as "Other", statistically valid results were unable to be generated.[23]

In the first model, for all 175 census tracts in New York City that contained residential units in historic districts, *Historic district concentration* was entered in the first step, *Timing of designation* was added in the second step, and then *Borough* dummy codes were added in the third step. *Historic district concentration* and *Timing of designation* were not found to be statistically significant variables[24] in any of the steps, which means neither had a predictive correlation with *Median contract rent*. Dummy codes for Brooklyn and Other, entered in the third step, however, were found to be significant (p=.015 and p=.009 respectively[25]), which means that the borough in which a census tract was located *was* correlated with the *Percentage change in median contract rent*, and that one can be at least 95% confident that this finding shows an actual correlation and is therefore not due to random chance. Only the third step was significant (.001—one can be 99% confident that the model shows an actual relationship between the independent variables and the dependent variable) with an R^2 of .105, which means that the model's independent variables could explain 10.5% of the variation in the dependent variable. According to the regression model, after controlling for *Historic district concentration* and *Timing of designation*, the *Median contract rent* for Brooklyn's HDCTs increased on average 44.4% more Manhattan's HDCTs. For Other HDCTs (The Bronx, Queens and Staten Island), the *Median contract rent* was on average 59.9% less than Manhattan HDCTs. As noted above, it is important to emphasize, that for regression analyses in general, a finding of "significance" does not imply *causation*, it merely suggests that changes in two variables (while holding other variables constant) are happening in a similar way—not that one is *causing* the other to change or vice versa.

In light of the *Borough* correlations that were revealed in the regression analysis of the full dataset, as outlined in the paragraph above, separate regression models for Manhattan and Brooklyn alone were run to further explore the relationships between the independent and dependent variables more deeply at the borough level. In these regression analyses, *Historic district concentration* and *Timing of designation* were not found to be significant,[26] and therefore the analyses did not suggest a relationship between these two independent variables and changes in *Median contract rent* in either Manhattan or Brooklyn. In short, while the comparative analyses revealed a greater rate of increase in *Median contract rent* in HDCT in the boroughs of Manhattan and Brooklyn when compared to

[23] OLS multiple linear regression analysis models were also run for "Other" (The Bronx, Queens and Staten Island), and none were found to be statistically significant. However, the findings could be attributable to small sample size (33 census tracts across all three boroughs), and therefore ThinkBrooklyn recommends that no definitive conclusions be drawn from this particular analysis.

[24] The p-values for the independent variables are as follows: *Historic district concentration* (p=.675), and *Timing of designation* (p=.385). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

[25] The p-value for Brooklyn (p=.015) means that one can be 98.5% confident that the results show an actual correlation that is not caused by random chance. The p-value for Queens (p=.009) means that one can be 99.1% confident that the results show an actual correlation that is not caused by random chance.

[26] The p-values for the independent variables in each of the models are as follows: Manhattan: *Historic district concentration* (p=.887) and *Timing of designation* (p=.433); and Brooklyn: *Historic district concentration* (p=.604) and *Timing of designation* (p=.874). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

all census tracts in those boroughs, according to the regression analyses, the changes cannot statistically be explained by *Historic district concentration* or *Timing of designation*.

2. *Percentage Point Change in Renter Households Paying 35% or More of Income to Housing, 1970-2010*

Table 2
Average Percentage and Average Percentage Point Increase of Renter Households Paying 35% or more of Income to Housing in Historic District Census Tracts (HDCTs) and All Census Tracts (CTs) by New York City and Borough[27]
(1970-2010)

	Avg. % Renter HH Paying 35% or More of Income to Rent 1970		Avg. % Renter HH Paying 35% or More of Income to Rent 2010		Average Percentage Point Increase of % Renter HH Paying 35% or More of Income to Rent 1970 to 2010	
	HDCTs	All CTs	HDCTs	All CTs	HDCTs	All CTs
New York City	25.7%	24.3%	34.3%	42.4%	8.8	18.1
Manhattan	28.5%	26.4%	32.4%	36.3%	4.3	9.9
Brooklyn	24.0%	24.2%	34.0%	44.3%	10.0	20.1
Other Boroughs	21.7%	22.0%	39.6%	45.2%	17.9	23.2

Data Sources: HDCT data: ThinkBrooklyn Analysis of NHGIS' U.S. Census Bureau Decennial Census (1970) American Community Survey 5-Year Estimates (2006-2010); Borough and New York City Comparisons: NHGIS' U.S. Census Bureau Decennial Census (1970) American Community Survey 5-Year Estimates (2006-2010)

Table 2.1
Lowest, Highest, and Standard Deviation for Percentage of Renter Households Paying 35% or More of Income to Housing Variables for Historic District Census Tracts in Regression Analysis

	1970 %	2010 %	Percentage Point Change (1970-2010)
Lowest % Paying 35% or More for an HDCT	11.1%	14.5%	-36.4
Highest % Paying 35% or More for an HDCT	50.9%	59.0%	39.8
Standard Deviation[28]	7.2%	9.4%	12.1

Data Source: ThinkBrooklyn Analysis of NHGIS' U.S. Census Bureau Decennial Census (1970) American Community Survey 5-Year Estimates (2006-2010)

[27] Borough and New York City comparisons are not averages based upon census tracts, but are the percentage as reported for that geography by the U.S. Census Bureau (via NHGIS).
[28] Standard deviation is a measure of how spread out a particular set of data is. To interpret standard deviation, subtract and add the amount of the standard deviation from the average for a variable (65% of all census tracts will always fall within that range).

The comparative analysis showed that the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* in historic district census tracts (HDCTs) looked quite different when compared to rates for all census tracts in New York City and the boroughs.[29] Table 2 (above) presents data for HDCTs, compared to all census tracts in New York City and its boroughs (the Bronx, Queens and Staten Island are combined because of the small HDCT sample size in those boroughs). As observed in Table 2, the average *Percentage of renter households paying 35% or more of income to housing* in the 175 HDCTs in New York City increased 8.8 percentage points (from 25.7% to 34.3%) from 1970 to 2010, which is less than the average percentage point increase for all census tracts in New York City (18.1). Therefore, while the average *Percentage of renter households paying 35% or more of their income to housing* in historic district census tracts rose, it increased at a slower rate than all census tracts in New York City. Similar patterns of change are seen for the boroughs of Manhattan and Brooklyn. These trends are not surprising given the higher average incomes in HDCTs relative to the New York City and borough comparison data *(please see Table 3 for Median household income data)*. The average *Percentage of renter households paying 35% or more of their income to housing 1970-2010* in historic district census tracts (HDCTs) in the Other boroughs (the Bronx Queens and Staten Island) is increasing at a similar rate (17.9) to all census tracts in New York City (18.1), but less so when compared to all census tracts in their respective combined-boroughs (23.2).

These comparative statistics point to clear differences in patterns between average rates of increase for the *Percentage of renter households paying 35% or more of income to housing* in HDCTs and the comparison areas of all census tracts in New York City and its boroughs. Absent regression analysis, one might presume that historic districting is statistically related to this dependent variable. However, when regression analysis was applied, *Historic district concentration* and *Timing of designation* were *not* found to be a statistically significant predictor of *Percentage point change in renter households paying 35% or more of income to housing 1970-2010*.

Three regression models were run to examine the correlations of the independent variables, *Historic district concentration*, *Timing of designation* and *Borough* on the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010*. One multiple OLS linear regression model was run for all 175 HDCTs in New York City; a second model for only HDCTs in Manhattan, and a third for only HDCTs in Brooklyn. Models were also run for all of the HDCTs in the Bronx, Queens and Staten Island combined, but in light of the small sample size of HDCTs in those boroughs, even collectively as "Other", statistically valid results were unable to be generated.

In the first model, using the full dataset (the 175 census tracts in New York City that have residential units in historic districts) for a stepwise OLS multiple linear regression, *Historic district concentration* was entered in the first step, *Timing of designation* was added in the second step, and then *Borough* dummy codes were added in the third step. *Historic district concentration* was not a statistically significant variable in any of the three steps,[30] which means that it had no statistical relationship to the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010*, nor did *Timing of designation*.[31] Dummy codes for HDCTs in Brooklyn

[29] For this indicator, the comparison data were not averaged from hundreds of census tracts, but were data as reported directly by the U.S. Census Bureau for the geographies of New York City, Manhattan and Brooklyn. The category of "Other" was derived by ThinkBrooklyn as the average of the three data points for The Bronx, Queens and Staten Island.
[30] P=.235 in the third step, which means one can be 76.5% confident that this independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.
[31] In the second step of the regression, *Timing of designation* had a significant p=value (.027), but was no longer found to be significant in the third step (p=.300), which means than one can be 70.0% confident that this independent variable varied

and the Other boroughs, entered in the third step, were found to be significant (p=.002 and p=.000 respectively, or a 99.8% and 100.0% confidence that the results demonstrate an actual correlation and are not caused by random chance), which means *Borough* correlated to *Percentage point change in renter households paying 35% or more of income to housing 1970-2010*. The model's overall p-value was significant (p=.000, or engendering a 100.0% confidence that the model shows an actual relationship between the independent variables and the dependent variable) with an R^2 of .189, which means 18.9% of the variation in the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* was explained by the regression model. After controlling for *Historic district concentration* and *Timing of designation*, the percentage of Brooklyn HDCT's renter households paying 35% or more of income to housing increased on average 5.9 percentage points more than in Manhattan between 1970 and 2010, and for Other HDCTs (the Bronx, Queens and Staten Island), the renter households paying 35% or more of income to housing increased on average 12.6 percentage points more than when compared to Manhattan HDCTs.

In light of the *Borough* correlations that were revealed in the regression analysis of the full dataset, separate regression models for Manhattan and Brooklyn alone were run. The results showed that *Historic district concentration* and *Timing of designation* were not significant and did not correlate with the changes seen in the *Percentage of renter households paying 35% or more of income to housing 1970-2010* in either Manhattan or Brooklyn.[32] In short, while the comparative analyses showed that HDCTs had a smaller increase in the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* compared to data for all census tracts in New York City its boroughs, according to the regression analysis for Brooklyn and Manhattan HDCTs, neither *Historic district concentration* nor *Timing of designation* could explain the changes seen in this dependent variable.

randomly and did not have a mathematically systematic pattern in comparison to the dependent variable and any nonrandom variation found in the second step was explained by the introduction of the *Borough* dummy codes.

[32] Manhattan's p-values were: *Historic district concentration* (p=.565), and *Timing of designation* (p=.832). In Brooklyn, p-values were *Historic district concentration* (p=.091) and *Timing of designation* (p=.382). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

3. Percentage Change in Median Household Income, 1970-2010

Table 3
Average Median Household Income
in Historic District Census Tracts (HDCTs) and All Census Tracts (CTs)
and New York City and Borough Comparisons[33]
(1970-2010)

	Average Median Household Income 1970 *(in 2010 dollars)*		**Average Median Household Income 2010**		**Average Change in Median Household Income 1970 to 2010 in Dollars (%)**[34]	
	HDCTs	All CTs	HDCTs	All CTs	HDCTs	All CTs
New York City	$46,642	$51,650[35]	$79,749	$50,285	$33,107 (84.8%)	-$1,365 (-2.6%)
Manhattan	$49,391	$44,153	$96,946	$64,971	$47,556 (116.1%)	$20,817 (47.1%)
Brooklyn	$40,430	$44,325	$75,208	$43,567	$32,079 (90.6%)	-$758 (-1.7%)
Other Boroughs	$51,107	$56,590	$50,182	$53,546	-$926 (-3.6%)	-$3,044 (-5.4%)

Data Sources: HDCT data: ThinkBrooklyn Analysis of Longitudinal Tract Data Base (2014) for U.S. Census Bureau Decennial Census (1970) and American Community Survey 5-Year Estimates (2006-2010). Borough and New York City Comparisons: U.S. Census Bureau Decennial Census (1970) American Community Survey 5-Year Estimates

Table 3.1
Lowest, Highest, and Standard Deviation for
Median Household Income Variables
for Historic District Census Tracts in Regression Analysis

	1970 ***(in 2010 dollars)***	**2010**	**Change in Median Household Income 1970 to 2010 in Dollars (%)**
Lowest Median Household Income for an HDCT	$14,412	$8,694	-$20,628 (-69.2%)
Highest Median Households Income for an HDCT	$132,256	$232,768	$175,776 (626.2%)
Standard Deviation[36]	$21,198	$41,466	$36,399 (104.4%)

Data Sources: ThinkBrooklyn Analysis of Longitudinal Tract Data Base (2014) for U.S. Census Bureau Decennial Census (1970) and American Community Survey 5-Year Estimates (2006-2010)

Comparative analysis showed that the average *Median household income* in HDCTs (historic district census tracts, or census tracts that have residential units located in historic districts) was increasing more when compared to rates

[33] Borough and New York City comparisons are not averages based upon census tracts, but are the *Median household income* as reported for that geography by the U.S Census Bureau.
[34] Please note that dollar amounts are rounded to the nearest whole dollar. Furthermore, for HDCTs, the average change in the last column is for *all* HDCTs, and is not the average for the averages reported in prior columns for average *Median household income* 1970 and 2010. However, for ALL Census Tracts, the data represent the percentage change of the dollar amounts reported in the 1970 and 2010 columns.
[35] Based upon an average of all 5 borough estimates as New York City data were not available for 1970.
[36] Standard deviation is a measure of how spread out a particular set of data is. To interpret standard deviation, subtract and add the amount of the standard deviation from the average for a variable (65% of all census tracts will always fall within that range).

for all census tracts in New York City and its five boroughs.[37] However, while multiple linear regression analysis revealed that there was a statistically significant relationship between *Historic district concentration* and change in *Median household income* when analyzing all HDCTs in New York City, when analyzed at the borough level, there was there a statistically significant correlation between *Historic district concentration* and *Median household income* only in Brooklyn.

Average Median household income rates of change between 1970 and 2010 varied among HDCTs, as well as between HDCTs and all census tracts in New York City and borough rates of change. Table 3 presents data for HDCTs, and all census tracts in New York City and its boroughs (the data for The Bronx, Queens and Staten Island are combined because of HDCT small sample size in those boroughs). As seen in Table 3, on average, *Median household income* in the 175 HDCTs in New York City increased by 84.8% in the 40 year period between 1970 and 2010, whereas in all census tracts in New York City combined it declined by 2.6%. Manhattan was the only borough that showed an increase in *Median household income* for all of its census tracts (whether those census tracts with concentrations of residential units in historic districts or not) between 1970 and 2010, and average *Median household income* was rising faster in Manhattan's HDCTs (116.1%) when compared to the borough overall (47.1%) for the same time period. Brooklyn HDCTs were also different when compared to the borough as a whole, with *Median household income* increasing 90.6% as compared to a decline of 1.7% in Brooklyn census tracts overall. Historic district census tracts in Other Boroughs (The Bronx, Queens and Staten Island) showed, on average, declines in *Median household income* (-3.6%) and in all census tracts (-5.4%), although HDCTs declined at a lesser rate.

The differences in *Median household income* found between historic district census tracts and all census tracts in New York City and the five boroughs via basic comparative analyses can be further explored through multiple linear regression analysis, which measures change in census tracts with higher and lower concentrations of historic district residential units, while also controlling for the independent variables of *Historic district concentration*, *Timing of designation* and *Borough*. OLS multiple linear regression analysis found that *Historic district concentration* was a statistically significant predictor of changes in *Median household income* in the full dataset of 175 HDCTs in New York City and for Brooklyn, but *not* for Manhattan.

One OLS multiple linear regression model was run to examine the relationships between the independent variables *Historic district concentration*, *Timing of designation*, and *Borough* and the dependent variable for all 175 HDCTs in New York City. A second regression model explored only the HDCTs in Manhattan, and a third, HDCTs in Brooklyn. Models were also run for all of the HDCTs in The Bronx, Queens and Staten Island combined, but in light of the small sample size of HDCTs in those boroughs, even collectively as "Other", statistically valid results were unable to be generated.

Similar to the regression analysis protocol for the two previous dependent variables, using the full dataset (175 historic district census tracts in New York City) for a stepwise OLS multiple linear regression, *Historic district concentration* was entered in the first step, *Timing of designation* was added in the second step, and *Borough* dummy codes were added in the third step.

[37] For this indicator, the comparison data were not averaged from hundreds of census tracts, but ThinkBrooklyn used the data as reported by the U.S. Census Bureau for each of the geographies (New York City, Manhattan, and Brooklyn). "Other" is derived as the average of the three data points for The Bronx, Queens and Staten Island.

In the first model (i.e. run for all 175 census HDCTs in New York City), *Historic district concentration* was found to be a significant variable (p=.038), which means it was positively correlated with the *Percentage change in median household income 1970-2010* and that one can be 96.2% confident that the result shows an actual correlation and is not due to random chance. *Timing of designation* was not a significant variable.[38] After controlling for *Borough* and *Timing of designation, Historic district concentration's* unstandardized coefficient (or slope) was .522, which is a measure of its mathematical relationship to *Percentage Change in Median household Income*. To understand the correlation of *Historic district concentration* on the *Percentage change in median household income*, one can multiply the percentage of a census tract's residential units that are in an historic district by .522. So, for example, for a census tract with 100% of its residential units in a historic district, the regression model predicts that the percentage change in *Median household income* was 52.2% compared to a census tract with zero historic district residential units, after controlling for *Borough* dummy codes and *Timing of designation*. The dummy coded *Borough* independent variable (step 3) showed Brooklyn was nearing significance (p=.091), and Other was significant (p=.000), which means that one can be 100.0% confident that the results show an actual correlation and are not due to random chance. HDCTs in the "Other" boroughs witnessed a *Median household income* decrease on average by 118.0% compared to the *Median household income* in Manhattan's HDCTs. The model overall in the third step was significant (p=.000, or 100% confident that the model showed an actual relationship between the independent variables and the dependent variable), with an R^2 of .200, which means 20.0% of the variation in the model was explained by the independent variables entered into the regression.

Stepwise OLS multiple linear regression models for Manhattan and Brooklyn HDCTs alone were also run. In Manhattan, *Historic district concentration* and *Timing of designation* were not found to be significant and did not affect the changes seen in *Median household income*.[39] In short, while there were increases in *Median household income* in Manhattan's historic district census tracts, according to the regression analysis, none of the changes could explained by *Historic district concentration* or *Timing of designation*. In Brooklyn, *Historic district concentration* was correlated with the *Percentage change in median household income1970-2010*, and had an unstandardized coefficient (slope) of .970. This means that for a census tract with 100% of its residential units in an historic district, the regression model would predict that the *Percentage change in median household income 1970-2010* would be 97.0% compared to a census tract with no historic district residential units. *Historic district concentration's* p=value was .016 (which means one can be 98.4% confident that the result (p=.016) shows an actual correlation and is not caused by random chance). The model's overall significance was .047 (which means one can be 95.3% confident that the model shows an actual relationship between the independent variables and the dependent variable). The R^2 for this model was .102, which means 10.2% of the variation in *Percentage change in median household income* was accounted for by the model.

[38] The p-value for *Timing of designation* was p=.628, which means this independent variable, in comparison to the dependent variable, most likely (with a 62.8% confidence) varied randomly and not in the same direction.
[39] *Historic district concentration* p=.557, and *Timing of designation* p=.538. For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

B. Background on U.S. Census Bureau Data Challenges

Overview

ThinkBrooklyn's approach to researching the intersection of affordable housing and historic districts took into consideration several challenges: (1) Unit of Analysis, (2) Longitudinal Data, (3) Geographic Boundaries and (4) Adequate Comparison Areas.

By comparing geographic areas that have as similar characteristics as possible, the study is able to examine the relationship between affordability and historic districting while minimizing additional factors that might relate to changes in affordability.

This section provides extensive background information regarding the methodological challenges of crafting a research design that examines the intersection between historic districts, and affordability and income indicators from the U.S. Census Bureau, as foundational information for future research. These challenges, referenced previously in the *Introduction*, include:

(1) **Unit of Analysis:** Measuring the change over time of rental housing affordability and income in historic districts as compared to change in nearby neighborhoods (as opposed to borough- or city-level change), is one approach to understanding the relationship of the two geographies. It is therefore of primary importance that indicators accurately measure change *within* historic districts. However, historic districts are of varying size (ranging from 1 to nearly 2,000 tax lots, according to the Department of City Planning),[40] and historic district boundaries do not align well with the geographies by which existing affordability and income data are available from the U.S. Census Bureau. If a plethora of longitudinal building-level data were available, then this issue would be moot. However, relevant affordability and income indicators are only available from the U.S. Census Bureau, and therefore the unit of analysis for these particular indicators is constrained by the geographies (block group, census tract, etc.) by which the U.S. Census Bureau provides data. While the block group is a smaller geography than the census tract, and therefore more easily aggregated into the geography of a particular historic district, census tract level data were determined more suitable for this study because they are available over the preferred timeframe. [41] Additionally, and as discussed in (2) below, there is a data source for harmonized census tract data, but not for block group data. Census tracts, however, do not align neatly with historic district boundaries, which is addressed in (3) below.

(2) **Longitudinal Data:** Finding longitudinal data for relevant indicators that are also measured consistently over time and use apropos geographic boundaries is another challenge. This study utilized the Longitudinal Tract Data Base (LTDB)[42], which contains harmonized[43] census tract level data for each decennial census since

[40] New York City Department of City Planning (2014). *MapPLUTO 14v.1 [Database]*. Accessed 8.5.14 http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml.

[41] U.S. Census Bureau block group geographies (which are smaller than census tracts and are therefore more easily aggregated and aligned with historic districts) are only available from 1980 to 2010, and 1980 data must be purchased. Cornell University sells a 1980 block group shapefile ($700) and Geolytics for $500, but either shapefile would need to be evaluated for consistency and quality. The U.S. Census Bureau began using block groups in 1940, but only for select geographies, and not until 1990 was the entire nation covered for block groups. As far as ThinkBrooklyn understands, block group data are not yet available in a harmonized format (block group boundaries change over time and harmonization (through, for example, areal weighting) makes it possible to, with a certain margin of error, track data longitudinally despite changing boundaries).

[42] Logan, J. Xu, Z. and Stults, B. (2012). Interpolating US Decennial Census Tract Data from as Early as 1970 to 2010: A Longitudinal Tract Database. Professional Geographer, 66(3), 412-420. Accessed 10/21/14 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4134912/, with more information available at http://www.s4.brown.edu/us2010/Researcher/Bridging.htm.

1970 matched to 2010 census tract boundaries.[44] While historic designation began in New York City in 1965, only 14 historic districts were designated prior to 1970.

(3) **Geographic Boundaries:** Census tracts whose geographic boundaries are 100% within an historic district would be ideal for analysis. However, only one census tract in New York City has this characteristic (Manhattan's Greenwich Village Historic District; three other census tracts are nearly 100% within an historic district.)[45] Therefore, ThinkBrooklyn performed an analysis to determine the percentage of each relevant census tract's residential units (rather than only an analysis by geographic area) that fell within a particular historic district. This was achieved by first joining MapPLUTO tax lot data (which include counts of residential units per each tax lot) with historic district[46] and census tract boundaries[47] to obtain total counts of residential units (based upon MapPLUTO data) that were in the census tract (denominator), and within the historic district portion of the census tract (numerator). Next, the percentage of a census tract's residential units within an historic district was calculated. As visualized in **Figure 1** below some census tracts may better represent an historic district via this method than if only considering census tract and historic district areal boundaries absent the residential units analysis.

(4) **Adequate Comparison Areas:** If one were to only compare changes of affordability and income indicators within historic districts to changes in New York City overall, substantial neighborhood variability would be masked. An important goal of the study's research design was to effectively isolate the relationship between historic districting and affordability by controlling for several neighborhood characteristics that might influence affordability (i.e. distance to transportation, open space, schools, safety, shopping districts and other neighborhood amenities). In order to control, as best as possible, for neighborhood change *not* due to historic designation (i.e. isolating that variable), ThinkBrooklyn, using only census tracts which had at least one residential unit in an historic district, developed a research design that examined whether census tracts with larger concentrations of historic district residential units were changing in ways that were systematically different from census tracts with smaller concentrations of historic district residential units. Been et al. (2014) used nearby neighborhood comparison zones in their building-level study, and ThinkBrooklyn incorporated the Been et al. approach as methodological precedent (but since using census tracts, ThinkBrooklyn included census tracts with relatively small percentages of residential units that overlap with an historic district.)[48] Another approach would be to look at census tracts that have zero historic district residential units, but are adjacent to historic district census tracts (please see Appendix 1: Recommendations for Future Research).

For example, as shown in **Figure 1**, the boundaries of Queens' census tract 285 are not fully aligned with the Jackson Heights Historic District boundary. However, via the visualization of the underlying spatial and residential

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[43] "Harmonized" means that researchers have: (1) used weighting methodologies to account for census tract boundary changes over time, and (2) addressed any changes in the way a particular Census question was asked to make the responses comparable over time.

[44] The US2010 Project (http://www.s4.brown.edu/us2010/Researcher/Bridging.htm. US2010) uses both population and areal weighting between 2000 and 2010, but uses the less accurate areal weighting for 1970, 1980 and 1990. Please see Appendix 3 for a full discussion of areal weighting.

[45] Based upon ThinkBrooklyn's spatial analysis of New York City Landmarks Preservation Commission (LPC) 2014 shapefile and U.S. Census 2010 census tract boundaries as provided by the New York City Department of City Planning at http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml#district_political.

[46] Please contact the New York City Landmarks Preservation Commission for the most recent historic district shapefile.

[47] The New York City Department of City Planning (NYC DCP) provides MapPLUTO data and U.S. Census Bureau geography shapefiles for New York City: http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml.

[48] Been, V., Ellen, I. G., Gedal, M., Glaeser, E., McCabe, B. (2014). Preserving History or Hindering Growth? The Heterogeneous Effects of Historic Districts on Local Housing Markets in New York City. New York, NY: Furman Center: Accessed 10/3/14 from http://furmancenter.org/files/NYUFurmanCenter_HistoricDistricts_2014.pdf.

tax lot analysis (only the tax lots with residential units are depicted on **Figure 1**), one can observe that most of the residential units in census tract 285 actually do fall within the historic district boundary (85%), and that the remainder of the census tract consists mostly of non-residential units.

Figure 1

Table 4 below references 213 census tracts[49] that have at least one residential unit in an historic district. These 213 census tracts cover 126 out of 132 historic districts (the remaining 6 historic districts have no residential units).[50]

Table 4
Number of Census Tracts by Tier of
Percentage of a Census Tract's Residential Units
in an Historic District

Tier	Percentage of a Census Tract's Residential Units in an Historic District	Number of Census Tracts
1	0.01-9.9%	69
2	10.0-19.9%	29
3	20.0-29.9%	16
4	30.0-39.9%	15
5	40.0-49.9%	17
6	50.0-59.9%	16
7	60.0-69.9%	15
8	70.0-79.9%	11
9	80.0-89.9%	9
10	90.0-99.9%	6
11	100.0%	10
Total	**0.01-100.0%**	**213**

Data Sources: ThinkBrooklyn analysis of NYC Department of City Planning PLUTO v.14.1 and U.S. Census Bureau 2010 Census Tract shapefile

[49] ThinkBrooklyn's regression analyses used 175 census tracts because LTDB-harmonized Census data are available only until 2010, and therefore historic districts designated after 2010 were not included in the analysis. Future research may decide to utilize the full 213 census tracts pending availability of more recent harmonized data.

[50] The following historic districts, six in total, contain no residential units (according to 2010 MapPLUTO data) and have therefore been excluded from ThinkBrooklyn's census tract analysis: Audubon Terrace (Manhattan, 1979); African Burial Ground & The Commons (Manhattan, 1993); Ellis Island (Manhattan, 1993); Governor's Island (Manhattan, 1996); West Chelsea (Manhattan, 2008); and Fort Totten (Queens, 1999).

C. Methodology

The statistical tools of comparative analysis and liner regression analysis were applied to examine the relationship between rental affordability and historic districting. The study looked at median rental prices, the percentage of households paying more than 35% of their income to housing, and median household income in historic districts and non-designated neighborhoods between the years of 1970 and 2010.

Multiple linear regression allowed researchers to more precisely quantify the relationship between: (1) the *independent variables* of *Historic district concentration* (the percentage of a census tract's residential units that fall within an historic district), *Timing of historic district designation* (number of years prior to 2010 that a census tract's historic district had been designated) and the *Borough*[51] in which an historic district was located, with each of the three single dependent variables cited above.

In light of the aforementioned considerations regarding U.S. Census data, ThinkBrooklyn conducted comparative analyses, as well as a series of multiple linear regression analyses (more specifically, stepwise Ordinary Least Squares (OLS) multiple linear regression) to address an overarching question: Did historic districting, while controlling for apropos independent variables, correlate to changes in rental prices, rental burden and median household income between 1970 and 2010 in New York City in a statistically significant way?

Three specific research questions drove the analysis:

1. Did rental prices increase or decrease from 1970 to 2010 more or less in census tracts with higher concentrations of residential units in historic districts than in those with lower concentrations?[52]
2. Did the percentage of rental households paying more than 35% of their income to housing increase or decrease from 1970 to 2010 more or less in census tracts with higher concentrations of residential units in historic districts than in those with lower concentrations?
3. Did household income increase or decrease from 1970 to 2010 more or less in census tracts with higher concentrations of residential units in historic districts than lower concentrations?

Multiple linear regression is a type of statistical analysis that allows one to estimate the relationship between one or more independent variables to a single dependent variable. For example, several of the studies[53] in

[51] Regression analysis for The Bronx, Queens and Staten Island did not find any statistically significant relationships between the three affordability and income indicators and *Historic district concentration* or *Timing of designation*, however, these findings could be attributable to small sample size (33 census tracts across all three boroughs).

[52] ThinkBrooklyn's regression analysis used residential unit concentration as a continuous variable (i.e. a variable that can take on any number between its minimum and maximum values) to measure higher and lower concentrations of residential units in historic districts for particular census tracts. For nomenclature purposes only, one can define "lower concentration" census tracts as those census tracts with less than 50%, and higher concentrations as those with 50% or more.

[53] The following are examples of these types of studies: (1) Cebula, R.J. (2009). The Hedonic Pricing Model Applied to the Housing Market of the City of Savannah and its Savannah Historic Landmark District. *The Review of Regional Studies*, 39(1), 9-22. Accessed 6/2/2015 from http://journal.srsa.org/ojs/index.php/RRS/article/download/182/137; (2) Heintzelman, M. D., & Altieri, J. A. (2013). Historic Preservation: Preserving Value? *Journal of Real Estate Finance and Economics*, 46(3), 543-563. Accessed 7/1/14 from http://scholar.google.com/citations?view_op=view_citation&hl=en&user=s6BbSLwAAAAJ&citation_for_view=s6BbSLwAAAAJ:W7OEmFMy1HYC; (3) Liechenko, R. M., Coulson, N. E., & Listokin, D. (2001). Historic Preservation and Residential Property Values: An Analysis of Texas Cities. *Urban Studies*, 38(11), 1973-1987. DOI:10.1080/00420980120080880; (4) Rickman, D. S. (2009). Neighborhood historic preservation status and housing values in Oklahoma County, Oklahoma. *The Journal of Regional Analysis and Policy*, 39(2), 99-109. Accessed 6/2/15 from http://ageconsearch.umn.edu/bitstream/132429/2/09-2-1.pdf (5) Zahirovic-Herbert, V., & Gibler, K. M. (2014). Historic

ThinkBrooklyn's literature review tested whether or not location in an historic district was related to a property's sales price. In the most basic of models, the dependent variable was sales price, and the independent variables were those a researcher theorized might correlate[54] with sales price (e.g. number of bathrooms, number of square feet, size of lot, etc.). Multiple linear regression analysis was then used by those researchers to estimate the extent to which the independent variables correlated with sales price (the dependent variable). To be more precise, multiple linear regression estimates how much a dependent variable's change is related to *each unit of change* in an independent variable. For example, if one selects an independent variable such as "number of square feet", multiple linear regression findings could predict (on average) how much sales prices might go up for each additional square foot, while controlling for other independent variables.

Three U.S. Census Bureau indicators were selected as dependent variables for this study in light of time and budget constraints, however, there are several additional indicators listed in Appendix 2 that ThinkBrooklyn recommends as apropos for exploring in future research.[55]

Selected Affordability and Income Indicators:[56]

1. Median contract rent (LTDB)[57]
2. Percentage of renter households paying 35% or more of income to housing (gross rent) (NHGIS)
3. Median household income (LTDB)

The dataset developed by ThinkBrooklyn for the OLS multiple linear regression analysis of the selected three U.S. Census Bureau indicators was composed of 175 census tracts, which all had at least one residential unit located in an historic district.[58] Only historic districts designated on or before 2010 were included in the analysis because the latest year LTDB data were available was 2010.[59] The following were selected as **independent variables**, or variables theorized to correlate with changes in the dependent variables tested:

District Influences on House Prices and Marketing Duration. *Journal of Real Estate Finance and Economics, 48*, 112-131. DOI: 10.1007/s11146-012-9380-1.

[54] In statistics, "correlation" is the degree to which two or more attributes or variables show a tendency to vary or fluctuate together, which is used as an indication of a relationship, but *not* as an indication of causation.

[55] The full list of proposed U.S. Census Bureau Affordability, Income and Demographic Indicators is based upon the original list of indicators in the study's proposal. The list of indicators evolved commensurate with ThinkBrooklyn's research, including cross-referencing the availability of harmonized census tract-level data in the LTDB, as well as data available from the NHGIS (which provides historic census data at the census tract level, but not harmonized).

[56] The source, years and geographies available for those indicators marked with "(LTDB)" are: U.S. Census Bureau Decennial Census or American Community Survey 5-Year Estimates via Longitudinal Tract Data Base (LTDB) (1970, 1980, 1990, 2000, 2006-2010). For those indicators marked with "(NHGIS)", the source, years and geographies available are: U.S. Census Bureau Decennial Census or American Community Survey 5-Year Estimates via National Historical Geographic Information System (NHGIS) (1970, 1980, 1990, 2000, 2006-2010).

[57] Median contract rent includes only rent negotiated as part of a lease agreement and may or may not include utility costs. Median "gross" rent includes rent negotiated as part of a lease *plus* utility costs. Median gross rent therefore might more fully capture costs as related to housing affordability. According to the United States Department of Housing and Urban Development (HUD), affordable housing is defined as: **"**In general, housing for which the occupant(s) is(are) paying no more than 30 percent of his or her income for gross housing costs, including utilities. Please note that some jurisdictions may define affordable housing based on other, locally determined criteria, and that this definition is intended solely as an approximate guideline or general rule of thumb."

[58] There were several census tracts that overlapped with more than one historic district. In those cases, the historic district with the largest proportion of residential units located in a particular census tract was chosen to be in included in the analysis.

[59] One census tract, Manhattan's census tract 9 (which contains the Stone Street Historic District), had a population of one person in 1970 and was therefore too small to elicit statistically viable data, so it was removed from the analysis.

- **Historic District Concentration**: Because census tracts and historic district boundaries do not neatly align, and each census tract may have one, or thousands, of residential units, ThinkBrooklyn developed this independent variable to measure the extent to which a census tract represents an historic district. *Historic district concentration* measured the percentage of a census tract's residential units that fell within an historic district. With this approach, it follows that census tracts that had larger percentages of residential units in an historic district were apropos proxies for changes (for whatever indicator is being measured) occurring within an historic district, while in the case of census tracts with smaller concentrations of residential units, change was more likely related to what was occurring *outside* of an historic district but in that same census tract. For example, if larger proportions of residential units were correlated with increases in *Median contract rent* for the same census tract(s), then the regression model might suggest that historic districting was correlated with changes in *Median contract rent*. *Historic district concentration* was a continuous variable[60] that was based upon ThinkBrooklyn's spatial and statistical analyses using the New York City Department of City Planning's MapPLUTO and 2010 Census Tract shapefiles[61], and the New York City Landmarks Preservation Commission's Historic District shapefile[62] to measure the percentage of a census tract's residential units that were located within an historic district.[63] The variable ranged from .05% to 100% of a census tract's residential units being located in an historic district. The average percentage of residential units in an historic district for the 175 census tracts included in the analysis was 31.5%. The count of residential units in a particular census tract that fell within an historic district ranged from 1 to 7,534, with an average for all 175 census tracts in the analysis of 809.8 residential units.
- **Timing of Designation**: Been et al. and the New York City Independent Budget Office studies showed that differences in property sales prices were to some extent based upon the timing of an historic designation.[64] ThinkBrooklyn calculated *Timing of designation* so that it tracked the number of years prior to 2010 that a census tract's historic district had been designated. It ranged from 0 (for historic districts designated in 2010) to 45 years (for historic districts designated in 1965), with an average, for all 175 census tracts, of 23.6 years.
- **Borough**: Been et al.'s research showed that there are differences in historic districting effects based upon the borough in which historic districts are located.[65] ThinkBrooklyn reflected this finding in its OLS multiple linear regression analysis, using "Borough" as a dummy-coded independent variable.[66] Manhattan

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[60] A continuous variable is a variable that can take on any number between its minimum and maximum values.
[61] For New York City Department of City Planning shapefiles please got to: http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml.
[62] Please contact the New York City Landmarks Preservation Commission for the latest historic district shapefile.
[63] Counts of residential units are from the NYC DCP Pluto database and include all known residential units whether owned or rented, occupied or vacant. Counts of *all* residential units were used, rather than just counts of renter households, because the data source did not categorize residential units by rented or owned, and there is no other known data source for this information.
[64] Been, V., Ellen, I. G., Gedal, M., Glaeser, E., McCabe, B. (2014). Preserving History or Hindering Growth? The Heterogeneous Effects of Historic Districts on Local Housing Markets in New York City. New York, NY: Furman Center: Accessed 10/3/14 from http://furmancenter.org/files/NYUFurmanCenter_HistoricDistricts_2014.pdf. New York City Independent Budget Office. (2003). Background Paper: The Impact of Historic Districts on Residential Property Values. New York, NY: Author. Accessed 7/16/14 from http://www.ibo.nyc.ny.us/iboreports/HistoricDistricts03.pdf.
[65] Been, V., Ellen, I. G., Gedal, M., Glaeser, E., McCabe, B. (2014). Preserving History or Hindering Growth? The Heterogeneous Effects of Historic Districts on Local Housing Markets in New York City. New York, NY: Furman Center: Accessed 10/3/14 from http://furmancenter.org/files/NYUFurmanCenter_HistoricDistricts_2014.pdf.
[66] All independent variables must be numeric or "continuous" variables in order to be used in regression analyses. A variable such as *Borough*, for example, is categorical and not continuous, and in statistics is referred to as a "nominal variable". Dummy coding allows a categorical (or nominal) variable to be converted to a numeric value so that it can be used as a continuous variable.

was the reference borough[67] (82 census tracts), Brooklyn was coded as its own borough (60 census tracts), and due to small sample sizes, The Bronx, Queens and Staten Island were combined into one dummy code, "Other" (33 census tracts in total across all three boroughs).

Descriptions of the three **dependent variables** are as follows:[68]

1. **Percentage Change in Median Contract Rent 1970-2010**: Data for this dependent variable were mined from the Longitudinal Tract Data Base (LTDB) of Brown University's US2010 program. LTDB provides data that are harmonized to 2010 census tract boundaries by accounting for changes over time in indicators and census tract boundaries. This harmonizing allows for the U.S. Census Bureau's *Median contract rent* indicator as measured in 1970 to be accurately compared to *Median contract rent* as measured in 2010 for this study.[69] Changes in a "median" indicator over time are a proxy of change, because it is an indicator that is the middle amount (i.e. half of renters are paying *more* than the median, and half are paying *less*). A "median" indicator does *not* suggest the exact or even average price that one might pay in rent, or the amount that any specific renter is currently paying. It is, however, the only longitudinal, publicly-available indicator representing all (market rate, subsidized, etc.) rental prices in New York City. Between 1970 and 2010, the largest decrease in percentage change for a particular census tract was -48.7% (i.e. a decline in *Median contract rent* of 48.7%), which occurred in Bronx census tract 143, which overlaps with a portion of the Clay Avenue Historic District, and the largest increase was 717.2%, which occurred in Manhattan census tract 31, which overlaps with a portion of the Tribeca East Historic District. The average percentage change in *Median contract rent* for all 175 census tracts with residential units in historic districts in New York City was 123.0%.

2. **Percentage Point Change in Percentage of Renter Households Paying 35% or More of Income to Housing 1970-2010**: Data for this U.S. Census Bureau indicator were obtained from the National Historic Geographic Information System (NHGIS),[70] and were calculated by the U.S. Census Bureau based upon answers to questions regarding rent, utility costs and income.[71] According to HUD, households who pay more than 30% of income to housing are considered to be in unaffordable housing situations. To be clear, this indicator does *not* suggest whether housing is affordable in general, but it *does* tells what percentage of renter households cannot afford (according to HUD affordability guidelines) their gross rent in comparison to their income. This variable was downloaded for the years 1970 and 2010 from the NHGIS website, and ThinkBrooklyn then harmonized the 1970 data to 2010 census tracts in order to ensure that the 1970 and 2010 data were comparable.[72] Once the 1970 data were harmonized, the *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* was calculated by subtracting the 1970 percentage from the 2010 percentage. The *Percentage point change in renter households paying 35% or*

[67] Being a "reference" or not being a reference makes no difference in the results of a regression analysis. Any of the boroughs could have been the "reference borough," but the standard practice is to choose the group with the highest number of cases, which for this study, was Manhattan.
[68] Descriptives for each of the variables that went into constructing the three dependent variables can be found in Tables 1.1, 2.1 and 3.1.
[69] 1970 rent was adjusted for inflation to 2010 dollars.
[70] The U.S. Census Bureau does not provide adequate historical data for this study on its website. NHGIS, among others, does provide historical census data (www.nhgis.org).
[71] U.S. Census Bureau (1976). *1970 Census User's Guide Part 1*. https://assets.nhgis.org/original-data/modern-census/1970CNT1-4.pdf. U.S. Census Bureau (2011). *2010 Census Summary File 1: 2010 Census of Population and Housing, Technical Documentation*. https://assets.nhgis.org/original-data/modern-census/2010sf1.pdf.
[72] 1970 NHGIS data for this variable was manipulated and processed through a programming file provided by LTDB for harmonizing user-provided data.

more of income to housing varied in the 175 historic district census tracts (HDCTs)[73] in New York City, from -36.4 percentage points to 39.8 percentage points, and on average increased for all census tracts with residential units in historic districts by 8.8 percentage points from 1970 to 2010.

3. **Percentage Change in Median Household Income 1970-2010:**[74] This indicator was mined by ThinkBrooklyn from the LTDB, and therefore 1970 data were already harmonized to 2010 data prior to ThinkBrooklyn obtaining the data. This indicator is a "median", meaning that half of the households in a census tract have incomes higher than the median, and half of the households have less. 1970 *Median household income* (reported in 1969 dollars in the underlying data file) was adjusted for inflation to 2010 dollars.[75] For the 175 historic district census tracts in ThinkBrooklyn's analysis, *Percentage change in median household income1970-2010* ranged from a minimum of -69.2% to a maximum of 626.2%, with an average percentage change of 84.8%.

As an example for the more technically-inclined, the following is a simplified OLS multiple linear regression equation based upon the analysis for this study and using percentage change in *Median contract rent* as the example dependent variable: $\Delta y = a + b_1X_1 + b_2X_2 + b_3X_3 + e$ where:

- Δy= the percentage change in *Median contract rent* 1970-2010
- a= the y intercept, which would provide the percentage change in *Median contract rent* between 1970 and 2010 when all other independent variables equal zero
- b= the slope for each of the independent (X) variables, and is a measure of the incremental relationship between an independent variable and a dependent variable; it is often referred to in this analysis as an "unstandardized coefficient"
- X = an independent variable
    - X_1= variables for borough dummy codes
    - X_2=percentage of a census tract's residential units that are within an historic district
    - X_3=number of years an historic district was designated as of 2010
- e=error term, which would be the amount of change in *Median contract rent* that cannot statistically be explained by the OLS multiple linear regression model

[73] HDCTs is an acronym used to refer to the census tracts used in the regression analysis. There are 175 HDCTs in the full dataset: 82 HDCTs in Manhattan, 60 HDCTs in Brooklyn, 15 HDCTs in Queens, 12 HDCTs in The Bronx and 6 HDCTs in Staten Island. Throughout this document, The Bronx, Queens and Staten Island were combined for a group of 33 HDCTs due to their individual small sample size.
[74] *Median Household Income* includes both renter and owner households, and is not available for renters only.
[75] In the 1970 decennial census, the U.S. Census Bureau asked census responders to report their total income from the last year. Therefore, the income reported was from 1969, and was adjusted for inflation accordingly.

D. New York City and Borough Analyses

Overview

Using multiple linear regression, it was found that *Historic district concentration* (i.e. the percentage of a census tract's residential units in historic districts) and *Timing of designation* had no significant relationship with rent or rental burden. This means that across New York City between the years 1970-2010, neither census tracts with higher concentrations of residential units within historic districts, nor the amount of time that a neighborhood has had historic district designation, had a significant relationship to median rental prices, or the percentage of households paying more than 35% of their income toward rent. *Historic district concentration* was found to have a statistically significant relationship for the *Percentage change in median household income* in New York City. When the regression models were run for only Manhattan historic district census tracts (Manhattan had 82 census tracts that contained residential units in historic districts), *Historic district concentration* and *Timing of designation* were not found to be statistically significant for rent, rental burden or income. When the regression model was run using only Brooklyn's HDCTs, (Brooklyn had 60 census tracts that contained residential units in historic districts), neither *Historic district concentration* nor *Timing of designation* were (similar to Manhattan) found to be statistically significant for changes in rent or rental burden. However, the percentage of a census tract's residential units in historic districts (*Historic district concentration*) was found to correlate with changes in median income in Brooklyn.

The following is a summary of findings based upon ThinkBrooklyn's OLS multiple linear regression analyses for New York City, Manhattan and Brooklyn. The summary presents highlights of the regression analyses. The previous section (A. Affordability and Income Comparative and Regression Analyses) presents the data and findings in greater detail.

a. New York City Historic District Analysis

ThinkBrooklyn's stepwise OLS multiple linear regression model posed the following question: does variation in the independent variable *Historic district concentration*, while controlling for the independent variables of *Timing of designation* (i.e. years since designation) and *Borough*, correlate with the change measured over time (1970-2010) in the three selected dependent variables? For two of the dependent variables (*Percentage change in median contract rent 1970-2010* and *Percentage point change in percentage of renter households paying 35% or more of income to housing 1970-2010),* the regression models run with the full dataset (175 census tracts in 81 historic districts in all 5 boroughs of New York City) showed that *Historic district concentration* and *Timing of designation* were found to have no statistically significant correlation ($p<.05$).[76]

[76]"P" is a measure of probability. A measure was considered significant in this study if its p-value ranged between.05 and .00, which is the standard practice for regression analyses. A p-value of .05 means that findings have a 5% chance or less of being caused by random chance, at which point ($p<.05$) they are considered statistically significant. In other words, when $p=.05$, there is a 95% confidence that the result shows an actual correlation. P-values were reported as follows: *Percentage Change in Median Contract Rent 1970-2010*: *Historic district concentration* ($p=.675$), *Timing of designation* ($p=.385$), and for *Percentage Point Change in Percentage of Renter Households Paying 35% or More of Income to Housing 1970*-2010: *Historic district concentration* ($p=.235$) and *Timing of designation* ($p=.300$). For all nonsignificant findings ($p>.05$), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

Historic district concentration was, however, found to be statistically significant for the *Percentage change in median household income1970-2010* for all 175 census tracts with residential units in historic districts in New York City, meaning there was a *correlative* relationship, but *not* necessarily a *causal* relationship. In other words, as *Historic district concentration* increased, the percentage change in *Median household income* increased. In the regression analysis of the 175 HDCTs (historic district census tracts in the regression analysis), *Historic district concentration* was significant (p=.038), which means that there is a 96.2% confidence that this finding (.522—the standardized coefficient) shows an actual correlation and is therefore not due to random chance. After controlling for *Borough* and *Timing of designation, Historic district concentration's* unstandardized coefficient was .522. The unstandardized coefficient is the slope, a mathematical measure of the independent variable's relationship to the dependent variable. In other words, in order to understand the relationship between *Historic district concentration* and *Percentage change in median household income,* one can multiply the percentage of a census tract's residential units that are located in an historic district (*Historic district concentration*) by .522. For example, for a census tract with 100% of its residential units in an historic district, the regression model predicts that the percentage change in *Median household income* would be 52.2% compared to a census tract with zero units in an historic district; and for a census tract whose *Historic district concentration* is 50.0%, the percentage change in *Median household income* predicted by the regression model would be 26.1%. The model overall was significant (p=.000)[77] with an R^2 of .200. R^2 is a measure of how much the regression model's independent variables explained the variation found in the dependent variable, and in this case, the model explained 20% (i.e. .200) of variation in the percentage change in *Median household income*.

For the 175 HDCTs in the regression analysis, there were statistically significant differences found among the boroughs of Manhattan, Brooklyn and Other (the Bronx, Queens and Staten Island), which means that Manhattan HDCTs, compared to Brooklyn HDCTs, and Other HDCTs, related to the dependent variables in different ways. How the boroughs differed is discussed above in the Affordability and Income Comparative and Regression Analyses section, but because *Borough* differences were found in the full (175 Historic District Census Tract) dataset, ThinkBrooklyn next conducted separate OLS multiple linear regression analyses, one for Brooklyn's, and another for Manhattan's, historic district census tracts to investigate the relationships of *Historic district concentration* and *Timing of designation* to the three dependent variables for Brooklyn and Manhattan, which are reported below. OLS multiple linear regression analysis models were also run for "Other" (the Bronx, Queens and Staten Island), and none were found to be statistically significant. However, the findings could be attributable to small sample size (33 census tracts across all three boroughs), and therefore ThinkBrooklyn recommends that no definitive conclusions be drawn from this particular "Other" analysis.

b. Manhattan Historic District Analysis

When the regression models were run for only Manhattan historic district census tracts (Manhattan had 82 census tracts that contained residential units in historic districts), the independent variables of *Historic district concentration* and *Timing of designation* were not found to be statistically significant, which means they did not correlate with changes in any of the three dependent variables of *Percentage change in median contract rent 1970-2010, Percentage point change in renter households paying 35% or more of income to*

[77] A p-value of .00 means that one can be 100% confident that the model shows an actual relationship between the independent variables and the dependent variable.

housing 1970-2010 and *Percentage change in median household income1970-2010*.[78] In other words, while there were varying degrees and directions of change in *Median contract rent*, *Renter households paying more than 35% of income to housing* and *Median household income* in Manhattan's historic district census tracts between 1970 and 2010, according to the regression analyses, the changes were not statistically correlated with the concentration of residential units in an historic district for the census tracts in the analysis, nor for the number of years since an historic district was designated. In conclusion, census tracts in Manhattan that have greater concentrations of historic district residential units are not changing in statistically significant different ways in relationship to the three dependent variables from the census tracts which have lower concentrations of historic district residential units.[79]

c. Brooklyn Historic District Analysis

When the regression model was run using only Brooklyn's HDCTs, (Brooklyn had 60 census tracts that contained residential units in historic districts), the independent variable *Historic district concentration* was (similar to Manhattan) not found to be statistically significant for *Percentage change in median contract rent 1970-2010* and *Percentage point change in renter households paying 35% or more of income to housing 1970-2010*, meaning the relationships were not correlated.[80] This being said, *Historic district concentration* was nearing the standard significance threshold of .05, and was reported as p=.091[81] for change in the *Percent of households paying 35% or more of income to housing, 1970-2010*.

Historic district concentration was, however, found to be correlated with the *Percentage change in median household income1970-2010*, and had an unstandardized coefficient of .970.[82] To understand the relationship between *Historic district concentration* and *Percentage change in median household income*, one can multiply the percentage of a census tract's residential units that are in an historic district by .97. For example, for a census tract with 100% of its residential units in an historic district, the regression model predicted that the percentage change in *Median household income* would be 97.0% more than a census tract with 0 residential units, while a census tract whose *Historic district concentration* was 50%, the model would predict a 48.5% increase in *Median household income* between 1970 and 2010. *Historic district*

[78] P-values for these models were as follows: Percentage change in *Median contract rent 1970-2010* (p=.723), *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* (p=.831) and *Percentage change in median household income1970-2010* (p=.703). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

[79] ThinkBrooklyn's regression analysis used residential unit concentration as a continuous variable (i.e. a variable that can take on any number between its minimum and maximum values) to measure higher and lower concentrations of residential units in historic districts for particular census tracts. For nomenclature purposes only, one can define "lower concentration" census tracts as those census tracts with less than 50%, and higher concentrations as those with 50% or more.

[80] The p-values for *Historic district concentration* were: *Percentage change in median contract rent 1970-2010* (p=.604) and *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* (p=.091). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

[81] A p-value of .091 means that the findings have a 9.1% chance of being caused by random chance, and are nearing the significance threshold of .05. A significance of .05 means that one can be 95% confident that the result shows an actual correlation and is therefore not caused by random chance.

[82] The unstandardized coefficient is a statistical measure of the mathematically-derived relationship between an independent variable and a dependent variable, while controlling for other independent variables.

concentration's significance was .016,[83] and the model's significance was .047.[84] The R^2 for this model was .102, which means 10.2% of the variation in *Median household income* was accounted for by the model (i.e. *Historic district concentration* and *Timing of designation combined*), or that 90% of what makes *Median household income* change could not be explained by either of the two independent variables in the regression analysis.

The independent variable *Timing of designation* did not correlate with any of the three dependent variables (*Percentage change in median contract rent 1970-2010*, *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* and *Percentage change in median household income1970-2010*) in a statistically significant way.[85]

[83] A p-value of .016 means that one can be 98.4% confident that the result shows an actual correlation and is not caused by random chance.
[84] A p-value of .047 means that one can be 95.3% confident that the model shows an actual relationship between the independent variables and the dependent variable.
[85] P-values for *Timing of designation* are as follows for each of the dependent variable's regression analyses: *Percentage change in median contract rent 1970-2010* (p=.874), *Percentage point change in renter households paying 35% or more of income to housing 1970-2010* (p=.382) and *Percentage change in median household income1970-2010* (p=.871). For all nonsignificant findings (p>.05), it means that with varying degrees of confidence, the independent variable varied randomly and did not have a mathematically systematic pattern in comparison to the dependent variable.

Part II: Building-Level Affordability Indicators

Part II of *The Intersection of Affordable Housing and Historic Districts* addresses the intersection of rental housing affordability and historic districts via the analyses of privately-owned and publicly-subsidized rental housing for which building-level data are available. According to the New York City Rent Guidelines Board, privately-owned and publicly-subsidized rental units, when combined with public housing rental units, make up approximately 13% of the rental units in New York City. Another 48% of New York City's rental units are rent-regulated, while the remaining 39% are market rate, for a total of 2.1 million rental units.[86] Attempts were made by ThinkBrooklyn, the Historic Districts Council, several Research Design Advisors, and the Manhattan Borough President's Office to obtain historical data regarding rent-regulated units **(**see Appendix 1 for further details**)** for analysis, but to no avail. However, the majority of privately-owned and publicly-subsidized rental units in New York City are tracked by New York University's Furman Center for Real Estate and Urban Policy's Subsidized Housing Information Project (SHIP) database, which was analyzed for this study.

Overview

ThinkBrooklyn's analysis of privately-owned and publicly-subsidized rental housing units in historic districts compared to units in non-designated neighborhoods found that historic district designation neither prevented the development, nor the maintained affordability, of subsidized units overall in New York City.

In Manhattan, Brooklyn and Staten Island historic districts, subsidized housing developed at a higher rate than in areas without historic designation in these boroughs, while Queens and The Bronx had more subsidized units developed outside of historic districts. Twenty-seven percent (27%) of the subsidized rental units located in historic districts in New York City were developed after the historic district was designated.

Subsidized units in many historic districts remained affordable whether or not the units were developed before or after historic district designation. Overall in New York City, affordability subsidies were maintained in historic districts at a rate of 74.6%, and outside of historic districts at a rate of 73.4%.

Manhattan's historic districts are less likely to have maintained affordability subsidies than the City as a whole, but Brooklyn, The Bronx, Queens and Staten Island were more likely to have had a higher percentage of subsidized rental units maintain their subsidies within historic districts than out.

A. Findings

According to ThinkBrooklyn's analysis of the Historic District SHIP Dataset, in the five boroughs of New York City, there are 30 historic districts which have a total of 96 BBLs with 3,906 rental units receiving one or more SHIP subsidies *(please see Table 6 for BBL and rental unit distribution by borough and historic district).* ThinkBrooklyn compiled counts and rates for the 96 BBLs located in historic districts, and compared them to the full Furman Center 2010 SHIP dataset (rentals only) by the following geographies: New York City, each of the five boroughs, and all 59 community districts in New York City (only community districts with SHIP historic district BBLs are included in the tables below, with the exception of Table 10, in which, in order to provide a large enough sample size for valid comparisons, only community districts with at least five historic district BBLs were included).

[86] New York City Rent Guidelines Board (2015). *2015 Housing Supply Report.* http://nycrgb.org/downloads/research/pdf_reports/15HSR.pdf.

Please note that most of the BBLs in the HD SHIP Dataset have only one building, so when reviewing the tables and statistics below, each BBL for most can be considered as one building.

All subsidies tracked in the Furman Center's SHIP dataset have expiration dates, and for those rental buildings which have renewable subsidies, owners may either "opt-out" and rent their units at market rate at the end of a subsidy's term, or choose to remain in a particular program by "renewing" a specific subsidy (or subsidies). Reasons for the expiration of subsidies of the remaining 25.4% (993) of the HD SHIP rental units may include either that an owner was unable to obtain other subsidies or loans (in the case of nonrenewable subsidies[87] (i.e. two BBLs with 65 rental units (6.5%) of the 993 units are in nonrenewable subsidy programs)), or the owner simply chose to opt-out of the program and began charging market rate rental prices[88] if the unit was not subject to other affordability (non-SHIP-tracked) restrictions. The SHIP database does not contain information about how a particular subsidy expired, or why owners chose to opt-out. Analysis of the HD SHIP Dataset revealed that historic district SHIP rental units have similar subsidy maintenance rates (74.6%) compared to SHIP rental units in New York City's non-historic district areas (73.4%).[89] *(please see Table 8)*

Analysis of ThinkBrooklyn's HD SHIP Dataset revealed that over a quarter (27.7% or 1,081) of the 3,906 subsidized rental units located in historic districts came on-line AFTER an historic district was designated, and that 74.6% (2,913) of the 3,906 rental units located in historic districts are still under government subsidy contracts and maintain their affordability requirements whether developed BEFORE or AFTER an historic district designation. *(please see Tables 5 and 6 below)*

[87] The following subsidy programs tracked in the SHIP database are nonrenewable: HUD's Project Based Rental Assistance Program (RAP), Rental Supplement Program, Section 221(d)(3) Below Market Interest Rate program and Section 236 program. Section 221(d)(3) was authorized by the National Housing Act of 1961 and allowed developers to obtain FHA insured, three percent BMIR mortgages from private lenders, who then immediately sold the mortgages at face value to Fannie Mae. It was replaced by the Section 236 program in 1968.

[88] According to the Furman Center, it should be noted that changes in market-rate rental prices do not necessarily mean that rents are no longer affordable to lower-income households; rather it simply means that there are no legal restrictions that rents maintain affordability. The Furman Center emphasized that in various New York City neighborhoods, market-rate rents may well be affordable to low- and moderate-income households. Additionally, the Furman Center noted that Mitchell-Lama buildings occupied before 1974 would automatically become rent-stabilized after opt-out/expiration (there is one BBL in an historic district with 112 units for which this situation applies).

[89] ThinkBrooklyn and Research Design Advisors recommend a t-test be conducted given that the decision to opt-out is at the project level, and the fact that the relevant "Ns" are low, so that the difference in means may not be statistically significant.

Table 5
Status of Subsidized Housing Information Project (SHIP)
Rental BBLs and Rental Units
in Historic Districts
(2010)

Status	SHIP Rental BBLs in Historic Districts	SHIP Rental Units in Historic Districts
CSDA (Currently Subsidized and Developed After HD Designation)	34.4% (33)	27.7% (1081)
CSDB (Currently Subsidized and Developed BEFORE HD Designation)	44.8% (43)	46.9% (1832)
NLDA (No Longer Subsidized and Developed AFTER HD Designation)	4.2% (4)	13.6% (533)
NLDB (No Longer Subsidized and Developed BEFORE HD Designation)	16.7% (16)	11.8% (460)
Total	**100.0% (96)**	**100.0% (3906)**

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015). Please note that most BBLs in ThinkBrooklyn's HD SHIP Dataset have only one building, and so when reviewing data in the White Paper's tables, each BBL can, for the most part, be considered as one building.

Table 6
SHIP Rental BBLs, Rental Units and Maintenance of Subsidies
by New York City Borough, Historic District and Community District
(1957-2010)

New York City Borough, Historic District (HD) and Community District (CD)	SHIP Rental BBLs in Historic Districts Developed 1957-2010	SHIP Rental Units in Historic Districts Developed 1957-2010	SHIP Rental Units in Historic Districts Maintaining Subsidy in 2010
Bronx	**6**	**517**	**100.0%**
Clay Avenue HD (CD 4)	1	8	100.0%
Grand Concourse HD (CD 4)	1	298	100.0%
Longwood HD (CD 2)	2	98	100.0%
Mott Haven East HD (CD 1)	2	113	100.0%
Brooklyn	**39**	**1085**	**81.5%**
Bedford Stuyvesant/Expanded Stuyvesant Heights HD (CD 3)	15	138	100.0%
Brooklyn Academy of Music HD (CD 2)	1	102	100.0%
Brooklyn Heights HD (CD 2)	2	232	81.5%
Clinton Hill HD (CD 2)	3	150	16.0%
Crown Heights North HD (CD 8)	9	130	75.4%
Crown Heights North II HD (CD 8)	4	220	100.0%
Fort Greene HD (CD 2)	1	97	100.0%
Park Slope HD Extension (CD 6)	1	8	100.0%
Prospect Heights HD (CD 8)	2	6	100.0%
Prospect Lefferts Gardens HD (CD 9)	1	2	100.0%
Manhattan	**49**	**2126**	**62.7%**
Central Park West - West 73rd - 74th Street HD (CD 7)	1	8	0.0%
Chelsea HD Extension HD (CD 4)	1	19	0.0%
East 10th Street HD (CD 3)	1	9	0.0%
Greenwich Village HD (CD 2)	3	427	5.4%
Hamilton Heights HD Extension (CD 9)	1	12	100.0%
Hamilton Heights/Sugar Hill HD (CD 9)	6	126	38.1%
Hamilton Heights/Sugar Hill HD Extension (CD 9)	1	42	100.0%
Hamilton Heights/Sugar Hill Northeast HD (CD 9)	3	46	100.0%
Hamilton Heights/Sugar Hill Northwest HD (CD 9)	7	62	100.0%
Madison Square North HD (CD 5)	1	416	100.0%
Manhattan Avenue HD (CD 7)	1	8	100.0%

New York City Borough, Historic District (HD) and Community District (CD)	SHIP Rental BBLs in Historic Districts Developed 1957-2010	SHIP Rental Units in Historic Districts Developed 1957-2010	SHIP Rental Units in Historic Districts Maintaining Subsidy in 2010
Mount Morris Park HD (CD 10)	5	36	100.0%
Riverside-West End HD Extension I (CD 7)	1	289	100.0%
Upper East Side HD (CD 8)	1	100	100.0%
Upper West Side/Central Park West HD (CD 7)	16	526	46.2%
Staten Island	**2**	**178**	**100.0%**
New York City Farm Colony- Seaview Hospital HD (CD 2)	2	178	100.0%
Total	**96**	**3906**	**74.6%**

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015). Please note that no SHIP rental units have been developed in Queens's historic districts, and therefore data for Queens are not included in this table, or in several other data tables, in Part II.

Table 7 (below), compares, by New York City borough, the percentages and counts of SHIP rental units developed from 1957 to 2010 within and outside of historic districts. Of the 3,906 SHIP rental units developed in historic districts, 54.4% were developed in Manhattan, 27.8% in Brooklyn, 13.2% in the Bronx, 4.6% in Staten Island, and 0% in Queens, which differs from the distribution of SHIP rental units developed outside of historic districts during that same time period.

Table 7
SHIP Rental Units
Developed In and Outside of Historic Districts
By New York City Borough
(1957-2010)

New York City Borough	SHIP Rental Units Developed in Historic Districts	SHIP Rental Units Developed Outside of Historic Districts
Bronx	13.2% (517)	28.6% (65,776)
Brooklyn	27.8% (1,085)	24.0% (55,188)
Manhattan	54.4% (2,126)	38.8% (89,365)
Queens	0.0% (0)	6.2% (14,369)
Staten Island	4.6% (178)	2.4% (5,482)
Total	**100% (3,906)**	**100% (230,180)**

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015)

SHIP rental units in Manhattan's historic districts are less likely to have maintained subsidies (62.7%) compared to SHIP rental units in historic districts in other boroughs, as well as compared to SHIP rental units outside of historic districts in Manhattan (71.3%). (*please see Table 8*) For the boroughs of The Bronx, Brooklyn and Staten Island,

the converse is true: a higher percentage of SHIP rental units have maintained subsidies in historic districts than SHIP rental units located outside of historic districts. The lower percentage of SHIP subsidy maintenance in Manhattan's historic districts may be at least partially be attributable to Manhattan's earlier average start date (1988) for SHIP subsidies compared to the other boroughs' SHIP subsidy average start dates (Bronx-1998, Brooklyn-1994, Staten Island-2003), and also compared to all of Manhattan's SHIP rental developments outside of historic districts, which have a later average start date (1993).[90] *(please see Table 9)*

Table 8
SHIP Rental Units Maintenance of Subsidies
by New York City Borough
In and Outside of Historic Districts
(2010)

New York City Borough	SHIP Rental Units in Historic Districts Maintaining Subsidy in 2010	SHIP Rental Units Outside of Historic Districts Maintaining Subsidy in 2010
Bronx	100.0%	73.8%
Brooklyn	81.5%	76.4%
Manhattan	62.7%	71.3%
Staten Island	100.0%	73.2%
New York City	**74.6%**	**73.4%**

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015)

[90] ThinkBrooklyn and Research Design Advisors recommend conducting a t-test in future research (given that the relevant "Ns" are relatively low) so that it can be determined whether there are statistically significant differences in findings.

Table 9
SHIP Average Subsidy Start Year
and (Average Years Since Start of Subsidy)[91]
for
SHIP Rental Units in Historic Districts and
ALL SHIP Rental Units both In and Outside of Historic Districts
by New York City Borough
(2010)

New York City Borough	SHIP Rental Units in Historic Districts Avg. Year Subsidy Started (Avg. No. Years Since Start of Subsidy)	ALL SHIP Rental Units Avg. Year Subsidy Started (Avg. No. Years Since Start of Subsidy)
Bronx	1998 (13.0 years ago)	1993 (18.0 years ago)
Brooklyn	1994 (16.8 years ago)	1995 (16.4 years ago)
Manhattan	1989 (22.1 years ago)	1993 (17.7 years ago)
Staten Island	2003 (8.5 years ago)	1984 (26.8 years ago)
New York City	**1991 (19.1 years ago)**	**1993 (17.7 years ago)**

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015)

There is substantial variation at the community district (CD) level in percentages and counts of SHIP rental units which have maintained their subsidies. In The Bronx, all SHIP rental units in historic districts remained subsidized as of 2010, which is logical given their relatively more recent subsidy start dates. *(please see Table 9)* In Brooklyn, the decrease in the percentage of SHIP rental units seems mostly attributable to CD 2 (Brooklyn Heights). In Manhattan, CDs 2, 4, 7 and 9, all have BBLs where SHIP subsidies are no longer maintained.

Table 10 (below) shows the variation in subsidy maintenance rates for SHIP rental units by New York City community district (for those community districts with at least five SHIP rental BBLs in any historic district) compared to the rates for all SHIP rental units (whether in or outside of historic districts). Data for four of the six community districts in Table 10 (BK-2 Fort Greene/Brooklyn Heights, BK-8 Crown Heights/Prospect Heights, MN-7 Upper West Side and MN-9 Morningside Heights/Hamilton) show similar patterns- either that maintenance of subsidy rates are similar between historic districts and the overall SHIP rental unit data, or, if there are different rates, they appear to be explained by average start dates.

Two of the community districts do not follow suit: BK-3 Bedford Stuyvesant, where 100% of historic district rental units maintained their subsidies despite earlier average start dates (18.0 years) than overall SHIP rental units in Community District 3 (14.1 years). In Manhattan's Community District 10 (Central Harlem), SHIP rental units in historic districts, and SHIP rental units overall (in and outside of historic districts), have similar average start dates, but SHIP rental units in historic districts are more likely to have maintained their subsidies.

[91] Because the Furman Center's SHIP dataset is current as of 2010, and because the latest subsidy start date in ThinkBrooklyn's HD SHIP Dataset is 2010, "Years since Start of Subsidy" is calculated based upon the number of years as of 2011 that a subsidy has been in place, ranging from 1 to 46 years.

Table 10
Average Percentages of SHIP Rental Units with Maintained Subsidies
in Historic Districts
and (Average Number of Years Since Subsidy Start)
Compared to All SHIP Rental Units
as of 2011
by Selected Community Districts

New York City Community District	SHIP Rental Units in Historic Districts Maintaining Subsidy in 2010 (Avg. No. Years Since Start of Subsidy)	All SHIP Rental Units Maintaining Subsidy (Avg. No. Years Since Start of Subsidy)
BK-2 Fort Greene/Brooklyn Heights	70.9% (27.4)	84.0% (21.0)
BK-3 Bedford Stuyvesant	100.0% (18.0)	86.8% (14.1)
BK-8 Crown Heights/Prospect Heights	91.0% (11.3)	84.8% (17.0)
MN-7 Upper West Side	65.0% (29.8)	66.2% (27.9)
MN-9 Morningside Heights/Hamilton	72.9% (14.2)	65.7% (16.5)
MN-10 Central Harlem	100.0% (13.4)	90.6% (13.6)

Data Sources: NYU Furman Center SHIP Database (2010) and ThinkBrooklyn HD SHIP Dataset (2015). Please note that in order provide a large enough sample size for valid comparisons, only community districts with at least five historic district BBLs were included in this table.

B. Methodology

To examine the relationship between historic districts and subsidized housing, individual buildings that receive affordability subsidies were examined across New York City and buildings within historic districts were compared to buildings outside of historic district boundaries. The primary source of data was New York University's Furman Center for Real Estate and Urban Policy's Subsidized Housing Information Project (SHIP) database, which tracks a series of federal, state and city programs. Changes in status related to receiving subsidies were analyzed related to the timing of historic designation, including specifically if subsidies were developed before designation, after designation, and what lengths of time subsidies were in place for. The data related to subsidized units in historic districts were then compared to all subsidized units at a Community District level so units could be compared within a similar geography.

The Subsidized Housing Information Project (SHIP) database from New York University's Furman Center for Real Estate and Urban Policy tracks privately-owned and publicly-subsidized rental[92] developments in New York City (and each development's buildings and rental units) that are subsidized by at least one of four programs: (1) U.S. Department of Housing and Urban Development (HUD) financing and insurance programs, (2) HUD project-based rental assistance programs, (3) New York City and New York State Mitchell-Lama programs, and (4) Low-Income Housing Tax Credit (LIHTC)-funded developments.[93] The SHIP database provides detailed information for nearly 2,500 rental developments from 1957 to 2010, and is comprised of approximately 5,000 buildings with 235,000 rental units.[94] The SHIP database is therefore an apropos data source for this study, in conjunction with other relevant databases, for tracking changes in counts of subsidized rental units over time in historic districts and comparative geographies in New York City. Government-subsidized rental housing programs are numerous, and one development (which may have one or more buildings consisting of one or many units), can often receive multiple subsidies from various funding sources. These subsidies last from several to over 30 years, some of which are renewable, while others are not. Owners of buildings with renewable subsidies may be eligible to "opt-out" of a particular subsidy program, at which point the relevant subsidy would "expire". The Furman Center's *State of New York City's Subsidized Housing: 2011* report cites that owners are more likely to opt-out during economic booms

[92] The SHIP database does not track all privately-owned and publicly-subsidized rental developments, but it does track the vast majority of them. SHIP also includes subsidized cooperative housing developments, but they are not included in this study's analyses.

[93] These four categories include the following subsidy programs: (1) U.S. Department of Housing and Urban Development financing and insurance programs: Section 221(d)(3), 221(d)(3), BMIR, 221(d)(4), Section 236, Section 223(f), Section 202 (for elderly) and Section 811 (for disabled); (2) HUD project-based rental assistance programs: Rent Supplement Program (Rent Supp), Section 236 Rental Assistance Payment (RAP), project-based Section 8, and the Project Rental Assistance Contract Program (PRAC) (for elderly or disabled tenants); (3) New York State Mitchell-Lama programs; and (4) Low-Income Housing Tax Credit-funded developments: LIHTC 4% and 9%. For a detailed description of subsidy programs, please see Furman Center (2011). *State of New York City's Subsidized Housing: 2011*. Accessed 1/10/15 http://furmancenter.org/files/publications/SHIPReportFinal.pdf.

[94] The SHIP dataset obtained by ThinkBrooklyn in July, 2014, and subsequently analyzed for this study, is the Furman Center's 2010 dataset, with the exception of two Borough-Block-Lots (BBLs) (2-02707-0011 and 3-1847-37) which were missing from the 2010 dataset and had pre-2010 subsidy start dates, but were included in the 2012 SHIP dataset. Upon the release of the 2012 SHIP dataset in January 2015, the first update since it was initially released in 2011, ThinkBrooklyn used the 2012 dataset to double check which BBLs were within historic districts, and inserted two missing BBLs into our 2010 dataset. All other fields used in ThinkBrooklyn's SHIP analyses are from the 2010 SHIP dataset. Future research should use the most recent SHIP dataset, which according to the Furman Center, should be released annually moving forward.

when they can command higher market rate rental prices, and also during times of recession due "to deteriorating physical conditions that cause the regulating agency to foreclose on the property."[95]

ThinkBrooklyn obtained the SHIP dataset from the Furman Center in July, 2014, and began a thorough review of the data. Once vetted, the file needed to be disaggregated so that each row was a single SHIP BBL (Borough-Block-Lot), since, in the original SHIP file, rental developments (defined as properties financed through the same programs) could have one or more associated BBLs.[96] The disaggregated SHIP BBL file was mapped and joined with the New York City Landmark Preservation Commission's (NYC LPC's) historic district shapefile, and SHIP rental BBLs which were within the boundaries of historic districts were selected for analysis.[97] From these selected BBLs, a new dataset (Historic District (HD) SHIP Dataset) was developed by ThinkBrooklyn by merging historic district and SHIP data fields, and adding missing SHIP data (primarily rental units for disaggregated BBLs) from publicly available data sources such as NYCityMap and New York City Department of Buildings.[98] Each HD SHIP BBL was then categorized into one of four "statuses" that describes when a BBL's rental units were first developed under a government subsidy, and whether the subsidy was still in place as of 2010:

a. **Currently Subsidized and Developed After HD Designation**: Subsidy currently (as of 2010) remains in place and rental units were developed AFTER an historic district was designated;
b. **Currently Subsidized and Developed Before HD Designation**: Subsidy currently (as of 2010) remains in place and rental units were developed BEFORE an historic district was designated;
c. **No Longer Subsidized and Developed After HD Designation**: Subsidy has expired and rental units were developed AFTER an historic district was designated;[99]
d. **No Longer Subsidized and Developed Before HD Designation**: Subsidy has expired and rental units were developed BEFORE an historic district was designated.

These statuses are helpful for analyzing whether there is a relationship between historic districts and the initial development, and the term of particular subsidized rental housing units in New York City. In addition to yielding basic information about the number of SHIP rental developments in historic districts, their location, concentration, and count and timing of rental units developed, the analyses of these data also explored the following questions:

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[95] Furman Center (2011). *State of New York City's Subsidized Housing: 2011* (page 19). Accessed 1/10/15 http://furmancenter.org/files/publications/SHIPReportFinal.pdf.

[96] BBLs (Borough-Block-Lot), rather than buildings and their addresses, were used for ThinkBrooklyn's SHIP analyses because the Furman Center noted that the BBL field was the most accurate (compared to address data) from their perspective due to the fact that some BBLs have more than one building, and so counts would be inaccurate if analyzed by address. If of interest, building counts can be provided by ThinkBrooklyn.

[97] ThinkBrooklyn obtained the most recent NYC LPC historic district shapefile as of July, 2014 from Jennifer Most, who was then with the NYC LPC. All historic district boundaries, names and designation dates are from this original LPC shapefile and were subsequently vetted, updated and confirmed by Jennifer Most in 2015.

[98] Each of these BBLs were checked against the NYCityMap website per the Furman Center's recommendation to verify that they were within an historic district, and to obtain the number of rental units and addresses when SHIP data could not provide those data.

[99] Government subsidized rental housing programs are numerous, and one development (which may have one or more buildings consisting of one or many units), can often receive multiple subsidies from various funding sources. These subsidies last from several to over 30 years, some of which are renewable, while others are not. Owners of buildings with renewable subsidies may be eligible to "opt-out" of a particular subsidy program, at which point the relevant subsidy would "expire". The Furman Center's *State of New York City's Subsidized Housing: 2011* report cites that owners are more likely to opt-out during economic booms when they can command higher market rate rental prices, and also during times of recession due "to deteriorating physical conditions that cause the regulating agency to foreclose on the property."

Are Historic District SHIP rental development rates similar or dissimilar to trends in SHIP rental development rates overall and in areas outside of historic districts? Did HD SHIP rental developments maintain subsidies at similar rates as SHIP rental developments overall and in areas outside of historic districts? Are there differential rates or development rates based upon the borough or community district in which the HD SHIP rental developments were located?

Appendix 1: Recommendations for Future Research

ThinkBrooklyn responded to the Historic Districts Council's 2014 Request for Proposals (RFP) with a scope of work presented as a menu of options given the substantial preliminary research and due diligence necessary to conduct the study in light of unknowns regarding data availability and the quality of available datasets. As ThinkBrooklyn embarked upon its investigations regarding the availability of data, and analyzed accessed datasets for cleanliness, completeness and accuracy, a prioritized and targeted scope of work was finalized with HDC and Research Design Advisors that aligned with the study's budget and timeline.

Research questions and proposed analyses included in ThinkBrooklyn's original menu of options which were not pursued given data, time and budget limitations, in addition to subsequent suggestions by the study's Research Design Advisors and the Review Committee, are included below for both Part I: U.S. Census Bureau Affordability and Income Indicators, and Part II: Building-Level Affordability Indicators. The following Recommendations for Future Research are presented in no particular order, and their numbering does not denote priority or chronology, but is merely included for ease of future reference and discussion.

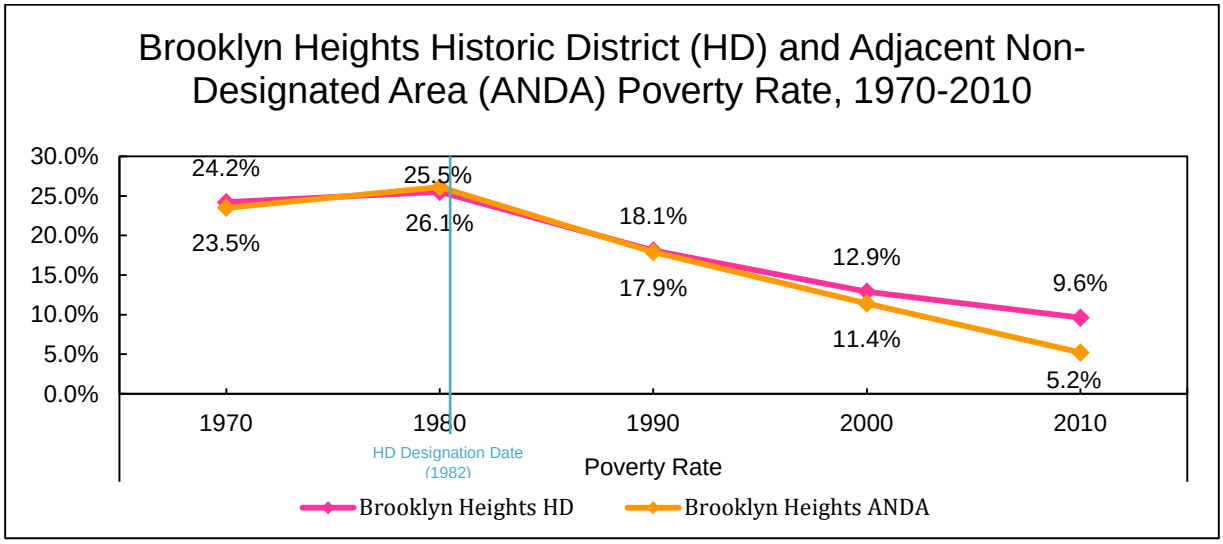
Part I: U.S. Census Bureau Affordability and Income Indicators

1. Apply a spatial weighting methodology that would allow for more of the 213 census tracts in New York City that have at least one residential unit in an historic district to be included in the analysis. ThinkBrooklyn recommends that this methodology include the process of areal disaggregation and re-aggregation, and weighting using cadastral data. This method, however, is only feasible for analysis of post-2000 data because it requires the New York City Department of City Planning's MapPLUTO data (in order to interpolate between census tracts and historic districts via tax lots weighted by residential units), which are not available prior to 2000 (please see Appendix 3for an overview of weighting methodologies).[100]
2. Explore utilizing a more accurate weighting methodology than that provided by LTDB for 1970, 1980 and 1990. The physical infrastructure of New York City was relatively highly developed by 1970, and therefore, more ancillary data (parks, water, roadbeds) could be included than LTDB provides given their national focus.
3. Expand the analysis by using qualitative and quantitative neighborhood assessments to select additional non-districted but adjacent census tracts to analyze.
4. Procure and analyze the more targeted and smaller geographies of block group harmonized data instead of census tract level data if they become available for the years of interest for the study's longitudinal analyses.
5. Incorporate in the analyses additional historic districts designated after 2010 while using the most recent census data harmonized to 2010.
6. Analyze the performance of additional dependent variables such as median gross rent from NHGIS, and from LTDB: per capita income, percentage of persons in poverty, total population, race/ethnicity, percentage foreign born, percentage persons over 25 with a Bachelor's degree or above, percentage in labor force, total households, percentage renter-occupied households, percentage owner-occupied households, and percentage of households that moved in less than 10 years ago.
7. Adjust the time periods (e.g. 1970-1990, 1980-2000, etc.) in the regression analysis to observe whether during certain time periods historic districting has had varying effects on affordability.

[100] This particular weighting methodology assumes that the number of residential units in a given tax lot is a reasonable proxy for population density. While not perfect, this is a substantial improvement over simple areal weighting, where a population is assumed to be uniformly distributed within a particular geography (in this case, a census tract). For a more detailed explanation, please see Appendix 3.

8. Develop an independent variable for the regression analysis that accounts for change in counts of historic district BBLs over time in a particular census tract.
9. Analyze historic district and non-historic district areas that currently have comparable median income levels and compare the rates of increase in median income in those areas over time in order to address causality (vs. correlation). Architectural merit and desirability of the buildings would need to be controlled for (which, of course, are inherently subjective qualities and therefore difficult to quantify for measurement).
10. Conduct a descriptive analysis that seeks to answer the question, "is change for a given measure (i.e. median household income, percentage of persons living in poverty, etc.) different within a single historic district when compared to an adjacent comparable neighborhood", and would track the specific indicator decennially from 1970 to 2010. Determining the criteria for "comparability" of neighborhoods is a challenge, but there are precedent methodologies to pursue (i.e. a recent study by NYU's Furman Center[101]). Furthermore, the sample size when comparing a single historic district to its comparable neighborhood would be quite small, and therefore results would need to be interpreted with caution. However, given historic districts' variability (i.e. different timing of designations, size, and types of neighborhoods in which historic districts are located, etc.), providing these data (within certain and clearly defined margins of error) may be a useful tool for understanding longitudinal historic district change within an individual historic district and in comparison to a comparable neighborhood (*please see **Figure 2** below as an example of a graph which uses fictitious data to illustrate such an analysis).*

Figure 2 (*fictitious data*)



Part II: Building-Level Affordability Income Indicators

Rent-Regulated Data

[101] Ellen, I. G., McCabe, B., Stern, E. (2016). 50 years of Historic Preservation in New York City. New York, NY: Furman Center. Accessed March 9, 2016 from http://furmancenter.org/files/NYUFurmanCenter_50YearsHistoricPresNYC_7MAR2016.pdf

1. Analyze changes in rent-stabilized units in historic districts and comparable neighborhoods since the early 1990s (data are available, if request granted, by contacting Andrew McLaughlin, Executive Director, New York city Rent Guidelines Board).
2. Review the viability of New York City Department of Finance rent-stabilized data. After several months of navigating the relevant departments of the New York City Department of Finance, ThinkBrooklyn was able to procure a dataset that includes building-level data of the annual counts of rent-stabilized units for all five boroughs of New York City. However, ThinkBrooklyn's review of the NYC DOF dataset revealed that these data only appear to capture a portion (approximately 80% of the known universe)[102] of rent-stabilized units beginning in 1999. NYC DOF had conveyed, in response to ThinkBrooklyn's initial inquiries, that their full dataset went as far back as 1984. Despite the fact that the NYC DOF dataset does provide at least some data for every year from 1984 to 2013, between 1984 and 1998, the average annual count of rent-stabilized units is only 70,120, while average annual counts according to the U.S. Census Bureau's *New York City Housing and Vacancy Survey (HVS)* for that same timeframe were close to 1 million.[103] After 1998, however, the NYC DOF average count is much closer to publicly available counts from the *NYC HVS*. For example, in 1999 the NYC DOF data show 842,835 rent-stabilized units in New York City, while the *New York City Housing and Vacancy Survey* estimates that in 1999 there were 1,020,588 rent-stabilized units.[104] ThinkBrooklyn expected upon its review of the NYC DOF dataset to find that not all rent-stabilized units would be reflected, as the dataset is based upon the fees that building owners pay to the New York City Department of Finance, and clearly not all building owners comply. This being said, ThinkBrooklyn does not believe that the large pre-1999 discrepancies reflect mere non-compliance.
3. Continue to follow up with the Office of the Manhattan Borough President (Basha Gerhards, Deputy Director of Land Use and ThinkBrooklyn's contact) to determine the status of ThinkBrooklyn's and the Manhattan Borough President's request for rent-controlled and rent-regulated units from New York State's Division of Housing and Community Renewal (DHCR). Details regarding data procurement efforts to date, contact information, etc. are available from ThinkBrooklyn upon request.

<u>SHIP Data</u>

1. Add an analysis of adjacent comparable neighborhoods to the current study to further control for various neighborhood changes not caused by historic districting.
2. Add the percent of subsidized units as a percent of historic residential units to the current study's presented findings.
3. Because the unit of analysis of the HD SHIP Dataset for this study is a particular project, and since the decision to opt-out is made at the project level and there are relatively low "Ns", it might be prudent to conduct a t-test to ascertain whether differences in means are statistically significant.
4. Account for zoning as a possible intervening variable in the current analysis.
5. Quantify and analyze the impact of gentrification on the findings of the current study, exploring the hypothesis that areas recently experiencing gentrification might be more likely lose subsidized units in historic districts.

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[102] In this case, "known universe" is defined as units included in the *U.S. Census Bureau's New York City Housing and Vacancy Survey (HVS)* which, through NYC HPD, uses NYS DHCR data to provide the most accurate estimates possible of rent-regulated housing units in New York City.

[103] U.S. Census Bureau. *New York City Housing and Vacancy Survey*. Accessed 1/5/15 http://www.census.gov/housing/nychvs/. ThinkBrooklyn engaged the New York City Department of Finance to ascertain the reasons for the discrepancy, and is awaiting clarification.

[104] U.S. Census Bureau. *New York City Housing and Vacancy Survey, 1999, Series 1ATable 14*. Accessed 1/5/15 http://www.census.gov/housing/nychvs/data/1999/s1at14.html.

6. Explore the proportion of new residential rental unit construction in New York City that uses SHIP subsidies (leveraging data since 1990 from NYU's Furman Center).
7. Explore the spatial distribution of HD SHIP developments that are expiring with the next 5 years.
8. When data become available from NYU's Furman Center (anticipated in 2016), examine the rate of opt-outs as a percentage of rental projects in and outside of historic districts for which owners have had at least one opportunity to opt-out.
9. Compare the rates of use of public affordable housing development subsidies in historic districts before and after historic district designation to explore whether owners seem less likely to develop affordable housing in historic districts than in non-districted areas.

Appendix 2: Affordability, Income and Demographic Indicators

The scope of work for this study with regards to the analysis of U.S. Census data included three indicators which were selected as dependent variables: *Median contract rent, Renter households paying 35% or more of income to housing and Median household income*. There are several additional affordability, income and demographic indicators listed below which ThinkBrooklyn recommends exploring in future research.[105] The source, years and geographies available for those indicators marked with "(LTDB)" are: *U.S. Census Bureau Decennial Census* or *American Community Survey 5-Year Estimates via Longitudinal Tract Data Base (LTDB) (1970, 1980, 1990, 2000, 2006-2010).*[106] For those indicators marked with "(NHGIS[107])", the source, years and geographies available are: *U.S. Census Bureau Decennial Census* or *American Community Survey 5-Year Estimates via National Historical Geographic Information System (NHGIS) (1970, 1980, 1990, 2000, 2006-2010).*

Affordability Indicators

1. Median contract rent (LTDB)[108]
2. Percentage of renter households paying 25% or more of income to housing (gross rent) (NHGIS)[109]
3. Percentage of renter households paying 35% or more of income to housing (gross rent) (NHGIS)

Income Indicators

4. Median household income (LTDB)
5. Per capita income (LTDB)
6. Percentage of persons in poverty (LTDB)

Demographic Indicators

7. Total population (LTDB)
8. Race percentages: Asian; Blacks, not Hispanic, Hispanic, Whites, not Hispanic; (LTDB)[110]
9. Percentage foreign born (LTDB)
10. Percentage persons over 25 with a Bachelor's degree or above (LTDB)
11. Percentage in labor force (LTDB)

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[105] This list, which has been vetted by HDC, is based upon the original list of indicators in the study's proposal, which evolved commensurate with ThinkBrooklyn's research, including cross-referencing the availability of harmonized census tract-level data in the LTDB, as well as data available from the NHGIS (which provides historic census data at the census tract level, but not harmonized).

[106] For additional information about U.S. Census Bureau indicators available via the LTDB, please see the LTDB codebook at: http://www.s4.brown.edu/us2010/Researcher/LTBDDload/Dfiles/codebooks.pdf.

[107] For additional information about U.S. Census Bureau indicators available via the NHGIS, please go to https://nhgis.org/.

[108] Median contract rent includes only rent negotiated as part of a lease agreement and may or may not include utility costs. Median "gross" rent includes rent negotiated as part of a lease *plus* utility costs. Median gross rent therefore might more fully capture costs as related to housing affordability. According to the United States Department of Housing and Urban Development (HUD), affordable housing is defined as: **"**In general, housing for which the occupant(s) is(are) paying no more than 30 percent of his or her income for gross housing costs, including utilities. Please note that some jurisdictions may define affordable housing based on other, locally determined criteria, and that this definition is intended solely as an approximate guideline or general rule of thumb." However, only median contract rent is available through the LTDB. A median gross rent measure can be created with additional work based upon available data from NHGIS.

[109] 25% and 35% are the only percentages available for the time period of 1970-2010 because in the 1970 Decennial Census the percentage of income paid to rent was calculated only for the following categories: less than 10%, 10-14%, 15-19%, 20-24%, 25-34% and more than 35%.

[110] Not available for 1970.

12. Total households (LTDB)
13. Percentage renter-occupied households (LTDB)
14. Percentage owner-occupied households (LTDB)
15. Percentage of households that moved in less than 10 years ago (LTDB)

Appendix 3: Weighting Methodologies Literature Review

A review of spatial interpolation and re-aggregation literature was conducted by ThinkBrooklyn in an attempt to determine the best method of reporting data for historic districts across time. There exist a number of challenges, chiefly the spatial incongruity of the data source (census tracts or block groups) and the desired reporting unit (historic districts), as well as the length of the time period in question (1965-present) for researching the intersection of affordable housing and historic districts. The field of spatial interpolation research is focused on finding methods to improve a simple areal weighting scheme, in which the attributes of source zones are applied to target zones based upon the percentage of the area of the respective target zones within the source zones. This method is not ideal due to its reliance on the assumption of uniform distribution of phenomena (i.e. population density) within the source zones. Dasymetric mapping, or "areal interpolation that uses ancillary spatial data to aid in the interpolation process" provides a potential solution to this issue. (Reibel & Bufalino, 2005) Dasymetric mapping techniques range from simple binary methods in which areas known to be unpopulated (such as parks, roadbeds, or industrial sites) are excluded from an areal weighting analysis, to complex methodologies that assign population weights based on different classes of land use or other data. (Langford, 2006)

Much of the research regarding spatial interpolation utilizes land cover classification categories (urban, suburban, forest, etc.) at the regional scale to approximate population densities and is thus not directly applicable to this study's hyper-local, hyper-urban context. (Kar & Hodgson, 2012) However, several studies are worthy of further consideration. In a study of Los Angeles County, Reibel and Bufalino (2005) use the length of streets within census tracts to interpolate population and housing unit counts between 1990 and 2000 census tracts. Given its focus on Los Angeles, and that they find this method to be an improvement upon areal weighting, this method is potentially a good fit for New York City. The core assumption of this technique according to the authors is "that the residential population density gradient at a given distance from the nearest street or road is constant." (p. 136-137) The authors provide suggestions for improving their analysis, such as using more detailed street data and/or querying the data to focus on residential streets if such attributes are available.

Another potentially viable dasymetric method focuses specifically on the issue of interpolating census data to smaller geographic units in New York City. In *The Cadastral-based Expert Dasymetric System (CEDS) for Mapping Population Distribution and Vulnerability in New York City*, Maantay et al. (2007) utilize attributes regarding the number of residential units and the total residential area within a given tax lot as weights to redistribute census populations to tax lot geographies. This methodology might be apropos for interpolating census data to historic districts. Another novel aspect of CEDS is its implementation of an "expert system" for choosing the variable on which to weight interpolation, since the cadastral dataset in use contains attributes for both residential units in a tax lot and residential area. (Maantay et al., 2007, p.87) In CEDS, "tract data were disaggregated down to the tax lot and then re-aggregated up to the block group. It was necessary to use the tract-level data as a starting point so that there would be a smaller unit of aggregation (block group) available in the census data with which to compare the estimated values." (p.88) The estimated block group populations were then compared to the actual block group populations to determine which variable was a more accurate proxy.

However, CEDS and other dasymetric techniques do pose several challenges for researching the intersection of affordable housing and historic districts in New York City. While longitudinal census data are widely available and a variety of useful ancillary spatial data are publicly accessible for New York City (i.e. buildings, roadbeds, sidewalks, parks, etc.), there is a paucity of such historical ancillary spatial data. While sparse, there is some research into areal interpolation techniques across time. Schroeder (2007) used a method known as Target-Density Weighting (TDW) to interpolate the indicator of population between 1990 and 2000 census tracts that had changed geometry and found it to be an improvement upon simple areal weighting. While his exact method is not directly applicable, his theoretical suggestion that "we may also reasonably assume that the population distribution at one time will be more similar to the population distribution 10 years later than to a uniform distribution" is of interest.

(p. 315) According to this assumption, population density weights could be determined with an advanced method such as CEDS using contemporary ancillary data, and these weights could then be extrapolated back in time in order to provide a more accurate method than simple areal weighting for dates lacking ancillary spatial data. While Schroeder does not endorse nor directly discuss such a practice, it is consistent with his core assumption. In a more recent study, Schroeder and Van Riper (2013) note that "there are some common settings in which TDW may produce large errors (e.g., in areas of urbanization or redevelopment, where one year's density distribution may differ greatly from another year's, or in cases where a target zone is much larger than its intersection with a source zone, making the entire target zone's density a poor indicator of density within the source zone)." (p. 2) This raises concerns about applying the theoretical assumptions of TDW to the case in question, given the urban study area and significant differences between census tract and historic district geometry.

In *The Impact of Landmarking on Housing Production in Manhattan*, the Real Estate Board of New York (REBNY) (2013) attempted to gauge the demographics of historic districts in a different way, by grouping census tracts based upon the percentage of property landmarked and summarizing the demographics of these grouped tracts. The RENBY study does not include a methodology section, thus it is unclear precisely what is meant by "Census Tract with over 50% Property Landmarked". (p. 3) This could indicate a group of census tracts in which 50% of each tract's area is landmarked, or a group of census tracts for which the number of tax lots (properties) were counted and then analyzed to determine that 50% of these lots were landmarked. Neither case would serve as a very rigorous method because REBNY does not account for density, or whether any people are living in the given areas (i.e. a tract could have 50% of its area landmarked, but that landmarked area could contain no residential buildings and thus the census data would not at all apply.) Yet REBNY's study does raise an alternative methodology of sorts for relating demographic data and historic districts, one that does not attempt to interpolate data to the historic districts, and thus does not rely on estimated statistics, but rather simply reports the data of tracts containing various amounts of landmarked properties. However, as mentioned earlier, the link between these reported demographics and the demographics within historic districts or the extent to which the population in historic districts contributes to these demographics is unclear from the REBNY report.

In conclusion, ThinkBrooklyn's literature review of weighting methodologies revealed CEDS as the most robust and appropriate method for interpolating census data in New York City. For future research regarding the intersection of affordable housing and historic districts, the CEDS methodology could be replicated to assign census counts to tax lots and then those tax lot counts could be subsequently re-aggregated to historic district geographies. However, because historical cadastral data are unavailable, this method is only applicable to the years 2002-present (i.e. the years that MapPLUTO are available). It is unclear which method of interpolation is optimal for the years not covered by MapPLUTO. As discussed earlier, the density weights calculated using MapPLUTO data could be extrapolated onto the earlier years under the assumption that patterns of density have remained substantially the same in these areas over time. This is a somewhat reasonable assumption given that new construction may be more limited within historic districts, making their density less subject to change than other areas of the city. However, areas outside historic districts but within the same census tract could have experienced substantial changes in density, altering the density surface of the tract and thus leading to interpolation error even if density within the historic district has remained constant.

Ideally, several methods could be tested for future research in the same manner of the 'expert system' used in CEDS. Extrapolating MapPLUTO into the past, street weighted interpolation, and a binary interpolation in which the footprint of residential buildings is used for areal weighting are the best candidates for such testing, in which population could be interpolated from tract to block group for all years in which data are available. The results of these tests could then be used to identify the most accurate method for each year by comparing the results to the actual block group counts for the same year. This all being said, such testing would likely be time and resource intensive.

Alternatively, a methodology similar to that used by REBNY could be replicated, in which no interpolation is conducted, but data for individual tracts (or groups of tracts) are reported based upon the percentage of their area that is landmarked. For the years that MapPLUTO data are available, the precise percentage of residential units that are shared by a given tract and historic district pair (or aggregation of historic districts) could be calculated. Pairs that share less than half of their residential units should likely be excluded as the link between them is tenuous, but the others could be reported based upon the percentage of residential units shared, yielding an implied interpolation. The percentages of shared residential units could be extrapolated into the past as previously discussed with density rates, and subject to the same assumptions.

Figure 3

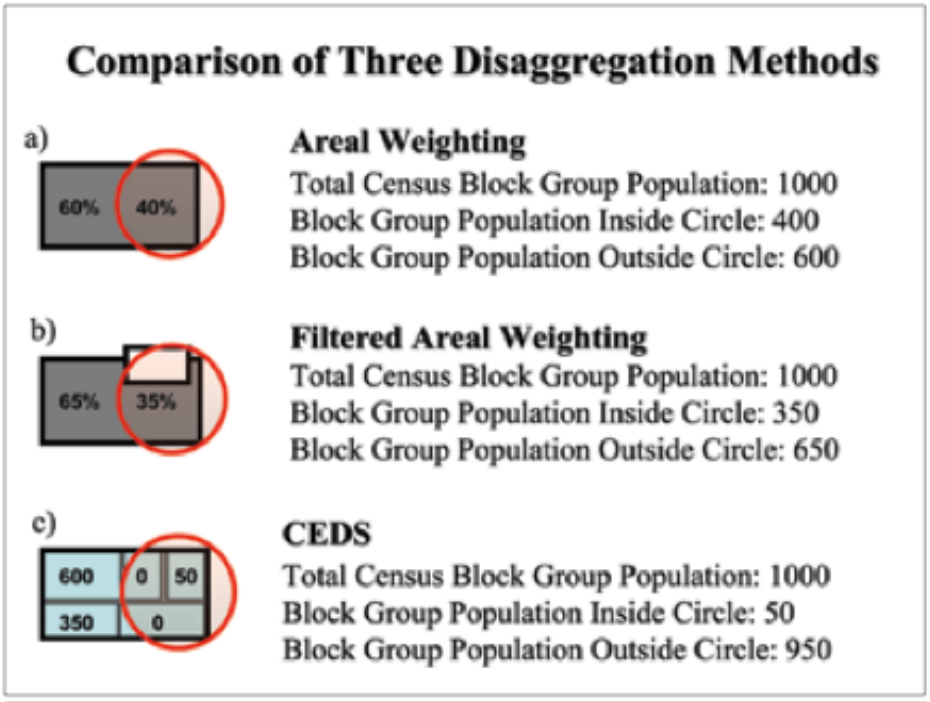

Figure 1. Methodological differences and potential improvement of population estimation of the CEDS method (c), over both filtered areal weighting (b), and simple areal weighting (a).

(Maantay et al., 2007, p.85)

Appendix 4: Literature Review of Comparable Studies

Overview

Commissioned by the Historic Districts Council (HDC) in 2014, *The Intersection of Affordable Housing and Historic Districts* examines the intersection of affordable rental housing and historic districts in New York City. Appendix 4 includes two sections: a Literature Review that briefly summarizes relevant literature, and a Reference List of all reviewed articles and reports. Detailed Summaries for each of the articles and reports are available upon request. The literature search was conducted July through August 2014, and included articles published within the last ten years (2004-2014). However, if happened upon and deemed particularly apropos, literature published prior to 2004 was included in the Literature Review. The literature search included, and the Literature Review, Reference List and Detailed Summaries address: (A) independent reports from both partisan (e.g. advocacy organizations, etc.) and nonpartisan (e.g. government agencies, nonpartisan think tanks, etc.) sources and (B) peer-reviewed journal articles.

The goals of the Literature Review, Reference List and Detailed Summaries are to: (1) provide a research context to inform the discourse surrounding the study; (2) provide precedents and insight related to data sources, research design and findings; (3) identify variables that have previously been found relevant to the study of the relationship between affordable housing and historic districts; and (4) supplement ideas for candidates to serve as Research Design Advisors and Review Committee members, as well as general stakeholders.

The Literature Review is divided into three thematic sections:

1. **Historic Districts and Property Values** covers the most prolific topic found in the literature.
2. **Historic Districts and Affordable Housing** details relevant research related to affordable housing.
3. **Additional Historic District Research** provides a brief summary of other apropos historic district research.

For each of these sections, there are three subsections:

A. *General Research Results,* which summarizes the literature for research conducted outside of New York City;
B. *Research About New York City*, which addresses research specifically regarding New York City's landmarked properties and historic districts; and
C. *Implications for HDC Study,* which cites the implications of the research for the Historic Districts Council's current study.[111]

[111] Please note that this Literature Review is not meant to be exhaustive given time and budget constraints. ThinkBrooklyn encourages stakeholders to contribute any references to relevant literature of which they are aware.

1. Historic Districts and Property Values

A. General Research Results

Most of the empirical research regarding historic districts reviewed by ThinkBrooklyn focused on the relationship of historic districts to property values, measured either by assessed property values or sales price data. These studies focused on individual cities or counties (almost all outside of New York City), and examined a) property values of historic district properties versus similar properties not in an historic district; b) appreciation rates of prices before and after historic designation in comparison to another neighborhood or local market not designated; and c) hedonic regression models[112] that, along with other variables, aimed to determine the unique relationship of historic districts to property values.

Several peer-reviewed studies found a positive relationship between property values and historic districting. For example, Liechenko, Coulson & Listokin, (2001) found greater assessed values and sales prices in several Texas cities in designated areas, and Rickman's (2009) study found higher appraised values in Oklahoma County, Oklahoma, but only for properties with more recent appraisal dates (2003 versus 2000). Similarly, Cebula (2009) found a price premium for homes in historic districts and landmarked properties by applying a hedonic regression model that studied sales prices in the City of Savannah, Georgia from 2000-2005. In Baton Rouge, researchers found a positive relationship between sales prices and location within historic districts, as well as more swift sales in properties near but not within historic districts (Zahirovic-Herbert & Gibler, 2012).

Not all studies found a positive relationship between property values and historic districting. Heintzelman and Altieir (2013) found declines in prices using a difference-in-difference model examining repeated sales[113] in the Boston metropolitan area between 2000 and 2007.

B. Research About New York City

Almost all of the studies reviewed by ThinkBrooklyn that were conducted outside of New York City examine only single-family homeownership properties. Clearly New York City's housing stock is far more varied, and so while much of the research tends to show a positive relationship between historic districting and property values, it is unclear how relevant those studies are to New York City. ThinkBrooklyn found only two published studies regarding historic districting and property values in New York City. In a study of changes in sales prices of one-, two- and three-family homes in Brooklyn, New York between 1975 and 2002, the New York City Independent Budget Office (2003) found that, while there were some periods when rates of appreciation were lower within historic districts, overall, rates of appreciation were greater in historic districts compared to similar nearby areas outside of historic districts. A National Bureau of Economic Research Working Paper Series draft by Been, Glaeser, Gould Ellen, Gedel and McCabe (2014) looked at sales price data from 1974 to 2009, and found that designation raised housing prices more relative to the neighborhood comparison area, but only in historic districts outside of Manhattan. In addition, Been et al., found a similar positive, but smaller, effect prior to designation.

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[112] Hedonic regression models attempt to measure components of various characteristics of a good that contribute to its value, or the price a buyer is willing to pay. Hedonic models related to home values often include measures that are characteristics of the building, such as number of bedrooms, bathrooms, amenities, square footage, as well as exogenous qualities like neighborhood, air quality, proximity to open space, etc.

[113] The repeat sales methodology controls for housing characteristics by using only data on properties that have sold more than once during the time period under study.

C. Implications for HDC Study

Some of the research reviewed by ThinkBrooklyn regarding property values aimed to address the concerns of property owners regarding their "property rights" related to regulation (Rypkema &Cheong., 2011), and contextualized rising property values as beneficial for owners and communities who may choose to pursue historic districting. However, several authors also discussed ramifications of increased property values that they claimed were due to historic districting, including higher taxes for owners, higher rents for renters, and displacement (Gale, 1991; Liechenko et al., 2001), but did not directly measure connections between property values and measures of affordability.

Although the HDC study does not propose to include measures of property values, some of the methodologies and data sources of the aforementioned studies are relevant. For example, appraised value data tend to yield more comprehensive datasets (they often include all properties in a particular study area) than actual sales price datasets. However, several authors also pointed out the limitations of appraised value because: (1) appraisers may subjectively inflate or deflate property values for various reasons; (2) assessed values tend to trail movement in the marketplace; and (3) some jurisdictions have rolling assessments which may complicate comparisons over time (because assessments in areas being compared could occur at different times) (Liechenko et al., 2001; Rypkema, Cheong, & Mason, 2011). Another major data point included in these studies was sales price, which was generally obtained from local governing agencies. In the studies ThinkBrooklyn reviewed, researchers used various other measures and statistical methods to attempt to isolate the effects of historic districting on sales price by controlling for other factors that may affect housing markets, including but not limited to: price per square foot, building classification, square footage and building age.

2. Historic Districts and Affordable Housing

A. General Research Results

While few studies reviewed by ThinkBrooklyn examined the relationship between historic districts and affordable housing, Rypkema & Cheong (2011) compiled federal data counting the number of low- and moderate-income housing units developed under the Federal Rehabilitation Tax Credit program, which started in 1976 and is available to properties in historic districts. The most recent report by the National Parks Service showed that over 7,000 low- and moderate-income housing units were built in 2013 (Department of the Interior, 2014) using these tax credits, and according to Dietrich (2014) these tax credits were available to landmarked and historic district properties in New York City. Dietrich (2014) also cataloged other economic incentives used by historic district property owners or developers to enhance housing affordability.[114]However, Dietrich (2014) did not provide data regarding these aforementioned tax incentives.

B. Research About New York City

A recent analysis by New York City's Independent Budget Office (NYC IBO) (2014) found that 48% of rental units in historic districts were rent-regulated, compared to 54% in non- historic district areas, and 53% citywide. Relatively recent reports[115] by the Real Estate Board of New York (REBNY)

[114] These incentives include HUD's HOME program, Insured Loan Program, and the Community Development Block Grant; New Market Tax Credit Program, Tax Increment Financing, and New York State's Homeowner Tax Credit Program. Future research could investigate whether or not building level data are available for these programs.

[115] Please note that REBNY does not detail how it arrived to its findings, but Dietrich, based upon counts of tax lots, stated that 25.7% of Manhattan tax lots are landmarked (which means they are landmarked buildings or are lots that are part of historic districts). The discrepancy between REBNY and Dietrich may be because REBNY included proposed historic districts or landmarks that were listed on NYC LPC's website at the time of their research, but this would need to be confirmed.

(2013a; 2013b) stated that, in Manhattan between 2003 and 2012: a) there were disproportionately fewer new units of affordable housing constructed on landmarked[116] properties; and b) census tracts with higher percentages of landmarked properties had higher median household incomes, lower racial diversity indices, greater declines in population between 2000 and 2010, fewer renters, and smaller than average household sizes. REBNY (2014) also conducted a follow-up study, which examined new housing and affordable housing production in the outer boroughs. This study found much lower rates of affordable housing production on landmarked properties.

C. Implications for HDC Study

NYC IBO's (2014) analysis studied the current percentages of rent-regulated units (48% in historic districts, 54% in non-historic district areas and 53% citywide), but did not measure change over time, nor did it address the underlying cause of the differences in the aforementioned percentages. Additionally, the NYC IBO report only compares historic districts to the percentage of rent-regulated units in the city as a whole and not to comparable geographic areas within the city. REBNY's (2013a and 2013b) studies also looked only at current data without historical comparisons, and did not provide methodological detail regarding how they determined the counts of new construction of affordable housing. Their presentation of census data also lacks a clear link between the populations represented in the data and the populations living in historic districts. In a rebuttal to REBNY's reports, Dietrich (2014) agreed that there has been disproportionate historic designation in Manhattan, but that this has had little to do with the supply of affordable housing. Dietrich also argued that there has been a long history of tension between supply and demand in housing that predates landmarking, and therefore no longitudinal connection existed between the New York City Landmarks Law and housing affordability. He postulated that many factors may limit the development of new and affordable housing, and that those factors should be considered in a careful analysis of this issue. In addition, Dietrich stated that the housing affordability crisis is more pronounced in the outer boroughs, where there has been proportionally far less historic designation.

Finally, Dietrich suggested that research should consider the impact of federal and state historic tax credit programs that can provide incentives for affordable housing. Dietrich's work is largely qualitative and does not offer data regarding affordable housing. However, it may provide a viable framework for further research examining the quantitative relationships between historic districts and affordable housing, as well as some direction toward data sources (including data regarding Low-Income Housing Tax Credits).

3. Additional Historic District Research

A. General Research Results

Rypkema, Cheong & Mason's (2011) report on economic indicators concluded that there is insufficient research overall about historic districts. They stated that economic and social benefits of historic districts therefore are "imperfectly understood" (p. 2) and research efforts need to be more consistent and credible, suggesting that one entity should be responsible for annually assessing and releasing relevant metrics. The authors recommended that future research should look at the relationships of historic districts to factors such as jobs and income, property values, heritage tourism, environmental measures, and downtown revitalization, as well as social benefits, including affordable housing. Despite historic district literature's limitations, Rypkema, Cheong & Mason (2011) reported that findings from 20 studies conducted over 15 years show that, in addition to social and cultural benefits, historic preservation offers economic benefits: jobs are created at higher rates than in other sectors and at lower costs per public

[116] REBNY's reports include both landmarked properties and properties within historic districts, while the IBO report states that it includes only properties in historic districts.

dollar; property values are higher in and near historic districts than in comparable areas; millions of dollars are contributed to local economies via heritage tourism; and costs are saved through environmental sustainability (i.e. refurbishing an existing building may be less resource intensive than building a new building), etc.

B. Research About New York City

As with property values and affordability, ThinkBrooklyn found little research that has been conducted on other impacts of historic districts in New York City, but Dietrich's (2014) qualitatively-based report suggested that there are economic, social, and environmental benefits attributable to the New York City Landmarks Law. He also concluded that landmarking in New York City has contributed to sustainability and economic benefits through job creation, tax revenues, and revenues from tourism and the film industry. As previously mentioned, REBNY (2013b) stated that in comparison to Manhattan and New York City overall, census tracts in Manhattan with higher percentages of landmarked area had higher median household incomes, lower racial diversity indices, greater declines in population between 2000 and 2010, fewer renters, and smaller than average household sizes.

C. Implications for HDC Study

While many of the aforementioned factors are outside the purview of the HDC study, including demographic and income measures is recommended. RENBY's (2013b) study raises a number of questions that might also be of interest to HDC's study. For example, it is of relevance to understand how racial demographics and median household income have changed over time within an historic district both before and after designation. The cross sectional differences (i.e. differences in race and income between historic districts and the rest of Manhattan and New York City at a single point in time) found by REBNY may have existed before historic designation, and therefore differences observed now may or may not be any different than differences before designation. It is also important to compare longitudinal changes in historic districts to changes over time in comparable geographic areas to examine whether changes within historic districts reflect larger shifts. Comparison areas could include a local neighborhood just outside of an historic district, as well as possibly a community district, borough, and New York City, as these geographies all provide an important context for any changes within historic districts. Finally, any study should take into account that census tract and historic district boundaries do not align very well when considering measures of change within historic districts.

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[117] Not all articles are available free of charge. Most that are not were obtained by ThinkBrooklyn from subscription-based databases, but in some cases ThinkBrooklyn was able to find a free version on the Internet. Where this is the case, an electronic link will take the reader to the article. If a free version is unavailable, a DOI number is provided in this Reference List. DOIs are an attempt to provide stable, long-lasting links for on-line articles, and are unique to a particular document. If one conducts an Internet search for a specific DOI, it should lead to a page on-line where the article can be purchased.

Glossary of Acronyms

DCP	New York City Department of City Planning
HDC	Historic Districts Council
HDCT	Historic District Census Tract
IBO	New York City Independent Budget Office
LPC	New York City Landmarks Preservation Commission
LTDB	Longitudinal Tract Data Base
MapPLUTO	MapPLUTO merges PLUTO tax lot data (extensive land use and geographic data at the tax lot level) with tax lot features from the Department of Finance's Digital Tax Map
NHGIS	National Historic Geographic Information System
OLS	Ordinary Least Squares
REBNY	Real Estate Board of New York
SHIP	Subsidized Housing Information Project, maintained by New York University's Furman Center for Real Estate and Urban Policy

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