

# What's The Use? Land Use Uncertainty, Real Estate Prices, and the Redevelopment Option

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## **Abstract**

We incorporate uncertainty surrounding future land-use restrictions to empirically assess the option value of redevelopment embedded in real estate prices for New York City (NYC) from 2003-2015. Using a two-stage estimation procedure, we interact predicted probabilities of land-use (re)zoning to either residential, commercial or manufacturing with an additional proxy for the property's redevelopment propensity. Over the period spanning 2003 to 2015, estimates of the average option value to redevelop in Manhattan and Brooklyn are 20% and 8.5% of total estimated property value, respectively. There is also evidence that manufacturing lots identified as likely to be rezoned by the model sell at an average premium of 50% per square foot. Lastly, we find evidence consistent with the hypothesis that the redevelopment option value is counter-cyclical.

**Keywords:** Land Use Restrictions, Real Options, Hedonic Pricing. Real Estate

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# 1 Introduction

Although limited research has been conducted on the impact of zoning regulations on property values within the context of an options pricing framework, it is hypothesized that land permitted for multiple uses will yield a higher price compared land restricted by law to a single-use. [Childs et al. \(1996\)](#) and [Geltner et al. \(1996\)](#) provide a theoretical foundation in an options pricing framework to cement the above intuition. Yet, no studies have attempted to estimate how potential changes in land use restrictions impact the option value to redevelop real estate.

Zoning policies typically regulate property characteristics in two dimensions: intensity and use. Intensity pertains to the permissible size and dimensions of a structure constructed on a specific plot of land, with one rationale being to ensure sufficient sunlight penetration to street level ([Bliss, 2016](#)). The second dimension, use, restricts the permitted purpose of the built property in order to minimize external costs associated with certain building types and maximize external benefits derived from agglomeration effects ([Strange and Rosenthal, 2001](#)). For instance, residential areas may suffer from air and noise pollution if situated adjacent to industrial factories, necessitating the allocation of designated land for industrial use at a considerable distance from residential zones. Similarly, the centralization of businesses within an industry can reduce travel costs for face-to-face interactions.

Michael Bloomberg was the mayor of the City of New York from 2002 through 2013. Over that period, the Bloomberg Administration rezoned approximately 40% of all the properties in the city.<sup>1</sup> As Dan Doctoroff, the former deputy mayor of economic development for the City of New York, noted in an interview:

We believed New York's economy needed a massive jolt of energy and a push forward to prepare it for the 21st century. If you looked across the city, there were thousands of acres of land that were unused, largely because they were zoned for industrial or manufacturing uses for which could not compete anymore.

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<sup>1</sup>The 40% figure refers to both changes in zoned use and intensity.

Many were on some of the most valuable real estate in New York, like along the waterfront, on the West Side of Manhattan, or near Downtown Brooklyn.... In the end, we did 140 separate rezonings during the Bloomberg administration. 40 percent of the city was rezoned.<sup>2</sup>

This study capitalizes on the numerous rezonings that took place during the Bloomberg administration to investigate the relationship between the option value for real estate redevelopment and changes in zoning designations related to allowable land use. Although prior research in Urban Economics has sought to determine the impact of zoning on property values ([McMillen and McDonald, 1991, 2002](#); [Glaeser and Gyourko, 2003](#); [Ihlanfeldt, 2007](#); [Brueckner and Singh, 2020](#); [Gyourko and Krimmel, 2021](#); [Tan et al., 2020](#)), these studies primarily concentrate on alterations in the permitted intensity of buildings.

To address the question of how changes in the land use component of zoning regulations impact property values, we estimate time-varying propensities of being zoned to each land use designation to proxy for the probabilities of switching zoning designation in the future. We then incorporate these probabilities into the hedonic pricing model of [Rosen \(1974\)](#) to identify how changes in the likelihood of being rezoned impacts the redevelopment option via the empirical framework employed in [Clapp and Salavei \(2010\)](#). Variation in expectations of future zoning designation around major rezoning events is used in a hedonic regression to identify the redevelop option component of real estate values.

Our findings reveal that the redevelopment option accounts for 20% of the total estimated property value in Manhattan and 8% in Brooklyn on average. Moreover, manufacturing-zoned properties with a high likelihood of transitioning to residential, as identified by our model, sell for a 50% premium per square foot. We also present evidence in line with [Grenadier \(1996\)](#) and [Geltner et al. \(2020\)](#) that the redevelopment option as a percentage of the total property value is counter-cyclical with the real estate cycle.

The rest of the paper is organized as follows: Section [2](#) presents the motivation for the

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<sup>2</sup>[Florida \(2017\)](#)

research and presents a motivation model to accompany the empirical analysis. Section 3 discusses the data sources and summary statistics. Section 4 presents the empirical framework and identification strategy. Section 5 presents and discusses the results of the estimation. Finally, Section 6 concludes.

## 2 Motivation

The value of a property,  $V_{i,t}$ , can roughly be separated into the value of the land,  $V_{i,t}^L$ , and the building that sits on the land,  $V_{i,t}^B$ . This relationship holds exactly if the construction industry is assumed to be perfectly competitive<sup>3</sup>:

$$V_{i,t} = V_{i,t}^B + V_{i,t}^L. \quad (1)$$

The value of the building,  $V_{i,t}^B$ , is the replacement cost to build a structure as similar as possible to the one that already exists on the land. This value tends to decrease with physical depreciation, increase with renovations, and the total floor area of the building. The main driver is the labor and capital cost of construction (Somerville, 1999).

Most of the variation in property values comes from the value of the land that the structure sits on (Davis and Heathcote, 2005; Knoll et al., 2017). In the urban economics literature, the value of land is thought to represent a call option on development or a significant redevelopment (Titman, 1985; Dixit and Pindyck, 1994). When choosing to develop land, the developer must choose both the use of the land and the intensity to which to develop the land. Childs et al. (1996) and Williams (1997) examine the option to continually redevelop a property. Childs et al. (1996) focuses on the option to reconfigure a property between two uses (as well as mixing the two uses), while Williams (1997) studies the option to increase the intensity or quality of the property while holding its use constant. Both Childs et al. (1996) and Williams (1997) find that the option to redevelop decreases with an increased

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<sup>3</sup>In which case, the replacement cost to the property owner is equivalent to the construction cost.

correlation between market value of uses and increases with uncertainty regarding future rents. [Riddiough \(1997\)](#) connects the real options framework to the risk of a regulatory taking, and shows that an increased risk of a regulatory taking decreases option value.

In New York City, a rezoned property can continue to operate under the prior use, but significant renovations or redevelopment cannot occur without switching land use to the new designation.<sup>4</sup> When making the redevelopment decision, the developer must weigh the expected net payoff of redeveloping the property to its highest and best use today, against the value of delaying the redevelopment into the future.

The key insight of this paper is to recognize the developer's value of waiting to redevelop is determined by their expectations of the value of the highest and best in the future, which is determined by their beliefs of the probability of a zoning change occurring. In other words, the zoning designation of any property in the future is uncertain, and the value of the redevelopment option (and consequently the value of the property as a whole) should reflect this uncertainty.

Consider a simple two-period example where a landowner is deciding to develop vacant land under uncertainty with regards to the future zoning designation. There are two possible zoning designations,  $z_t \in \{1, 2\}$ . Today the land is zoned for use  $i$ ,  $z_t = i$ . In period  $t+1$ , there is some probability,  $\alpha > 0$ , of being rezoned to use  $j \neq i$ , and a probability of  $(1 - \alpha) > 0$ , of keeping the same zoning designation. From the perspective of the landowner, the choice to develop will depend on weighing the payoff of developing the property to its highest and best use today for property type  $i$ ,  $HBU_i$ , with tomorrow's expected payoff and with the possibility of being able to develop to use  $j$ . In this situation, the value of land is

$$V_{i,t}^L = \max \left\{ NPV_i, \left( \frac{1 - \alpha}{1 + r} \right) NPV_i + \left( \frac{\alpha}{1 + r} \right) NPV_j \right\}, \quad (2)$$

where  $NPV_i$  is the net present value of developing to the highest and best use given the

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<sup>4</sup>New York City Zoning Resolution, Article 5, Chapter 2, 52-20. <https://zr.planning.nyc.gov/article-v/chapter-2/52-20>.

zoning designation today is  $i$ , and  $r > 0$  is the net rental rate on the built property (assumed constant across uses). The developer will only choose to wait if

$$NPV_j - NPV_i \geq \left(\frac{r}{\alpha}\right) NPV_i. \quad (3)$$

That is, the developer will wait to the later period to develop for the chance event of the zoning designation changing only if the developed property is expected to be more valuable under use  $j$  by an amount larger or equal to the rents foregone by waiting a period to develop,  $r \cdot NPV_i$ , divided by the probability of switching zoning designation,  $\alpha$ . This hurdle rate,  $\frac{r}{\alpha}$ , is decreasing in the probability of switching zoning designations and increasing in the opportunity cost of waiting to develop. For the special case where a zoning change is certain,  $\alpha = 1$ , the value of the property if it were to be developed to use  $j$  must be at least as large as the opportunity cost of waiting. As the probability of being rezoned becomes extremely unlikely, the hurdle value gets larger and the developer will never choose to wait. The key takeaway from this toy model is that the probability of being rezoned, something that occurs with a non-insignificant frequency in New York City from 2003-2015, will impact the option value of development. The intuition of the toy model above is easily extended to the case of redevelopment.

There is limited research which examines to what degree the zoning process is dynamic across geographies.<sup>5</sup> In New York City, we find that 2% of all properties in the beginning of the sample switched land use designation (as opposed to height restriction) at the end of the sample in 2015. Table 1 details the number of zoning changes that occurred for all lots present in the beginning of the sample. Figure 1 shows the nature of each transition and where they occurred across space.

Out of 294,040 tax lots, 5,758 (or roughly 2%) of lots changed land use designation.<sup>6</sup> On net there was an increase in residential and mixed use zoned lots, a small decline in

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<sup>5</sup>See [Gyourko et al. \(2008\)](#) and [Gyourko et al. \(2021\)](#).

<sup>6</sup>The 2% figure does not account for changes in height restriction.

commercial lots, and a 20% decline in manufacturing lots. Yet, there is significant variation in changes conditioning on the initial zoning designation. For example, even though there was a steep decline in manufacturing lots overall, 84 residential and 30 commercial lots were rezoned to be manufacturing.

Out of the 16,149 commercially zoned lots at the beginning of the sample, 14,598 (90%) stayed commercial, 1,466 (9%) switched to residential, and the remaining percent is split relatively evenly between manufacturing and mixed-use manufacturing /residential. For the 13,325 lots zoned manufacturing at the beginning of the sample, where we see the most zoning changes, 10,538 (79%) stayed manufacturing, 865 (6.5%) switched to commercial, and 1,922 (14.5%) switched to residential or mixed use manufacturing/residential. Most residential lots stayed residential, but a not insignificant amount of residential lots did switch. Out of the 263,365 lots zoned residential at the beginning of the sample, 595 switched to commercial and 84 switched to manufacturing.

[Table 1 about here.]

[Figure 1 about here.]

### 3 Data

The panel dataset used is constructed from various data sources described below. The final dataset includes 48,929,331 observations. Each observation represents a single lot-quarter from 2002q2 until 2017q4. For each observation, there are a total 109 descriptive variables representing the characteristics of the building, the geographical characteristics of the area around the building, as well as demographic information at the census tract level.

Below, we describe the sources of the data. The Primary Land Use Tax Lot Output dataset is used to track zoning designation as well as a wealth of other property and locational characteristics. It is used in both the estimation of (re)zoning propensities and the hedonic sales model. New York City’s Rolling Sales dataset reports all property transactions and is

used in the hedonic estimation. The policy dummies in the first stage come from the New York City Department of City Planning’s Zoning Application Portal, which was scraped to compile the dataset. Lastly, both the American Community Survey data as well as Bing Maps data is used in post-estimation to decompose option value by location and demographics.

Selected summary statistics are presented in Table 1.

### 3.1 Geography

In the dataset, tax lots are either located physically on the boroughs of Manhattan or Brooklyn whose natural boundary is the East River. Each borough is separated into legislative districts known as “community districts,” where the elected community board advises on land use matters, and participates in the city budgeting process. Manhattan is composed of twelve community districts, and Brooklyn is composed of 18 community districts. The boundaries of which are in the thick blue lines in Figure 2.

Each community district is composed of several statistical tabulation areas by the United States Census known as “census tracts” represented by thin black lines in Figure 2. Census tracts have a population between 1,200 and 8,000 people, with a Census-designated optimum of 4,000. Manhattan is composed of 238 census tracts, while Brooklyn is composed of 761 census tracts. Census tracts are the most granular geography used in this study.

[Figure 2 about here.]

### 3.2 Primary Land Use Tax Lot Output

The main dataset employed is the Primary Land Use Tax Lot Output (PLUTO), provided by the New York City Department of City Planning. It contains extensive land use and geographic data for the vast majority of the tax lots in NYC. The panel dataset was released on an annual basis from 2002-2007, but since 2009, it has been released on a semi-annual basis.



PLUTO includes over 70 fields for each tax lot. Of main interest to this paper is extensive information on zoning designations for each property. Zoning is broken down into primary zoning district, overlay district, and special purpose districts. Each category can contain zoning designations ordered by the share of area of the tax lot designated to each use from largest to smallest.

Other variables of interest include the Floor Area Ratio (FAR) of a building broken down into commercial, residential, office, retail, garage, storage, and factory. There are a number of building descriptors such as number of floors of the building (NumFloors), the area of the lot (LotArea), an identifier for an irregular lot, an identifier for special lot characteristics such as waterfront property, basement type, year built (YearBuilt), the last year the building was significantly altered (LastAlter), and the separately assessed value of the land (AssessLand) and building (AssessBldg) as estimated annually by the Department of Finance for tax purposes.

The process of merging all versions of PLUTO together is no trivial task. The variables included with each release can change from year-to-year, so special care must be taken so that all variables are comparable. The merged dataset contains 48,929,331 million rows, and then we create a quarterly time series from each observation date. For example, if there is an observation from a property in 2002q1 and 2003q4, we duplicate the 2002q1 row to create observations for 2002q2 -2003q3. If a zoning change took effect in 2002q4, we then go back to correct for the timing of the policy change, altering the observations from 2002q4 - 2003q2.

### **3.3 Transaction Data**

Property transactions come from the New York City Department of Finance’s Rolling Sales data. The Rolling Sales dataset is released on an annual basis from 2003-present. It contains all property transactions that take place in the city. In addition to a subset of variables from the PLUTO dataset, the Rolling Sales data contains the nominal transaction price of the

property (SalePrice), as well as the gross square footage (GrossSqFt) of the building and the square footage of the lot the building sits on (LandSqFt). Gross square footage is defined as the total floor area encompassed by the exterior walls of a property. The land area is then the remaining square footage of the lot.

Real estate property transactions are notoriously noisy. In order to remove outliers, for each year and borough I regress the logarithm of sale price on the logarithm of gross square ft. interacted with a census tract dummy – a granular measure of geography – along with other building and lot characteristics. I then remove all observations whose studentized-residual is greater than 3.7. Finally, I do a visual inspection for each year and borough to remove all clear outliers that may impact estimation in the hedonic model.

### **3.4 American Community Survey**

The American Community Survey (ACS) is an annual survey performed by the US Census Bureau that collects demographic, economic, and housing data for neighborhoods across the US. The survey commenced in 2005, but for smoothing purposes, data is only available from 2009 -present. Each observation represents a 5-year moving average. The data we use is on the census tract level. To get an idea of how granular a census tract is, NYC is broken up into 1,335 individual census tracts; this is far more granular than neighborhoods or even community districts.

Demographic data includes median age (MedAge) and the racial makeup of each neighborhood broken down into white, African-American, Asian, Native American, and other. The “other” designation is largely made up of the Latin American population.

Economic data in the ACS includes the percentage of households with children, the percentage of households that report using public transportation as their main transportation to work, the percentage of those households that primarily walk to work, mean transit time to work, median household income (MedHHIncome), the percentage of those reported being unemployed (%Unemployed), the percentage of households fully covered by health insurance,

the percentage of households below the poverty line, and the percentage of households with an annual income greater than \$100,000.

The housing portion of the ACS includes the estimated vacancy rate, the percentage of residents who rent (%Rent), the percentage of residents without a vehicle, and the median gross rent of the area (MedGrossRent).

Finally, the education section includes the percentage of those with a less than ninth grade primary school education, the percentage with somewhere between a ninth to twelfth grade education, the percentage of those without a high school diploma, the percentage of those with a bachelor's degree or higher, and lastly, the percentage of residents born in the US.

### **3.5 ULURP Data**

Data concerning the Uniform Land Use Review Process was collected by scraping data from the DCP's newly released Zoning Application Portal (ZAP). ZAP is a web tool that allows the public to track the progress of current and past zoning applications through the ULURP process. The information includes the date that each step of the ULURP was cleared, as well as the status of each step.

From the above information I am able to “dummy out” the ULURP process, creating six review-stage legislative dummies: one for the quarter in which the application was certified (CertDum), one for the community board recommended approval or disapproval (ResComDum), one for the approval of the borough president, one for if the DCP has held its public forum, one for if the DCP approved the application, and lastly, and one for if the City Council voted to pass the application into law.

I match each zoning application by its identifier to lot identifiers (BBLs) using the shape files released by the Department of City Planning for zoning map amendments. Using post-GIS and a shape file version of PLUTO called mapPLUTO, I find all properties that intersect the ZMA shape file for each version of MapPLUTO before and after the zoning amendment

went into effect. I then check that each intersecting property did indeed change zoning designation and remove those that do not.

### 3.6 Bing Maps Data

Finally, we conjecture that simple straight-line (also known as “as the crow flies”) distance to a city center is not sufficient to capture the complexities of NYC’s transit system. The subway system is extremely important to getting around in New York City, and there is evidence that its importance is reflected in property prices (Gupta et al., 2022). Mainly, we believe that residents value how easily they are able to travel to midtown Manhattan, from which you can get anywhere else in the city. Yet, transit times will also be correlated with distance to nearest subway or bus station, how many subway lines are in proximity to a property, and the idiosyncrasies of each subway line.

To capture such complexities in the data, we opt to use the Bings Map API to calculate transit time using either the subway or bus to Grand Central Station. In addition to being a central point in New York City’s local subway system, it is also the meeting point of other major transportation systems such as New Jersey Transit, Long Island Rail, and the Metro North system.

Lastly, in order to handle the fact that transit times vary across time of day, I average the predicted transit times at 9am, 12pm, 5pm, and 9pm for all weekdays in a fixed week in August 2018. One implicit assumption is that estimated transit times in August of 2018, are representative of the entire sample.

### 3.7 Data Discussion

A brief discussion of the data is presented below.

Selected summary statistics for the full panel dataset are reported in Table 2. This sample includes all observations for all boroughs and all years.

Figure 3 presents the range of sale price to gross square feet between the 33<sup>rd</sup> and 66<sup>th</sup>

percentiles in Manhattan and Brooklyn. There appears to be a common cyclical component between the two boroughs, but real estate prices in Manhattan have increased far more than Brooklyn over the sample period.

[Figure 3 about here.]

[Table 2 about here.]

## 4 Empirical Framework

[Clapp and Salavei \(2010\)](#) develop a method to identify the option value to redevelop a property within the hedonic model. They posit that using the age of a structure as a proxy for structural depreciation produces a biased estimate for net depreciation because structure age might be positively correlated with the option value to redevelop the property. The intuition is that as a building ages, physical depreciation causes the value of the property to decline. In addition, as the building ages, the difference between the value of the property if it were developed for its highest and best use and the current property value increases, causing the option value to redevelop to increase as a share of total property value. These opposing effects make building age a biased proxy for net depreciation. In order to separate the two effects, [Clapp and Salavei \(2010\)](#) suggest using a proxy for the likelihood of redevelopment. The proxies proposed correspond to various measures of intensity. Examples are the fraction of nearby sales that are teardowns, the ratio of assessed structure value to assessed land value, and the ratio of average floor-area-ratio (FAR) of nearby new construction to FAR of the property considered.

The proxy of [Clapp and Salavei \(2010\)](#) captures the relationship between state of the built structure, and the option value to redevelop. The closer to redevelopment a property is, the greater the difference between the rate of return for the property built to its highest and best use,  $r_{HBU}$ , and the current rate of return,  $r$ . Simultaneously the net present value of cash flows from the current structure,  $V_{i,t}^B$ , decreases as cash flows are relatively

low, and redevelopment is expected to commence soon, terminating the flow of cash from the structure. The net present value of cash-flows post-redevelopment,  $V_{i,t}^L$ , increases as redevelopment becomes more likely because the rents foregone by redevelopment,  $r \cdot NPV_i$ , decrease.

Munneke and Womack (2017) extend the framework in Clapp and Salavei (2010) by directly estimating the probability of redevelopment in a probit regression, and using those probabilities directly in place of the proxy used by Clapp and Salavei (2010). They make further improvements by addressing selection bias via Lee et al. (1982).

The motivational model presented in Section 2 posits the landowner will wait to redevelop only if the net benefit of waiting to redevelop is greater than a hurdle rate equals to the ratio of the net rental yield to the rezoning probability,  $\frac{r}{\alpha}$ . The empirical methodology of Clapp and Salavei (2010) proxies for the effect of the net-rental yield on the hurdle rate. When the assessed share of land value of a property is high, low net rental rates cause a decrease in the hurdle rate of redevelopment, and thus the property has a higher propensity to redevelop.

It is unclear if the proxy of Clapp and Salavei (2010) will pick up changes in the hurdle rate due to rezoning propensities,  $\alpha$ . In this paper, we address that concern by capturing the effect of the rezoning probability on the hurdle rate by directly estimating rezoning propensities in a first-stage multinomial logistic regression. We then interact the generated propensities from the first stages in the hedonic model with the redevelopment proxy as proposed by Clapp and Salavei (2010).

## 4.1 First Stage: Zoning Process

We model the long-run propensities to be (re)zoned as a multinomial logistic model at each time point. In addition, to standard locational and structure characteristics, I incorporate dummy variables in the logistic regression which correspond to the various stages of the Uniform Land Use Review and Procedure. The formal model is

$$\ln \frac{Pr(\Psi_{i,t} = \phi_z | X_{i,t})}{Pr(\Psi_{i,t} = \phi_S | X_{i,t})} = \alpha_z X_{i,t}, \quad (4)$$

where  $\Psi_{i,t}$  is a categorical variable that identifies the zoning designation lead two years into the future,  $\phi_z$  is the vector whose  $z^{th}$  element - which indexes the zoning designation - is equal to unity, and all other elements are equal to zero.  $X_{i,t}$  is the vector of explanatory variables. These include individual property and locational characteristics, legislative variables from the ULURP, as well as census tract-specific variables that measure how the land use distribution of the census tract deviates from the community district and borough.

The long-run (re)zoning propensities are non-linear functions of the exogenous parameters:

$$\hat{\eta}_{i,t,z} := Pr(\Psi_{i,t+2} = \phi_z | X_{i,t}) = \frac{\exp(\alpha_z X_{i,t})}{1 + \sum_{s=1}^{S-1} \exp(\alpha_s X_{i,t})}. \quad (5)$$

Note that I call the generated regressors long-run propensities because the model does not include current zoning designation as a regressor. The zoning process is highly persistent, and if one truly wanted to know the zoning designation a process a year from any given date the best predictor would be the current zoning designation. What we attempt to estimate is akin to the ergodic or zoning distribution unconditional of a property's use today.

It can be instructive to think of these propensities as the optimal land use distribution for the city that moves with underlying market and economic conditions. However, because there are significant frictions associated with rezonings and redevelopments, the city planners are always *chasing* the optimal distribution.

## 4.2 Second Stage: Hedonic Model

The second stage is a linear regression of the logarithm of sale price per square foot on building characteristics, locational characteristics, and the long-run zoning propensities interacted with the redevelopment proxy. The model can be viewed as a hedonic model of real estate

prices where propensity to be redeveloped as well as the propensity to be zoned to each use are unobserved building characteristics that are priced.

The functional form specification is motivated by the Fenton-Wilkinson approximation of [Fenton \(1960\)](#), which states a sum of log-normally distributed random variables can be approximated by a log-normal distribution. In the asset pricing context, an asset's value is determined by the sum of the term structure of cash flows. If each cash flow is distributed log-normally, then the asset's value is a sum of log-normal distributions.

The estimation equation formally is Equation [6](#),

$$\ln P_{i,t} = a_{i,t} + v'_t q_{i,t} + \sum_z \gamma_z \hat{\eta}_{i,t,z} LSA_{i,t} + u_{i,t}, \quad (6)$$

where  $LSA_{i,t}$  is the proxy for redevelopment defined as

$$LSA_{i,t} := \frac{\text{Assessed Land Value}_{i,t}}{\text{Assessed Total Value}_{i,t}}, \quad (7)$$

$q_{i,t}$  is a vector of property and locational characteristics,  $v_t$  is a vector of implicit market prices on the hedonic characteristics which vary by year,  $a_{i,t}$  capture census tract-year fixed effects, and  $u_{i,t}$  is an error term assumed to be normally distributed with mean zero and constant variance  $\sigma_u^2$ .

The idea is that redevelopment option consists of an intensity dimension and a potential rezoning dimension. By interacting the probability of being rezoned to each designation next year with the intensity proxy, we can understand how the potential to be rezoned impacts the option to redevelop.

The option value to redevelop property  $i$  is then computed as



$$\widehat{OV}_{i,t} := \exp \left( \hat{a}_t + \hat{v}'_t q_{i,t} + \sum_{j=1}^S \hat{\gamma}_j \hat{\eta}_{i,t,j} LSA_{i,t} + \frac{\sigma_u^2}{2} \right) - \exp \left( \hat{a}_t + \hat{v}'_t q_{i,t} + \frac{\sigma_u^2}{2} \right), \quad (8)$$

where that hat notation refers to estimated coefficients or predicted variables.

Taken as a percentage of prices today  $P_{i,t}$ , the above equations simplifies to

$$\frac{\widehat{OV}_{i,t}}{\hat{P}_{i,t}} = 1 - \exp \left( - \sum_{j=1}^S \hat{\gamma}_j \hat{\eta}_{i,t,j} LSA_{i,t} \right). \quad (9)$$

I then define the option value associated with the propensity to be zoned use  $s$  as

$$\widehat{OV}_{i,t}^s := \exp \left( \hat{a}_t + \hat{v}'_t q_{i,t} + \sum_{j=1}^S \hat{\gamma}_j \hat{\eta}_{i,t,j} LSA_{i,t} + \frac{\sigma_u^2}{2} \right) - \exp \left( \hat{a}_t + \hat{v}'_t q_{i,t} + \sum_{j \neq s} \hat{\gamma}_j \hat{\eta}_{i,t,j} LSA_{i,t} + \frac{\sigma_u^2}{2} \right). \quad (10)$$

The above equation as a percentage of the price of the property similarly simplifies to

$$\frac{\widehat{OV}_{i,t}^s}{\hat{P}_{i,t}} = 1 - \exp \left( - \hat{\gamma}_{t,s} \hat{\eta}_{i,t,s} LSA_{i,t} \right). \quad (11)$$

### 4.3 Identification

A primary concern with regards to estimation of the hedonic model is potential endogeneity between the land use propensities and prices. It is difficult to disentangle the effect of (re)zoning propensities on prices from the effect that prices might have on (re)zoning propensities themselves.

In order to address such concerns, we focus our estimation in the hedonic model on the sub-sample of real estate transaction that occur within a year of a nearby major zoning

change. We define a zoning change to be major if more than twenty lots changed zoning designation in a given census tract for any given year. We identify 41 such zoning changes throughout the sample.

For each major zoning change event, an area is defined within a mile radius of any lot that changed zoning designation, but not within 1,000 feet of any lot that switched zoning designation. The intuition is that a major zoning change event may very well be endogenous to transaction prices in the area of the rezoning. However, when an area experiences a large rezoning, neighbors that did not experience the rezoning reevaluate their expectations about what their future zoning designation looks like. For example, if the major zoning change made a neighboring area’s zoning distribution move closer to the area in question, it would be a signal that area in question’s zoning distribution is close to the target of the city planner. Thus, we should expect a zoning change in the area in question to be less likely in the near future. However, if the land use distribution of the area that experienced a zoning change moves further away from the area in question, we should expect an increase the probability of zoning change in our neighborhood occurring in the future.

Figure 4 illustrates the identification strategy visually for the Hudson Yards rezoning. The red dots represents properties that were rezoned residential, and the blue dots indicate properties that were rezoned commercial. The black dots indicates a sale of an entire building that occurred within one-year of the rezoning. Only the black dots that lie within the gray-shaded area are used in estimation. The black dots in the interior of the gray-shaded areas are directly in the area of the rezoning, whose property value is affected by the future change in amenities and market conditions caused by the rezoning. The gray area is more distant, and we assume that changes in property value primarily come from the changes in expectations of future zoning caused by the Hudson Yard rezoning.

[Figure 4 about here.]

To capture the update in beliefs caused by a major rezoning, in the first stage of the empirical design spatial covariates capturing the deviation of the zoning distribution of the

census tract to the greater community district and borough are included. For example, the variable “ $\%C \mid CT - \%C \mid CD$ ” is defined as the percentage of lots in the census tract zoned for commercial use, minus the percentage of lots zoned commercial in the larger community district. And the variable “ $\%C \mid CT - \%C \mid Boro$ ” is defined as the percentage of lots in the census tract zoned for commercial use, minus the percentage of lots zoned commercial in the larger borough.

Revisiting the example of Hudson yards, assume the community district is mostly composed of manufacturing lots pre-rezoning, and assume for the areas in the identified region that the lots zoned commercial in their census tracts are more or less equal to the same percentage in the community district. Then the Hudson Yards rezoning occurs, and the percentage of lots zoned commercial in the community district,  $\%C \mid CD$ , increases, and now the percentage of lots zoned commercial in the census tract is much smaller than the community district. If there is a negative coefficient is estimated for  $\%C \mid CT - \%C \mid CD$ , the predicted propensity to be rezoned to commercial increases. Importantly, the change in the propensity was not due to high property values within the rezoned area, but due to investors updating their beliefs that the properties in question might too be rezoned commercial in the future.

## 5 Results

The results of the two-stage estimation procedure are presented below; each is accompanied by a discussion. The entire estimation procedure is run separately for the boroughs of Manhattan and Brooklyn, and each run includes years 2003 -2015.

Before showing the results of the hedonic model, we present evidence from a series of robustness checks that confirm the generated proxy for land use uncertainty predicts in-sample zoning changes. In addition, we demonstrate that the proxy for redevelopment motivated by [Clapp and Salavei \(2010\)](#) predicts in-sample redevelopments.

## 5.1 First Stage: Estimating Land Use Uncertainty

In the first stage, we run a multinomial logistic regression to capture the uncertainty regarding future zoning designations. Table 3 presents summary statistics for the sample used for estimation, while Table 4 presents coefficients and significance.

The main drivers of future land use uncertainty are the distributional characteristics of a lot’s census tract with respect to land use, and how it differs from the lot’s community district (borough). For example, the variable  $\%C|CT_{i,t} - \%C|CD_{i,t}$  is defined as the percentage of lots zoned commercial (C) in the census tract (CT) associated with lot  $i$  in year  $t$ , minus the percentage of lots zoned commercial in the entire community district (CD) associated with lot  $i$ . To give a sense of how granular these groupings of geographical area are, there are two hundred and thirty eight census tracts that make up the borough of Manhattan, and fourteen community districts. Figure 2 shows the boroughs of Manhattan and Brooklyn broken into community districts (blue border), and census tracts (black border). The idea is if the localized area surrounding a property has more commercial lots than the larger geography, then the current lot is more likely to either be currently commercially zoned or rezoned to commercial in the future. Coefficients of the deviation of both the percentage of lots zoned as commercial or manufacturing in the census tract from the entire borough are significant. Results show if the census tract is either more commercial or manufacturing than the borough, then lots in that tract are more likely to be rezoned as commercial or manufacturing regardless of current zoning. This implies that commercial and manufacturing lots tend to be clumped together away from residential lots.

[Table 3 about here.]

[Table 4 about here.]

Other significant variables driving the propensity to be rezoned are the age of the structure, the floor area ratio, the number of floors, the assessed value of the land, and the legislative dummies.

An interpretation can be difficult in the multinomial logistic model, in which marginal effects are computed by integrating over the exogenous variables. Results for Manhattan are presented in Table 5, and for Brooklyn in Table 6.

For Manhattan, each percent deviation of commercial lots in the census tract to the borough increases the propensity to be commercially zoned by almost 0.6% and decreases the probability of being residential by nearly the same amount. It does not appear to have a statistically significant effect on the propensity to be manufacturing. Each percentage point deviation of manufacturing zoned lots from the borough increases the likelihood to be zoned commercial by 0.02%, manufacturing by 0.028%, and residential by 0.05%. Older buildings increase the likelihood of residential or manufacturing and decrease the likelihood of being commercially zoned. Taller buildings have a lower likelihood of being zoned for manufacturing. A ten percent increase in the assessed value of the land increases the propensity to be commercial by 0.6% and decreases the likelihood of being zoned residential by 0.056%.

[Table 5 about here.]

The legislative variables have a significant impact. Having a certified ULURP application increased the likelihood of being commercial by 32%, decreased the change of being manufacturing by roughly 3%, and decreased the likelihood of being residentially zoned by 29%. Also how the community board weighs in on the zoning application also has a statistically significant impact. Applications for which the community board is a majority in favor of the proposed zoning change are 21.9% less likely to be commercial in the future, 2.75% more likely to be manufacturing, and 19.2% more likely to be residential.

[Table 6 about here.]

After running the estimation, the land use propensities are generated by simply taking the model prediction for each classification. Then the base case (residential) propensity is computed by taking unity minus the sum of all imputed propensities.

## 5.2 Robustness Check: Do Land Use Propensities Predict Zoning Changes?

Now that land use propensities for each tax lot have been generated, we test whether our generated propensities are predictive of zoning changes. Since we have a limited sample to work with and the zoning process is highly persistent, we see if we can explain the probability that a zoning change occurs during the sample with zoning propensities at the beginning of the sample.

To determine if our generated land use propensities are actually predictive of zoning changes, we create a dummy variable,  $D_i$ , that is equal to unity if a lot has a different zoning designation in 2017 than it did in 2002, and zero otherwise. We remove the few lots that have gone through two or more rezonings over the sample to avoid the case where a lot switched to a new designation and then switched back to their original designation.

We regress  $D_{i,t}$  on what we define to be the *transition propensity* at the beginning of the sample,  $T_{i,2002}$ , as the sum of the propensities to be a land use different from how it was zoned in 2002.

$$T_{i,2002} := \sum_{s \in \{C,R,M\} \setminus Z_{i,2002}} \hat{\eta}_{i,2002,s}, \quad (12)$$

where  $Z_{i,2002}$  is the zoning designation of lot  $i$  in 2002.

For example, for a manufacturing zoned lot, the transition propensity is the sum of that lot's propensity to be commercial or residential. We run a separate regression for each zoning designation, and also include a specification with census tract fixed effects. Table 7 presents results.

[Table 7 about here.]

Regressions (1) - (3) show the estimation results. All results show that transition propensities are positively correlated with a zoning change occurring throughout our sample, and all results are statistically significant at the 0.1% significance level. For commercial, manufacturing, and residential, respectively, a one percentage point increase in the transition propensity translates into an increased probability of being rezoned by 0.223%, 0.112%, and 0.19%. Including census tract level fixed effects does not hinder the effect, and for commercial and residential, it makes the effect much stronger. This suggests that even within a census-tract, the transition propensities help to distinguish which buildings will transition.

### 5.3 Does Land Share of Assessed Value Predict Redevelopments?

It is imperative that we test if the land share of assessed value, our proposed proxy motivated by [Clapp and Salavei \(2010\)](#), predicts redevelopments in our sample. Since redevelopments occur over a very long cycle, we opt to do an experiment similar to the prior experiment by testing whether the proxy measured in the beginning of the sample predicts a redevelopment occurring by the end of the sample. We create a dummy variable,  $R_i$ , indicating whether or not a redevelopment has occurred throughout the entire sample. A redevelopment here is defined as either as a major renovation or a construction project that alters the size or egress of a structure.

We then regress  $R_i$  on five dummies representing which quintile of land share of assessed value the property falls into. Results are presented in [Table 8](#).

[Table 8 about here.]

Regression (1), the baseline, shows all coefficients are statistically significant, and there is roughly a 10 percentage point increase in the probability of redevelopment going from the bottom quintile to the top quintile. Controlling for age and the remaining FAR the property owner is legally allowed to add on to the building does not take away the effect of our



proxy, although it does dampen it a bit. The difference between the top and bottom quintile decreases to roughly 7 percentage points. Age has a non-linear impact on the probability of redevelopment, reaching an inflection point at around 60 years. This implies that after 60 years of operation, the benefit from having a ‘historic’ building outweighs redevelopment. Instead, property owners likely invest in the upkeep of their property little-by-little each year to stave off depreciation. Remaining FAR is also statistically significant, with each additional floor that is allowed to be added on to the redeveloped building increasing the odds of redevelopment by 2 percentage points. Lastly, regressions (3)-(4) add community district, and census tract fixed effects respectively, and they do not seem to hinder our proxy’s ability to predict redevelopment.

## 5.4 Hedonic Regression

Next, a hedonic model is estimated by regressing the logarithm of sale price per square feet on various property characteristics. The advantage of defining intensity as in Equation 14 is that it is increasing in option value; the greater percentage of the total value of the property is due to the land, the higher the option value should be. And when intensity is equal to zero – the land is not valued – it can be interpreted as if there is no option value to redevelop.

For years 2003-2015, I have complete data for 9,853 transactions in Manhattan, excluding condominium sales, which make up the majority of residential transactions in Manhattan. We have 105,047 transactions for Brooklyn. Summary statistics for the estimation sample are presented in Table 9 and Table 10 respectively.

[Table 9 about here.]

[Table 10 about here.]

Regression results from the hedonic model estimation for both Manhattan and Brooklyn are presented in Table 11.

[Table 11 about here.]

The regression specification above regresses the logarithm of the transaction price per gross square foot on land share of assessed value (LSA) interacted with land use propensities, as well as the logarithm of the total assessed value per gross square foot. The LSA terms reflect the option value to redevelop into each use, while the total assessed value terms are interacted to allow for the possibility that changes in the future expected zoning of an area might also impact real estate values through the existing building characteristics.

All coefficients on the “LSA” term which captures the land share of assessed value are significant at the 5% level with the exception of the  $\hat{\eta}_{i,t,R}$  term for Manhattan (which is significant at the 10% level) and the  $\hat{\eta}_{i,t,C}$  term for Brooklyn. For both boroughs, option value is most sensitive to propensities to be zoned commercial, followed by manufacturing and residential.

## 5.5 Discussion: What is the value of a zoning change?

Directly estimating the change in value of real estate due to a legislative change in land use is not addressed in this paper. Zoning changes do not happen in laboratories, and we do not know of any natural experiments that have occurred in recent U.S. history, or in any place in any time. For such an experiment to exist, many properties would need to change its land-use zoning independently of the value of the property itself.

As an alternative to a natural experiment, one could simultaneously estimate a structural model of the decision of the city planner to alter the land use distribution of the city. It is not clear what the structure of such models would be. And we have anecdotal evidence to support the claim that the incentives of the city planner changes with the election of a new mayor. Furthermore, prices would need to be formed in a way that takes into account uncertainty with regards to how the city planner will act in the future.

However, to make some progress on answering the question, we ask if properties identified by the model as likely to switch zoning designation sell at a premium in comparison to their

counterparts. Specifically, we seek to confirm Dan Doctoroff’s story that there was hidden value locked in inefficient manufacturing zoned lots.

We run a regression of the log-sale price per sq. ft. on the propensity to be rezoned to residential and commercial zoning designations, on the sub-sample of all manufacturing lots that sold during the sample period of 2003-2015. Results are reported in Table 12.

[Table 12 about here.]

Regression (1) only includes a quadratic age term to control for depreciation. The estimates are puzzling, suggesting a discount of 14.3% for properties identified as likely to switch to residential, and a unbelievably large premium of 120% per sq. ft for properties identified as likely to switch to commercial. Regression (2) adds community district-year fixed effects to control for unobserved spatial-temporal variation, and the results are encouraging: lots identified as very likely to switch residential sell for an estimated average premium of 23%, with the result statistically significant with a p-value of less than 0.001. The average premium for properties very likely to switch commercial sell for an estimated average premium of only 8.6%, and the result is not statistically different from zero. Lastly, Regression (3)-(4) use census tract-year fixed effects, with Regression (4) also adding controls that were used in the first-stage zoning model that generated  $\hat{\eta}_{i,t,C}$  and  $\hat{\eta}_{i,t,R}$ . We find that the estimated average premium per sq ft, for a manufacturing lot identified as likely to switch to residential sell for a premium of 49.7% and 50% respectively in Regressions (3)-(4). In other words, a 1% increase probability of switching from manufacturing to residential, results in a percent-increase of 50BP in the sale price of the parcel. The added controls in (4) barely moves the estimated premium. The estimated premium for manufacturing lots likely to switch to commercial is 18.1% and 16.3% respectively, but once again are not statistically different from zero.

Echoing the concerns that began this section, our results do not necessarily imply the premium is due zoning propensities, or if zoning propensities are themselves impacted by the value of the parcels. At a very minimum is evidence that either the city planners

are selectively choosing and identifying lots with high values to be rezoned, that market participants are paying a premium for the rezoning likelihood, or some combination of both. What we can say is that the effect of a 1% in the assessed value of the property only leads to a 5.6 BP percentage decrease in the propensity to be zoned residential; the effect is small and in the opposite direction. This suggests that the estimated premium is more likely due to market participants valuing the possibility of a rezoning, and not the value of the property itself.

## 5.6 Discussion: Option Value to Redevelop Across Space

Table 13 and Table 14 present how option value varies across the entire sample for Manhattan and Brooklyn respectively. The mean option value in Manhattan is 20% of total value, and it is broken down into 28% related to commercial development, 8.5% manufacturing, and 66.3% residential. The option value to redevelop has a standard deviation of 10 percentage points. Lots in Brooklyn have far less option value, with a mean of 8.5% and standard deviation of 4.7 percentage points. Much of Brooklyn’s option value is attributed to residential development, with only 1% going to commercial and 4.4% being attributed to manufacturing.

[Table 13 about here.]

[Table 14 about here.]

Table 15 and Table 16 exhibit how the breakdown of option value varies across demographic factors. On the racial dimension, the higher percent Asian a census tract is, the more the redevelopment option is a fraction of total value in Manhattan. In contrast, the more African-American a neighborhood, the more the option value to redevelop constitutes total property value. Neighborhoods that are the least Asian have option values of 10.64% for commercial, 1.77% manufacturing, and 88.77% residential, while neighborhoods that are the most Asian have redevelopment rates of 57.71% for commercial, 18.75% manufacturing, and 26.43% residential. The distribution of the least African-American census tracts

is 40.43% commercial, 9.17% manufacturing, and 54.25% residential. The census tracts which are most African-American have nearly all residential value; the breakdown is 9.51% commercial, 3.73% manufacturing, and 87.72% residential.

One may think the racial breakdown may be related to income. When looking at the same breakdown but for median household income in Manhattan, it is very similar to the breakdown for Asian census tracts. The least Asian neighborhoods have a similar option value to the lowest income census tracts, while the most Asian look very close to the highest income quartile. However, the top quartile of African-American census tracts has more variation than income dynamics might suggest. The top quartile of African-American tracts have more redevelopment option value than the lowest income bracket, and the option value itself is attributed 3% more to residential development. They both have extremely little manufacturing potential.

[Table 15 about here.]

[Table 16 about here.]

Education also has similar option value characteristics as median household income. At the top of the income and education bracket, the quartile of tracts with the highest degree earners has 6% more option value associated with residential redevelopment and 10% more residential.

Tracts with more renters have a lower amount of option value and have less of the option value devoted to commercial use, less to manufacturing, and more to residential.

Median age of the households in the census tract seems to have a positive correlation with option value. The older the residents of the neighborhood, the more option value there is, likely due to higher incomes.

The changes to option value in Brooklyn are not as drastic as in Manhattan. There is far less variation in option value. This may have to do with the fact that the majority of option value in Brooklyn is associated with residential. More research needs to be done on what is driving the results from Brooklyn.

## 5.7 Discussion: Option Value Across Time

Figure 5 and Figure 6 show how the option value to redevelop as a percentage of total estimated value has changed each year for Manhattan and Brooklyn respectively. A visual inspection gives credence to the idea that the option value to redevelop is acyclical. For both Manhattan and Brooklyn, we see option value decrease from 2003-2008, when the great financial crisis hit. From 2008-2010, there is a drastic increase in option value. Once NYC real estate starts to boom again from 2010-2015, we also see a decrease in the option value to redevelop.

This is consistent with Grenadier (1996), which finds that development cascades can occur in periods where there is a downturn in demand for real estate services. As rents from real estate decline during an economic downturn, the opportunity cost introduced from the lost rent during a redevelopment decreases. Landlords then have greater incentive to exercise the redevelopment option, as they can earn even more rents once the recession ends and the



property is improved.

[Figure 5 about here.]

[Figure 6 about here.]

## 6 Conclusion

We ask how the option value to redevelop is related to land use restrictions, and how the redevelopment value is related to various demographic and building characteristics. A dataset is constructed that captures land use changes, property transactions, building characteristics, demographics, and economic information for all properties and census tracts in New York City from 2002-2017.

Using a two-stage estimation procedure, propensities to be zoned to either residential, commercial, or manufacturing land uses are interacted with the ratio of assessed land to total assessed value of the property. This ratio proxies for the propensity to be redeveloped.

We find evidence that all option value terms are statistically significant. We estimate the the average option value in Manhattan for years 2003-2015 is 20% of total estimated value, and we estimate that it is 8.5% in Brooklyn. In a sense, Furthermore, the option value broken down by the potential to develop into different land uses shows clear correlations with race, income, and education. Lastly, we present evidence that the option value to redevelop is acyclical with the real estate cycle.

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## **.1 Description of ULURP**

The ULURP sets forth a legislative process that any rezoning in NYC needs to follow. This section serves as a brief description of the data-points that will be collected.

First a application is submitted either by an individual, company, interest group, or the mayor's office. The application is then certified by the city planning commission a sub-committee of the City Council (CC) usually within 6 months (though no official time-limit is imposed). Once certified, the process continues. Dates of both submission of application and certification are collected.

Once the application is certified, the community board (CB) holds a town meeting where affected residents are allowed to discuss, vote, and send forth a recommendation to the BP and CPC. The date, vote tally, and recommendation (recommend, recommend with revisions, or do not recommend) is collected.

If the project affects a single borough, with the information from the CB, the BP makes a recommendation to the CPC. The date, and recommendation are collected. The BP has 30 days from receiving the CB recommendation. If the project affects multiple boroughs, a borough board (BB) is formed and votes on a recommendation.

Upon receiving the BP's recommendation, the CPC holds a vote on the proposal. They either vote to approve, approve with changes, or reject a proposal. Zoning map changes are required to go in-front of the City Council (CC). The date and outcome are collected.

The CC then reviews the proposal within 50 days of the CPC vote. The vote tally and recommendation are collected. If the vote passes, the mayor has 5 days to veto. In the case of a veto, the CC can overrule the veto with a 2/3rds majority and has 10 days to do so.

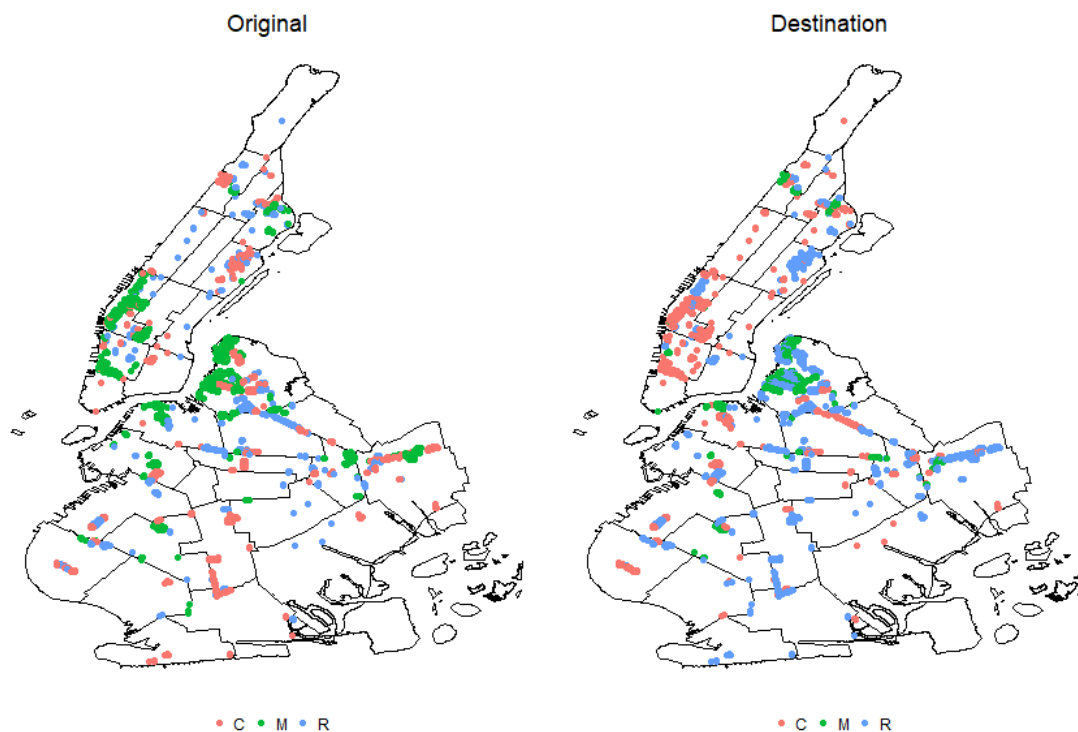
To add an additional source of nuance to the proposal, it is an unwritten tradition in the CC where the CC typically votes with the local member; giving the local member veto power.



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Figure 1: Zoning transitions in Brooklyn (bottom) & Manhattan (top) from 2003 -2015. The figure on the left shows the original zoning designation of each property, and the figure on the right shows the zoning designation each property switched to. The dots are colored by zoning designation; red being commercial, green being manufacturing, and blue being residential.



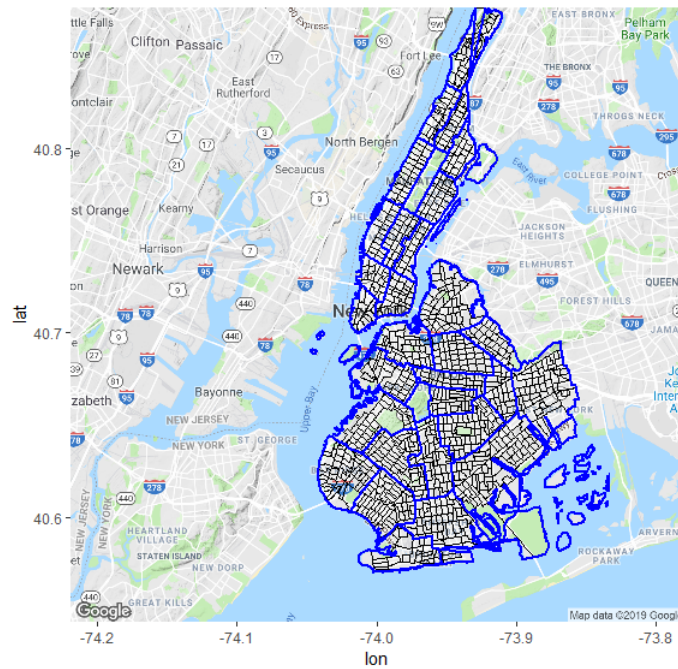


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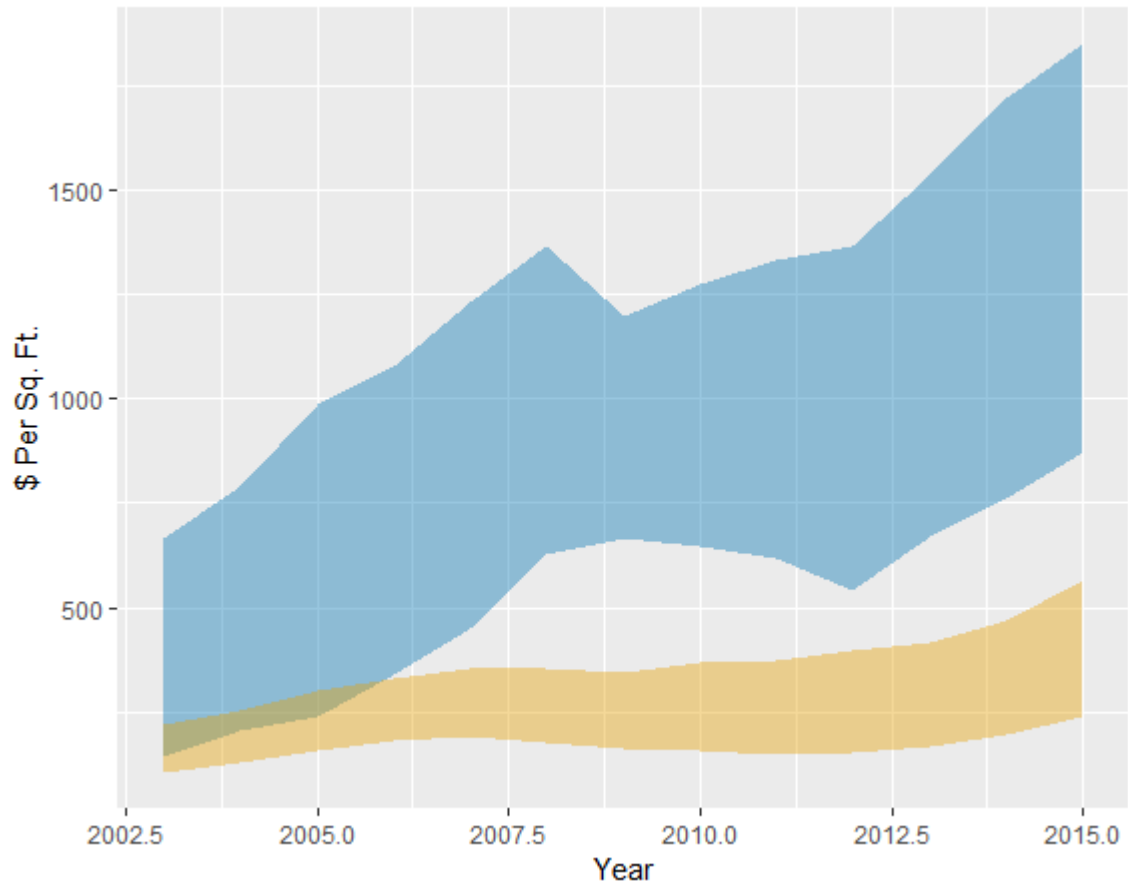
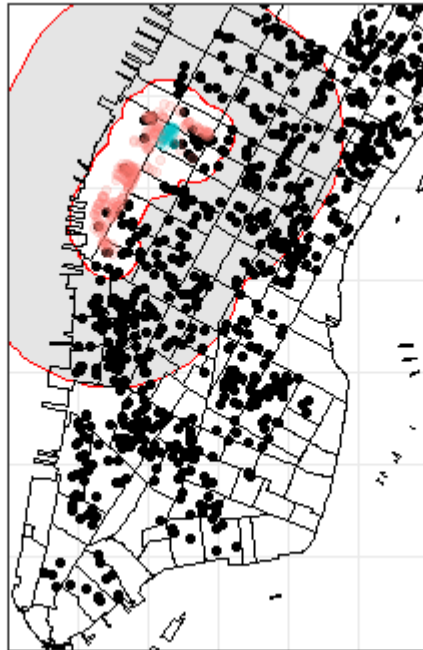


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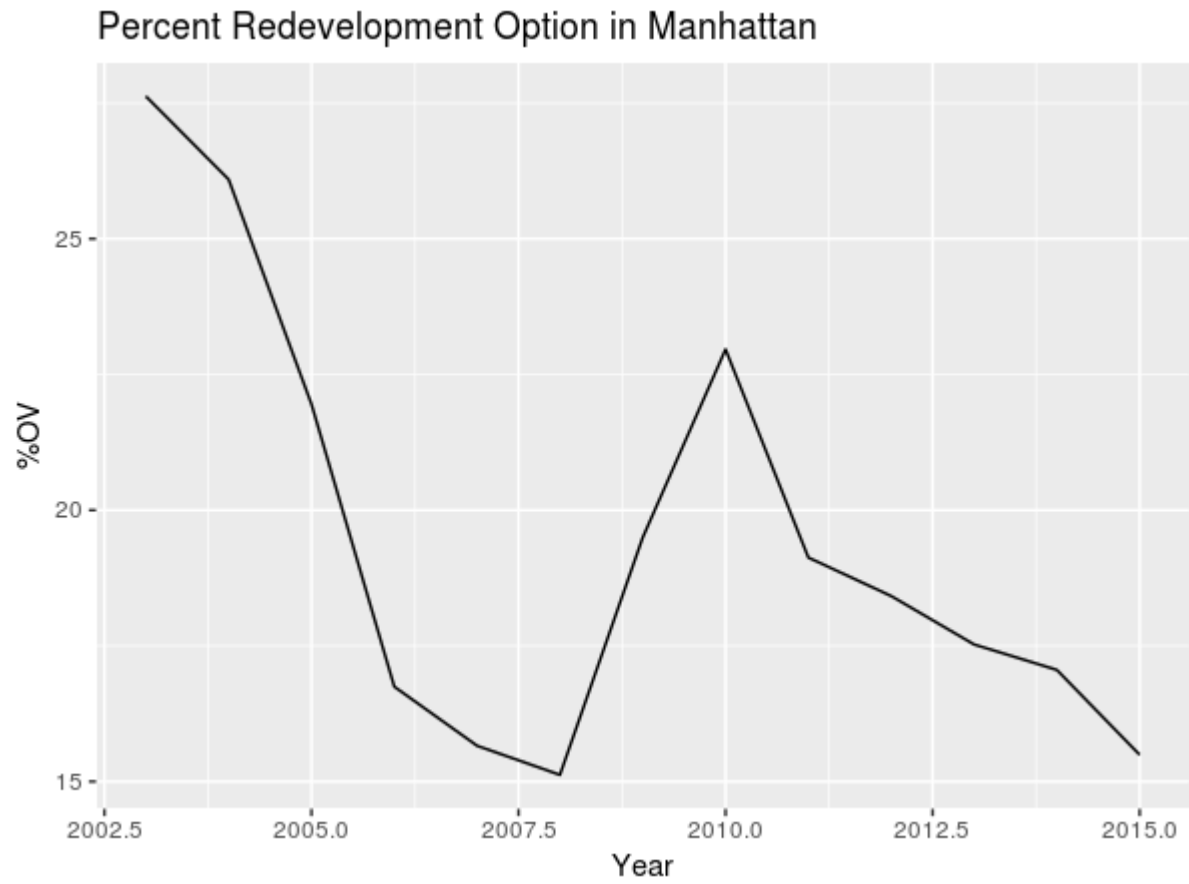


Figure 5: Option value to redevelop of a percent of total value over time for Manhattan.

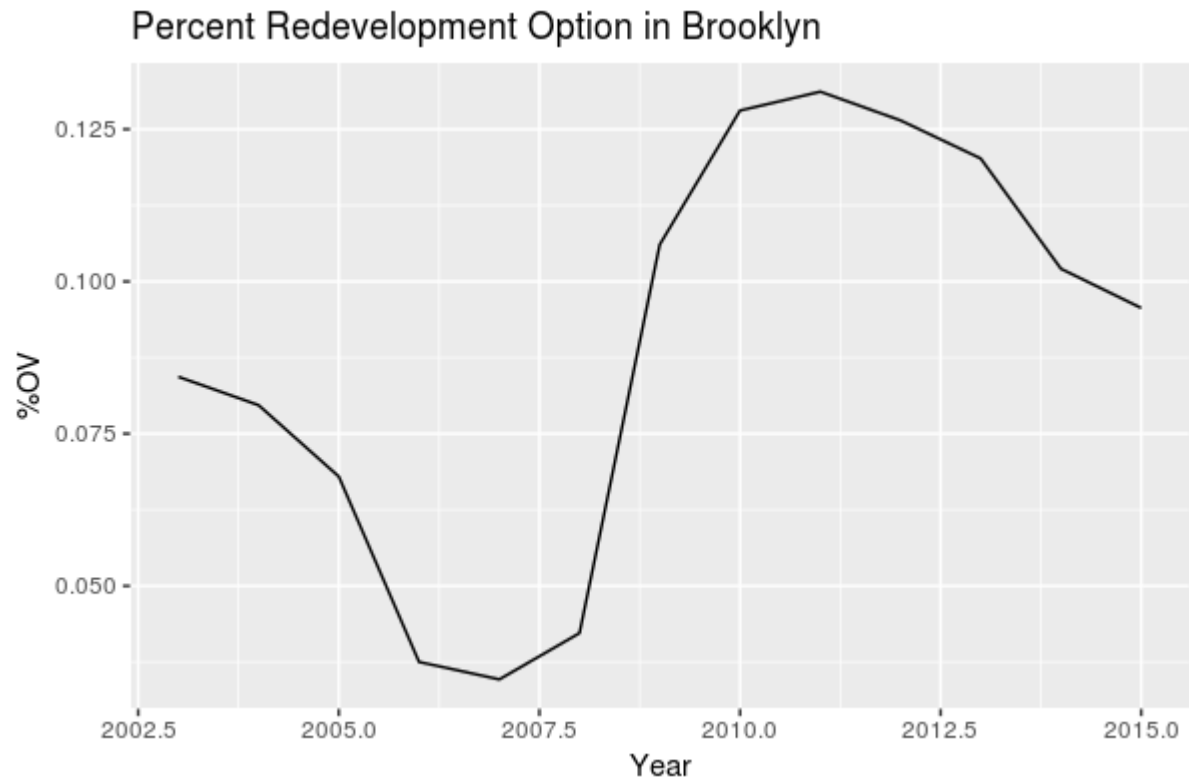


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Table 1: Zoning changes that occurred or did not for all lots present in the beginning of the sample from all boroughs from 2003-2017. Res/Man refers to a mixed zoning designation where the property can be used for both residential and manufacturing purposes.

| Source        | Commercial | Manufacturing | Residential | Res/Man | Total   |
|---------------|------------|---------------|-------------|---------|---------|
| Commercial    | 14,598     | 30            | 1,466       | 55      | 16,149  |
| Manufacturing | 865        | 10,538        | 935         | 987     | 13,325  |
| Residential   | 595        | 84            | 262,683     | 3       | 263,365 |
| Res./Man.     | 24         | 1             | 713         | 463     | 1,201   |
| Net Change    | (-67)      | (-2,672)      | (2,432)     | (307)   |         |

Table 2: Selected summary statistics.

| Statistic    | N          | Mean      | St. Dev.   | Min    | Max           |
|--------------|------------|-----------|------------|--------|---------------|
| SalePrice    | 470,565    | 1,309,629 | 16,215,434 | 10,040 | 4,111,111,766 |
| GrossSqFt    | 470,565    | 4,270     | 35,125     | 10     | 8,942,176     |
| LandSqFt     | 470,565    | 3,266     | 16,202     | 0      | 7,649,136     |
| NumFloors    | 48,929,331 | 2.4       | 1.77       | 0      | 104           |
| BldgArea     | 48,929,331 | 6,469     | 65,238     | 0      | 49,547,830    |
| LotArea      | 48,929,331 | 5,165.    | 71,089     | 1      | 29,305,534    |
| YearBuilt    | 48,861,359 | 1938      | 27.42      | 1661   | 2017          |
| MetroTimeGCS | 48,929,175 | 18.92     | 8.39       | 0.07   | 51.83         |
| UR           | 21,951,046 | 6.286     | 3.359      | 0.000  | 62.700        |
| MedHHIncome  | 21,939,060 | 62,398.91 | 23,743.18  | 8,694  | 247,167       |
| %Rent        | 21,947,586 | 52.11     | 25.17      | 0      | 100           |
| MedGrossRent | 21,413,884 | 1,294.56  | 288.22     | 231    | 3,479         |
| MedAge       | 21,949,333 | 37.22     | 5.74       | 17.3   | 94            |
| HSGradRate   | 41,108,638 | 60.85     | 11.33      | 27     | 85.6          |

Table 3: Summary statistics from first-stage estimation.  $\%C|CT - \%C|CD$  refers to the difference between the percentage of lots zoned to commercial (C) in a lots specific census tract (CT) and the community district (CD). The same notation holds for manufacturing zoned lots (M), and the borough (Boro). LotArea is the area of the lot. Age refers to the age of the building. LastAltered refers to the year the building had its last major alteration. MetroTimeGCS is the estimated transit time to Grand Central Station.

| Statistic           | N          | Mean      | St. Dev.   | Min    | Pctl(25) | Pctl(75) | Max     |
|---------------------|------------|-----------|------------|--------|----------|----------|---------|
| $\%C CT - \%C CD$   | 16,016,931 | -0.00000  | 0.095      | -0.813 | -0.023   | -0.004   | 0.940   |
| $\%M CT - \%M CD$   | 16,016,931 | -0.0001   | 0.123      | -0.282 | -0.039   | -0.003   | 0.994   |
| $\%C CT - \%C Boro$ | 16,016,931 | -0.00005  | 0.123      | -0.289 | -0.022   | -0.006   | 0.981   |
| $\%M CT - \%M Boro$ | 16,016,931 | -0.0001   | 0.133      | -0.073 | -0.041   | -0.034   | 0.966   |
| LotArea             | 16,016,931 | 4,132.826 | 29,613.590 | 17     | 1,914    | 2,967    | 9,218,6 |
| Age                 | 16,016,931 | 80.766    | 25.529     | 0.000  | 73.500   | 98.500   | 217.75  |
| LastAltered         | 16,016,931 | 72.237    | 31.558     | -0.500 | 52.500   | 94.500   | 216.75  |
| MetroTimeGCS        | 16,016,931 | 15.814    | 5.599      | 0.070  | 12.050   | 19.888   | 40.207  |

Table 4: Results of the first-stage choice model of land use designation two years into the future. The sample includes all lots from both Manhattan & Brooklyn for years 2003-2015.  $\%C|CT - \%C|CD$  refers to the deviation of % properties zoned (C)ommercial ((M)anufacturing) in the census tract from the community district  $\%C|CT - \%C|Boro$  refers to the respective deviation but from the borough. CertDum is a dummy variable which is one if a ULURP application for a zoning change is in progress and it is certified. ResComDum is a dummy that is equal to one if a ULURP application is in progress and the residential community board approved of the application.

|   | Land Use    |             |
|---|-------------|-------------|
|   | C           | M           |
| $\%C CT - \%C CD$                             | 0.225       | 0.775       |
| $\%M CT - \%M CD$                             | -0.449      | -5.421***   |
| $\%C CT - \%C Boro$                           | 6.322***    | 4.884***    |
| $\%M CT - \%M Boro$                           | 4.349***    | 15.69***    |
| LogLotArea                                    | -0.527      | 0.327       |
| Age   | -0.00793*** | -0.00341*** |
| LastAltered                                   | -0.0000558  | 0.000368    |
| FAR   | 0.0468      | 0.0950***   |
| LogBldgArea                                   | -0.340      | 0.0641      |
| LotFrontage                                   | 0.00160     | 0.000630    |
| NumFloors                                     | -0.0200     | -0.136***   |
| LogAssessLand                                 | 0.608***    | 0.187       |
| MetroTimeGCS                                  | 0.00379     | 0.0333      |
| CertDum                                       | 3.137***    | 1.002**     |
| ResComDum                                     | -2.106**    | -0.215      |
| Constant                                      | -0.443      | -9.582***   |
| N   | 2,118,441   |             |
| $R_P^2$                                       | 0.514       |             |
| * $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$ |             |             |

Table 5: Marginal effects for propensity to be rezoned commercial (C), manufacturing (M), and residential (R) in Manhattan based on the first-stage regression for years 2003-2015. Marginal effects are computed by integrating over observed values of regressors, and the t-statistics are computed using the delta-method. *t*-statistics in parenthesis.

|                     | C                       | M                      | R                     |
|---------------------|-------------------------|------------------------|-----------------------|
| $\%C CT - \%C CD$   | 0.0119<br>(0.16)        | 0.0141<br>(1.17)       | -0.0260<br>(-0.32)    |
| $\%M CT - \%M CD$   | 0.0357<br>(0.42)        | -0.116***<br>(-4.14)   | 0.0800<br>(0.90)      |
| $\%C CT - \%C Boro$ | 0.593***<br>(9.81)      | 0.0135<br>(1.35)       | -0.606***<br>(-9.17)  |
| $\%C CT - \%M Boro$ | 0.219*<br>(1.91)        | 0.288***<br>(13.31)    | -0.507***<br>(-4.39)  |
| LogLotArea          | -0.0607*<br>(-1.95)     | 0.0155***<br>(4.03)    | 0.0452<br>(1.45)      |
| Age                 | -0.000785***<br>(-5.58) | 0.0000444**<br>(2.12)  | 0.000741***<br>(5.77) |
| LastAltered         | -0.0000115<br>(-0.14)   | 0.00000918<br>(0.55)   | 0.00000236<br>(0.03)  |
| FAR                 | 0.00349<br>(1.29)       | 0.00143***<br>(2.88)   | -0.00492*<br>(-1.68)  |
| LogBldgArea         | -0.0369*<br>(-1.75)     | 0.00668<br>(1.61)      | 0.0303<br>(1.40)      |
| NumFloors           | -0.0000150<br>(-0.01)   | -0.00278***<br>(-3.30) | 0.00280<br>(1.56)     |
| LogAssessLand       | 0.0614***<br>(7.16)     | -0.00510<br>(-1.10)    | -0.0563***<br>(-8.46) |
| CertDum             | 0.316***<br>(5.86)      | -0.0255*<br>(-1.80)    | -0.291***<br>(-6.44)  |
| ResComDum           | -0.219**<br>(-2.50)     | 0.0275**<br>(2.17)     | 0.192**<br>(2.26)     |

*t*-statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 6: Marginal effects for propensity to be rezoned commercial (C), manufacturing (M), and residential (R) in Brooklyn based on the first-stage regression for years 2003-2015. Marginal effects are computed by integrating over observed values of regressors, and the  $t$ -statistics are computed using the delta-method.

|                     | C                       | M                       | R                      |
|---------------------|-------------------------|-------------------------|------------------------|
| $\%C CT - \%C CD$   | -0.0533<br>(-0.49)      | 0.0161<br>(0.25)        | 0.0372<br>(0.34)       |
| $\%M CT - \%M CD$   | -0.0130<br>(-0.41)      | -0.117***<br>(-5.46)    | 0.130***<br>(4.78)     |
| $\%C CT - \%C Boro$ | 0.251**<br>(2.41)       | 0.0262<br>(0.39)        | -0.278***<br>(-2.68)   |
| $\%M CT - \%M Boro$ | 0.0327<br>(1.18)        | 0.269***<br>(13.25)     | -0.302***<br>(-11.14)  |
| LogLotArea          | -0.0123**<br>(-2.51)    | 0.00958***<br>(4.03)    | 0.00272<br>(0.40)      |
| Age                 | 0.0000464<br>(1.02)     | 0.0000970*<br>(1.93)    | -0.000143**<br>(-2.11) |
| LastAltered         | -0.0000520**<br>(-2.43) | -0.0000370**<br>(-2.39) | 0.0000889***<br>(3.22) |
| LotFrontage         | 0.0000260***<br>(2.90)  | -0.00000757<br>(-0.86)  | -0.0000185<br>(-1.31)  |
| NumFloors           | -0.00521***<br>(-2.83)  | -0.0141***<br>(-7.39)   | 0.0193***<br>(5.98)    |
| LogAssessLand       | 0.0130***<br>(8.70)     | 0.00337***<br>(3.01)    | -0.0164***<br>(-8.08)  |
| MetroTime           | -0.000585***<br>(-3.43) | -0.000137<br>(-1.22)    | 0.000722***<br>(3.33)  |
| CertDum             | 0.00476<br>(0.75)       | -0.0557***<br>(-3.29)   | 0.0510***<br>(2.66)    |
| ResComDum           | -0.00280<br>(-0.97)     | -0.0141<br>(-0.98)      | 0.0169<br>(1.10)       |

$t$ -statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 7: Regressions (1)-(3) show results from regressing a dummy indicator whether or not a zoning change occurred during the sample on transition propensities at the beginning of the sample defined as the sum of propensities to be a zoning designation other than the lot's current designation, for lots zoned commercial, manufacturing, and residential respectively at the beginning of the sample. Regressions (4)-(6) include census tract fixed effects.

|                | (1)                   | (2)                   | (3)                     | (4)                  | (5)                   | (6)                    |
|----------------|-----------------------|-----------------------|-------------------------|----------------------|-----------------------|------------------------|
| $T_{i,2002}^C$ | 0.223***<br>(0.00632) |                       |                         | 0.362***<br>(0.0178) |                       |                        |
| $T_{i,2002}^M$ |                       | 0.112***<br>(0.00938) |                         |                      | 0.0832***<br>(0.0118) |                        |
| $T_{i,2002}^R$ |                       |                       | 0.0193***<br>(0.000844) |                      |                       | 0.0554***<br>(0.00219) |
| Constant       | -0.0252***            | 0.140***              | 0.00128***              | -0.0973***           | 0.153***              | -0.000256*             |
| Tract FE       | -                     | -                     | -                       | Yes                  | Yes                   | Yes                    |
| $N$            | 15,338                | 12,508                | 260,349                 | 15,325               | 12,498                | 260,347                |
| adj. $R^2$     | 0.075                 | 0.011                 | 0.002                   | 0.575                | 0.737                 | 0.164                  |

Standard errors in parentheses

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



Table 8: Regressions (1)-(4) predict redevelopment over the sample on quintile dummies of assessed land value as a percentage of assessed total value. Regression (1) presents baseline results. Regression (2) controls for a quadratic term in the age of the structure as well the remaining designated FAR permitted by the New York City Zoning Resolution (FAR Remaining). Regression (3) includes community district fixed effects, and Regression (4) includes census tract fixed effects. The bottom row F-statistics are from a test that the coefficients on all five quintiles are equal to one another.

| $R_i$            | (1)                    | (2)                           | (3)                             | (4)                             |
|------------------|------------------------|-------------------------------|---------------------------------|---------------------------------|
| Q1               | 0.0687***<br>(0.00143) | 0.00813*<br>(0.00340)         | 0.225***<br>(0.0112)            | 0.0603<br>(0.0390)              |
| Q2               | 0.0733***<br>(0.00143) | 0.0115**<br>(0.00366)         | 0.243***<br>(0.0113)            | 0.0794*<br>(0.0390)             |
| Q3               | 0.0793***<br>(0.00143) | 0.0154***<br>(0.00374)        | 0.249***<br>(0.0113)            | 0.0896*<br>(0.0390)             |
| Q4               | 0.102***<br>(0.00143)  | 0.0331***<br>(0.00376)        | 0.262***<br>(0.0113)            | 0.103**<br>(0.0390)             |
| Q5               | 0.165***<br>(0.00143)  | 0.0785***<br>(0.00382)        | 0.290***<br>(0.0112)            | 0.129***<br>(0.0390)            |
| Age              |                        | 0.000718***<br>(0.0000928)    | 0.00104***<br>(0.0000943)       | 0.000910***<br>(0.000102)       |
| Age <sup>2</sup> |                        | -0.00000161*<br>(0.000000664) | -0.00000823***<br>(0.000000680) | -0.00000771***<br>(0.000000719) |
| CD FE            | -                      | -                             | Yes                             | -                               |
| Tract FE         | -                      | -                             | -                               | Yes                             |
| adj. $R^2$       | 0.111                  | 0.120                         | 0.141                           | 0.153                           |
| F(4,.)           | 777.56***              | 377.48***                     | 207.96***                       | 190.44***                       |

Standard errors in parentheses

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

Table 9: Summary statistics for hedonic regression of Manhattan; 2003-2015.

|                      | Mean     | Std. Dev. | Min     | Max       |
|----------------------|----------|-----------|---------|-----------|
| SaleSqFt             | 680.92   | 947.32    | 1.96    | 35,416.67 |
| LotArea              | 3,862.48 | 4,812.18  | 320     | 58,24     |
| Age                  | 95.23    | 19.23     | 1.75    | 119.75    |
| $\hat{\eta}_{i,t,C}$ | .2812    | .3353     | .0013   | .9959     |
| $\hat{\eta}_{i,t,M}$ | .0703    | .1952     | .0001   | .9859     |
| $\hat{\eta}_{i,t,R}$ | .6483    | .3868     | .0030   | .9983     |
| AssessTotalSqFt      | 49.73    | 64.94     | .490929 | 2,163     |
| FloorArea            | 3,509.80 | 8,691.54  | 130     | 359,251   |
| NumFloors            | 5.104    | 4.26      | 1       | 63        |
| LastAltered          | 43.94    | 52.95     | -12.25  | 119.75    |
| ExemptTotalSqFt      | 2.62     | 13.55     | 0       | 373.60    |
| MetroTimeGCS         | 9.969675 | 6.47      | .07     | 26.2      |
| LSA                  | .4008    | .2324     | .0121   | .9911     |
| Observations         | 5,276    |           |         |           |

Table 10: Summary statistics for hedonic regression of Brooklyn; 2003-2015.

|                      | Mean     | Std. Dev. | Min      | Max      |
|----------------------|----------|-----------|----------|----------|
| SaleSqFt             | 290.48   | 194.77    | 9.6153   | 2,854.33 |
| LotArea              | 2,676.87 | 4,256.58  | 340      | 362,142  |
| Age                  | 88.11    | 24.04     | .5       | 118      |
| $\hat{\eta}_{i,t,C}$ | .0189    | .0726     | 1.40e-15 | .9999    |
| $\hat{\eta}_{i,t,M}$ | .0398    | .1491     | 1.33e-32 | .9999    |
| $\hat{\eta}_{i,t,R}$ | .9412    | .1650     | 3.77e-06 | 1        |
| AssessTotalSqFt      | 11.80    | 12.46     | .1425    | 499.36   |
| FloorArea            | 1,570.58 | 2,755.36  | 80       | 146,300  |
| NumFloors            | 2.4555   | .8697     | 1        | 75       |
| ExemptTotalSqFt      | 1.1238   | 4.51      | 0        | 239.59   |
| MetroTimeGCS         | 16.3896  | 4.56      | 2.81     | 28.65    |
| LSA                  | .3985    | .2384     | .0068    | .9906    |
| Observations         | 35,253   |           |          |          |

Table 11: Hedonic estimation results from Manhattan and Brooklyn from the identified subsample. LSA is the land share of assessed value, and  $p(z)$  corresponds to the land use propensities. Standard errors are computed using the Huber-White sandwich estimator and are clustered across census tracts.

|  | Manhattan           | Brooklyn            |
|--|---------------------|---------------------|
| $\log \frac{SalePrice}{GrossSqFt}$                             | $\beta$ / SE        | $\beta$ / SE        |
| $\hat{\eta}_{i,t,C} \times \text{LSA}$                         | 0.851***<br>(0.161) | 0.439<br>(0.446)    |
| $\hat{\eta}_{i,t,M} \times \text{LSA}$                         | 0.698***<br>(0.217) | 0.423**<br>(0.166)  |
| $\hat{\eta}_{i,t,R} \times \text{LSA}$                         | 0.221*<br>(0.128)   | 0.222***<br>(0.036) |
| $\hat{\eta}_{i,t,C} \times \log \frac{AssessTotal}{GrossSqFt}$ | 0.459***<br>(0.063) | 0.735***<br>(0.162) |
| $\hat{\eta}_{i,t,M} \times \log \frac{AssessTotal}{GrossSqFt}$ | 0.590***<br>(0.124) | 0.118***<br>(0.038) |
| $\hat{\eta}_{i,t,R} \times \log \frac{AssessTotal}{GrossSqFt}$ | 0.200***<br>(0.024) | 0.258***<br>(0.012) |
| Controls $\times$ Year   | Yes                 | Yes                 |
| CT $\times$ Year FE  | Yes                 | Yes                 |
| Observations   | 4,521               | 30,215              |
| $R^2$  | 0.637               | 0.549               |

Table 12: Estimation results for the sale premium of manufacturing lots that are likely to be rezoned. The sample is all sales of manufacturing zoned lots in Manhattan and Brooklyn from 2002-2015. The dependent variable is the natural logarithm of the sale price per sq. ft. of the property sold. *Age* refers to number of years the current structure has existed on the parcel.  $p(R)$  and  $p(C)$  are generated probabilities of being zoned (in the long-run sense) to residential and commercial respectively. The deviation variables represent how the distribution of lots zoned residential and commercial in a parcel's census tract differ from the distribution of the parcel's community district and borough. p-values are from the asymptotic assumptions of OLS.

| $\log(\frac{SalePrice}{GrossSqFt})$ | (1)         | (2)         | (3)         | (4)         |
|-------------------------------------|-------------|-------------|-------------|-------------|
| Age                                 | -0.0258***  | -0.0153***  | -0.0145***  | -0.0145***  |
| Age <sup>2</sup>                    | 0.000235*** | 0.000124*** | 0.000119*** | 0.000119*** |
| $\hat{\eta}_{i,t,R}$                | -0.143***   | 0.233***    | 0.497***    | 0.500***    |
| $\hat{\eta}_{i,t,C}$                | 1.245***    | 0.0855      | 0.181       | 0.163       |
| %R   CT – %R   CD                   |             |             |             | 0.802       |
| %C   CT – %C   CD                   |             |             |             | 2.299       |
| %R   CT – %R   Boro                 |             |             |             | -7.996      |
| %C   CT – %C   Boro                 |             |             |             | -1.648      |
| CD × Year Fixed-Effects             | -           | Yes         | -           | -           |
| Tract × Year Fixed-Effects          | -           | -           | Yes         | Yes         |
| Observations                        | 4,838       | 4,838       | 4,838       | 4,838       |
| R <sup>2</sup>                      | 0.134       | 0.458       | 0.643       | 0.643       |

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

Table 13: Summary statistics for option value in Manhattan

| All Properties          | N     | Mean  | St. Dev. | Min     | Pctl(25) | Pctl(75) | Max   |
|-------------------------|-------|-------|----------|---------|----------|----------|-------|
| $OV/\text{Total Value}$ | 9,853 | 0.200 | 0.100    | 0.007   | 0.119    | 0.275    | 0.455 |
| $OV^C/OV$               | 9,853 | 0.280 | 0.308    | 0.00000 | 0.022    | 0.438    | 0.995 |
| $OV^M/OV$               | 9,853 | 0.085 | 0.207    | 0.000   | 0.004    | 0.037    | 0.987 |
| $OV^R/OV$               | 9,853 | 0.663 | 0.364    | 0.001   | 0.306    | 0.976    | 0.999 |
| Commercial              | N     | Mean  | St. Dev. | Min     | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 3,040 | 0.191 | 0.084    | 0.013   | 0.123    | 0.251    | 0.426 |
| $OV^C/OV$               | 3,040 | 0.599 | 0.304    | 0.001   | 0.318    | 0.897    | 0.995 |
| $OV^M/OV$               | 3,040 | 0.085 | 0.158    | 0.00001 | 0.014    | 0.064    | 0.969 |
| $OV^R/OV$               | 3,040 | 0.352 | 0.331    | 0.001   | 0.060    | 0.685    | 0.993 |
| Manufacturing           | N     | Mean  | St. Dev. | Min     | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 746   | 0.218 | 0.092    | 0.014   | 0.143    | 0.288    | 0.444 |
| $OV^C/OV$               | 746   | 0.259 | 0.233    | 0.003   | 0.084    | 0.393    | 0.891 |
| $OV^M/OV$               | 746   | 0.647 | 0.281    | 0.005   | 0.425    | 0.885    | 0.987 |
| $OV^R/OV$               | 746   | 0.140 | 0.183    | 0.004   | 0.040    | 0.139    | 0.949 |
| Residential             | N     | Mean  | St. Dev. | Min     | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 6,067 | 0.202 | 0.107    | 0.007   | 0.114    | 0.286    | 0.455 |
| $OV^C/OV$               | 6,067 | 0.123 | 0.161    | 0.00000 | 0.013    | 0.184    | 0.965 |
| $OV^M/OV$               | 6,067 | 0.016 | 0.063    | 0.000   | 0.003    | 0.011    | 0.950 |
| $OV^R/OV$               | 6,067 | 0.883 | 0.162    | 0.019   | 0.840    | 0.985    | 0.999 |

Table 14: Summary statistics for option value in Brooklyn.

| Statistic               | N       | Mean  | St. Dev. | Min    | Pctl(25) | Pctl(75) | Max   |
|-------------------------|---------|-------|----------|--------|----------|----------|-------|
| $OV/\text{Total Value}$ | 105,047 | 0.085 | 0.047    | 0.002  | 0.042    | 0.125    | 0.305 |
| $OV^C/OV$               | 105,047 | 0.010 | 0.044    | 0.000  | 0.002    | 0.007    | 0.793 |
| $OV^M/OV$               | 105,047 | 0.044 | 0.139    | 0.000  | 0.007    | 0.021    | 0.994 |
| $OV^R/OV$               | 105,047 | 0.948 | 0.144    | 0.001  | 0.975    | 0.990    | 1.000 |
| Commercial              | N       | Mean  | St. Dev. | Min    | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 1,949   | 0.071 | 0.044    | 0.003  | 0.035    | 0.102    | 0.255 |
| $OV^C/OV$               | 1,949   | 0.143 | 0.214    | 0.0001 | 0.012    | 0.172    | 0.793 |
| $OV^M/OV$               | 1,949   | 0.073 | 0.116    | 0.000  | 0.015    | 0.081    | 0.981 |
| $OV^R/OV$               | 1,949   | 0.792 | 0.243    | 0.017  | 0.712    | 0.969    | 1.000 |
| Manufacturing           | N       | Mean  | St. Dev. | Min    | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 3,918   | 0.105 | 0.061    | 0.003  | 0.055    | 0.146    | 0.305 |
| $OV^C/OV$               | 3,918   | 0.013 | 0.045    | 0.000  | 0.002    | 0.009    | 0.632 |
| $OV^M/OV$               | 3,918   | 0.529 | 0.371    | 0.0004 | 0.141    | 0.930    | 0.994 |
| $OV^R/OV$               | 3,918   | 0.471 | 0.366    | 0.001  | 0.074    | 0.851    | 0.999 |
| Residential             | N       | Mean  | St. Dev. | Min    | Pctl(25) | Pctl(75) | Max   |
| $OV/\text{Total Value}$ | 99,180  | 0.084 | 0.047    | 0.002  | 0.042    | 0.125    | 0.274 |
| $OV^C/OV$               | 99,180  | 0.008 | 0.027    | 0.000  | 0.002    | 0.006    | 0.766 |
| $OV^M/OV$               | 99,180  | 0.025 | 0.071    | 0.000  | 0.007    | 0.019    | 0.974 |
| $OV^R/OV$               | 99,180  | 0.970 | 0.075    | 0.025  | 0.977    | 0.990    | 1.000 |

Table 15: A breakdown of option value across various demographics for Manhattan. Q1 refers to the bottom quartile of census tracts, which contains the smallest 25% of values. Q4 is then the quartile of 25% largest of values. The first row shows the percentage of estimated property value that is attributed to total option value. The bottom three rows then break down the distribution of how optional value is related to the propensity of each property to be categorized as each land use. All demographic information is on the census tract level. GCT refers to Grand Central Station.

| Percent African American            | Q1    | Q2    | Q3    | Q4    |
|-------------------------------------|-------|-------|-------|-------|
| Option Value as % of Property Value | 20.39 | 18.96 | 17.66 | 16.19 |
| % Commercial                        | 40.43 | 45.36 | 39.99 | 9.51  |
| % Manufacturing                     | 9.17  | 15.50 | 8.38  | 3.73  |
| % Residential                       | 54.25 | 42.93 | 54.60 | 87.72 |
| Percent Asian                       | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 16.02 | 20.92 | 18.55 | 17.58 |
| % Commercial                        | 10.64 | 24.24 | 42.36 | 57.71 |
| % Manufacturing                     | 1.77  | 7.75  | 8.74  | 18.75 |
| % Residential                       | 88.77 | 71.84 | 52.23 | 26.73 |
| Median Age                          | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 16.63 | 17.11 | 19.10 | 20.14 |
| % Commercial                        | 34.28 | 32.12 | 31.65 | 37.33 |
| % Manufacturing                     | 12.04 | 11.15 | 8.69  | 5.49  |
| % Residential                       | 55.95 | 59.35 | 63.10 | 60.37 |
| Median Household Income             | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 14.92 | 18.61 | 19.81 | 19.68 |
| % Commercial                        | 15.12 | 31.48 | 42.52 | 45.38 |
| % Manufacturing                     | 1.14  | 8.54  | 8.46  | 18.98 |
| % Residential                       | 84.57 | 62.79 | 53.21 | 39.31 |



| Percent Renters                        | Q1    | Q2    | Q3    | Q4    |
|--|-------|-------|-------|-------|
| Option Value as % of Property Value    | 20.22 | 19.63 | 18.31 | 14.94 |
| % Commercial                           | 37.74 | 38.37 | 32.74 | 26.59 |
| % Manufacturing                        | 12.72 | 11.73 | 7.29  | 5.52  |
| % Residential                          | 53.14 | 53.58 | 62.61 | 69.53 |
| Percent w/ Bachelor's Degree or Higher | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value    | 14.38 | 18.52 | 20.50 | 19.62 |
| % Commercial                           | 15.12 | 38.69 | 37.60 | 43.52 |
| % Manufacturing                        | 1.21  | 8.43  | 15.17 | 12.28 |
| % Residential                          | 84.44 | 55.67 | 51.44 | 47.95 |
| Metro Time to GCT                      | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value    | 21.13 | 20.91 | 18.06 | 19.84 |
| % Commercial                           | 34.80 | 26.64 | 20.34 | 30.25 |
| % Manufacturing                        | 12.01 | 6.74  | 5.97  | 9.38  |
| % Residential                          | 57.05 | 69.29 | 75.42 | 63.41 |

Table 16: A breakdown of option value across various demographics for Brooklyn. Q1 refers to the bottom quartile of census tracts, which contains the smallest 25% of values. Q4 is then the quartile of 25% largest of values. The first row shows the percentage of estimated property value that is attributed to total option value. The bottom three rows then break down the distribution of how optional value is related to the propensity of each property to be categorized as each land use. All demographic information is on the census tract level. GCT refers to Grand Central Station.

| Percent African American            | Q1    | Q2    | Q3    | Q4    |
|-------------------------------------|-------|-------|-------|-------|
| Option Value as % of Property Value | 11.46 | 11.13 | 11.43 | 12.09 |
| % Commercial                        | 0.85  | 1.27  | 1.36  | 0.68  |
| % Manufacturing                     | 3.11  | 7.46  | 4.38  | 2.19  |
| % Residential                       | 96.37 | 91.74 | 94.60 | 97.42 |
| Percent Asian                       | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 12.06 | 11.67 | 11.20 | 11.19 |
| % Commercial                        | 1.02  | 0.91  | 1.22  | 1.03  |
| % Manufacturing                     | 3.68  | 5.07  | 5.30  | 3.21  |
| % Residential                       | 95.64 | 94.36 | 93.90 | 96.11 |
| Median Age                          | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 11.70 | 11.32 | 11.42 | 11.66 |
| % Commercial                        | 1.66  | 1.11  | 0.75  | 0.66  |
| % Manufacturing                     | 6.50  | 5.32  | 3.70  | 1.83  |
| % Residential                       | 92.30 | 93.97 | 95.87 | 97.77 |
| Median Household Income             | Q1    | Q2    | Q3    | Q4    |
| Option Value as % of Property Value | 11.65 | 11.57 | 11.66 | 11.23 |
| % Commercial                        | 1.52  | 0.84  | 0.71  | 1.11  |
| % Manufacturing                     | 4.46  | 4.54  | 4.10  | 4.14  |
| % Residential                       | 94.44 | 94.99 | 95.52 | 95.08 |