The Price of Urban Amenities in Manhattan from 1985 to 2002

Preliminary results in preparation for senior honors thesis

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Introduction

An experienced real estate professional will tell you, "Location, Location, Location!" If you have ever looked for a home or are looking for one, the old real estate adage should come as no surprise. In metropolitan cities such as San Francisco, Chicago, and New York City, it is common knowledge that significant determinants of housing prices are micro-neighborhood characteristics and locational amenities. Amenities such as proximity to Central Park and water views often translate to substantially higher prices. Living close to a local subway stop or an express subway stop means the difference between a 10 and 20-minute commute to work. Living directly on Central Park versus near it can mean the difference between a beautiful view or simply recreational access. Living on historic Park Avenue provides one of the most prestigious addresses in all of New York City. How are these uniquely New York urban amenities capitalized into property prices? How much more are buyers willing to pay to live in a prestigious neighborhood such as the Upper East Side? How does a historically significant neighborhood affect prices? Do buyers pay more to live in higher performing school districts? And how about proximity to shopping, restaurants, and business districts? What is the price of convenience?

These are the questions I will attempt to answer in the following pages. However, perhaps a more interesting question to think about is how prices of these urban amenities have changed given Manhattan's immense economic growth over the last two decades. Many neighborhoods within the city have also changed dramatically as financial professionals flush with cash have moved in by raising real estate prices citywide. How has increasing demand for amenities such as Central Park changed their respective prices? Has the price of direct Central Park views increased significantly due to rising demand and constrained supply? The last two decades have also seen significant economic, political, and cultural changes. Economic recession drastically cut home sales in the early 1990s and economic boom caused unprecedented sales in Manhattan in the late 1990s. Many new residential neighborhoods have also emerged such as the Meatpacking district, SoHo, Tribeca, and the Lower East Side. Only within the last few years have these regions of Manhattan become mature residential and commercial markets. Drawing upon Sherwin Rosen's theoretical research on the hedonic price function in 1973, the purpose of this paper is to examine the price dynamics of these non-market urban amenities by estimating repeat cross-sectional hedonic regressions by year from 1986 to 2002. These regressions will help us understand how these hedonic prices change over time and we will be able to draw explanations for the changes in buyers' behaviors. I will first provide a brief literature review of relevant papers followed by a summary of the theoretical foundations of Sherwin Rosen's hedonic framework. I will then detail the specification that I propose and summarize the steps in creating the data set and implementing Geographical Information Systems. Next, the paper will describe the preliminary results of three regressions that I have chosen to highlight. Finally, I will end with a conclusion that explains the implications of my findings and outlines a list of the next steps for further research.

Literature Review

The literature surrounding the hedonic model is broad and far reaching. It has been applied to wages to determine the returns to education and experience. It is often heavily used in labor economics to study the role of compensating differentials in wage determination. Researchers have also used the model to improve the accuracy of the quality of life and housing indices. The following is a brief summary of the literature that focuses on the economic valuation of public, environmental, and locational amenities. Since many public goods do not explicitly trade on open markets, the hedonic method has become the standard to study the amenities provided by these goods. The implicit prices recovered by the hedonic method can offer insight into how individuals value amenities such as open space, clean air, convenience, and public transportation. Furthermore, because the approach is rooted in basic economic principles and empirical data, the approach represents a revealed preference alternative to easily biased survey-based contingent valuation techniques.

The primary premise to many hedonic studies is well summarized by Paul Cheshire and Stephen Sheppard in their paper, "On the Price of Land and the Value of Amenities." They write, "a house represents not only a bundle of structural characteristics but also a set of location specific characteristics…"(Cheshire and Sheppard 1995). They draw on Wilkinson (1973), who made the fundamental distinction between dwelling-specific and location-specific attributes.

Researchers have taken advantage of this distinction by analyzing many types of location specific attributes including environmental amenities and risks. Smith and Huang (1995) examines the value of clean air. Using a hedonic model applied to property prices, they estimate the marginal willingness to pay for reducing particulate matter. Irwin (2002) studies the effect of permanently preserved open space on property values using a hedonic pricing model based on residential sales in Central Maryland. Results show that properties near open space exhibit a significant premium. Furthermore, the authors show that the open space is most valued for providing an absence of new residential development rather than for providing a bundle of open space amenities. With regards to environmental risk, Brookshire et al. (1985) estimates the effects of living in high-risk earthquake zones on real estate properties. They hypothesize that people pay less for houses located in relatively hazardous areas; in other words, homebuyers "self insure" against earthquake risk by purchasing homes in areas where the expected damage from earthquakes is relatively low. Their results indicate that living outside a less earthquake prone area can increase the home value by up to $4,600 dollars or about the equivalent of half the impact of swimming pool. Their conclusions suggest that home-buyers process risk information rationally and accurately in a well defined market situation such as the California real estate market. Other hedonic studies have looked at the effect of noise (McMillan et al. 1980), water pollution (Leggett and Bockstael 2000), climate (Cragg and Kahn 1999), and proximity to hazardous waste sites (Nelson 1981) on housing prices. Refer to Boyle and Kiel (2001) for a full review and survey of real estate hedonic studies applied to environmental externalities.

Several hedonic papers have also studied how specific neighborhood characteristics are capitalized into real estate values. These characteristics range from historical district designation to quality of public school education to central business district proximity. Both Asabere and Huffman (1991) and Leichenko and Coulson (2001) measure the effect of historic districting on housing prices. Both discover that the net effect is significantly positive in Philadelphia, PA and Abilene, Texas, respectively. Asabere and Huffman (1991) find that residential parcels within historic districts can attract huge price premiums in some cases as high as 131%. Another study by Benson et al. (1998) specifically looks at the value of a view. The author accounts for different types and qualities of views in Bellingham, Washington. By employing a detailed classification scheme, they find that the premium of a view can range substantially depending on quality from just 8.2% to 58.9% for an unobstructed view of the ocean. Brasington (1999) explores which measures of public school quality are most capitalized into housing prices in New Orleans, LA. He finds that test scores, expenditure per pupil, and student/teacher ratio are consistently capitalized in property prices whereas graduation rate, teacher experience and education levels are much less so. The effect of architectural and visual quality has also been examined. Vandell and Lane (1989) begin preliminary analysis on the effect of design and architecture on office rents in Boston, Massachusetts. Their results confirm the hypothesis that well designed buildings require monetary premiums. Similarly, Shilton and Zaccaria (1994) also study office buildings except their hedonic model looks at the effect of the presence of neighborhood landmarks, select avenue addresses and building size in Manhattan. They look at midtown office buildings sales transactions between 1980 and 1990 and discover that proximity to landmarks such as Grand Central Station and Bryant Park substantially influences price. However, the avenue effect has a limited influence on the value of office buildings in Manhattan. Some researchers have also studied the economic benefits of urban cultural amenities. Clark and Kahn (1988) employ a two-stage hedonic wage model to derive the benefits of five cultural amenities including theaters, museums, zoos, and symphony halls. The results of their study demonstrate that many cultural amenities are important in the *intercity* choice of location.

Advances in computer and mapping technology have now made it easier to include proximity measures in hedonic models. Proximity to urban amenities is a significant component of neighborhood attributes. Geographical Information Systems (GIS), a software program that enables researchers to easily calculate distances between addresses and physical landmarks such as water, parks, and specific buildings has made the process more efficient by automating all distance calculations. Carroll et al. (1996) uses GIS to study the effect of proximity to churches on residential values in Henderson, Nevada. They find that churches of many different denominations all seem to have a positive effect on property values. Adair et al. (2000) use GIS to examine housing prices and accessibility in the Belfast, Ireland. Using transaction data from a sample of over 2000 residential properties sold during 1996, they implement GIS to measure properties' distance to workplace, shopping centers, and educational establishments. Their results are mixed; the variance in house prices across all Belfast that can be explained by accessibility is low, less than 2%. However in regions of lower income, this effect is magnified, implying that transport accessibility is more important for households whose income constrains car ownership/use and residential location choice. Paterson and Boyle (2002) use GIS to create a set of visibility indicators. They discover that the effect of living near a recreational amenity such as a lake is significantly greater if the amenity is in visible range. They also study disamenities such as new development which may lower property values. By creating visual indicators which determine if the disamenity is physically visible from the property, they find that these disamenities only detract from sales price if directly observable. Hence, GIS computer software has enabled researchers to study a plethora of new types of amenities that would otherwise have been too arduous to measure.

Because environmental amenities, neighborhood characteristics, and proximity measurements have all individually been found to be significant determinants of property values, Li and Brown (1980) do a comprehensive study of neighborhood characteristics including visual quality, noise pollution, proximity to industries and commercial establishments, using detailed data to estimate the influence of these micro-neighborhood factors on housing prices. They include variables such as distance to oceans, rivers, recreation areas, quality of school system. Their empirical results show that all of the included proximity measures were statistically significant. Furthermore they find that income is positive and significant in the absence of these micro-neighborhood characteristics, but when these characteristics are included, income becomes insignificant. This leads to the conclusion that income and other socioeconomic measurements were actually acting as proxies for many of the micro-neighborhood characteristics. Their work is furthered by Cheshire and Sheppard (1995), which I mention earlier. Cheshire and Sheppard also include several locational amenities in their hedonic regression. They expand a bare bones hedonic model by adding layer after layer of location and neighborhood specific characteristics. Their results demonstrate the importance of location specific amenities, discovering that the market price of land not only reflects the price of land as a space with a particular level of accessibility to certain amenities, but also reflects the net value of neighborhood characteristics, local public goods, and all other non-structural specific characteristics of the property.

Because real estate property location is inherently a spatial choice, some studies have also looked at how the estimated hedonic prices can vary spatially by neighborhood. Traditional hedonic papers treat determinants of housing in fixed coefficient specifications. Such an assumption implies that these marginal prices of property characteristics carry the same weight across all neighborhoods in a particular sample. However, as mentioned earlier in Adair et al. (2000), the authors find that the effect of accessibility on housing price varies by sub-market. Can (1990) also overcomes this assumption and attempts to account for "spatial dynamics operating in local urban housing markets." By allowing for the quantification of neighborhood effects, they conclude that the contribution of various housing attributes varies spatially by neighborhood.

While Can (1990) tackles the inter-neighborhood spatial variations in coefficients for property characteristics, Edmonds (1985) analyzes the inter-temporal variances of hedonic price functions. The author studies price, site, and location characteristics of residential lots in Tokyo, Japan. The regressions they run on sales between 1970 and 1975 provide evidence of inter-temporal structural changes in the hedonic price function. In a more recent paper, Costa and Kahn (2003) examines the rising nature of implicit prices for non-market public goods. They claim that rising income has made normal goods such as safety, health, climate, and the environment more valuable, hence increasing demand for such amenities. In this study, they specifically look at the value of living in a temperate climate; supplies of this natural phenomenon are static and cannot change over time. They look at data from 1970, 1980, 1990, and 1999 with a vector for housing characteristics and vector for climate controls. Across all years, they discover that the price of owning a home in regions with warm January and cool July temperatures has increased significantly. In other words, the cost of purchasing homes in temperate climates is rising over time and hence they speculate that other non-market goods have experienced a similar appreciation.

In general there is a lack of hedonic property research applied to Manhattan. Furthermore, most hedonic literature focuses on cross-sectional snapshots of data in certain years. Kahn and Costa (2003) show preliminary results by running regressions in four time periods and observing the increasing price of climate as an environmental good. However, no studies have attempted to look at the changes in implicit prices of urban amenities in yearly increments over a long time period. This study hopes to add to the hedonic literature by studying the monetary impact of a set of urban amenities on Manhattan condominium transactions over the last two decades. Time period regressions can offer insight into how the degree to which urban amenities are capitalized in real estate may or may not change over time in response to changing economic conditions. A better understanding of the intertemporal stability of hedonic prices will also improve the accuracy of housing and quality of life indices.

Theoretical Foundation

I will now provide a concise overview of the hedonic theory. Critical to Rosen's framework first published in 1974, is an understanding of the difference between explicit and implicit markets. For example, we can consider the automobile market as an explicit market with observed prices and transactions. However, while they are traded in a single market, cars are very heterogeneous goods. They are characterized by a range of prices corresponding to quality and attributes. Hence, we should look at the automobile not as a single entity, but rather as a bundle of characteristics. This idea was first proposed by Kelvin Lancaster (1966) who believed that our utility is generated not by the goods themselves, but rather the *characteristics* of those goods. When deciding which car to buy, we consider each of these different characteristics such as airbags, leather seating, navigation system, and horsepower. We then decide which attributes we value most and purchase the car whose "bundle" of attributes yields the highest utility. The notion of implicit markets hence is the production and consumption of those features of the car, making up the "bundle" which is explicitly traded in the market place. The hedonic approach provides a methodology for econometrically estimating and identifying the structure of the prices for these implicit attributes. By examining the explicit market for the price of these bundles of characteristics, the hedonic method can estimate the prices of the individual attributes that compose the "bundle."

In the estimation of the hedonic price function applied to real estate, consumers are assumed to derive and maximize utility from the consumption of a house that embodies a vector Z of N characteristics, plus the consumption of a composite commodity representing all other goods, X. This heterogeneous commodity must be traded in a perfectly competitive market in which both buyers and sellers have perfect and full information. The preferences of the household can thus be represented by the utility function

$$U = u(\mathrm{Z}, \mathrm{X}, \alpha)$$

where α is a vector of demographic characteristics that describe the household. Assuming that the household faces a price function P(Z) for the house with characteristics Z and fixed income I, we can then assume a budget constraint

$$I = X + P(Z)$$

According to this budget constraint, the household will maximize utility by choosing a house with characteristics Z and an amount of X to purchase. Put another way:

$$\max u(Z, Y, \alpha) \text{ subject to } I \geq P(Z) + X$$

The derivative of P with respect to each of the characteristics gives us the hedonic implicit price and the function P(Z) is the hedonic price function. On the supply side, each producer equates the marginal cost of each characteristic to its hedonic price. Producers will build houses until the marginal cost of building another house of type Z is equal to the value of the house P(Z). Sellers of existing housing stock are just a special type of producer whose cost function is determined by the costs of house repair and remodeling. When prices equalize demand and supply of every home Z, the market is in equilibrium; marginal cost curves are tangent to marginal price curves. Because the hedonic function involves the interaction between supply and demand, the resulting implicit price does not convey any fundamental information on the drivers of that price.

The estimation of the hedonic price function marks the completion of the first step of Rosen's framework. The hedonic price function can then be used as an input in an analysis of the consumer demand for specific attributes of the house. The second stage of the Rosen's framework uses the prices obtained in the hedonic price function to estimate a complete demand curve. Few studies have successfully estimated the structure of this demand and most have encountered difficulties arising from endogeneity and the non-linearity of the household budget. Without household demographic and income data, the second stage of Rosen's framework is thus, beyond the scope of this paper. Furthermore, the second stage would introduce an entirely new set of econometric and estimation problems.

Model

As I briefly overview above, the hedonic price function will help us recover the implicit prices for urban amenities such as Central Park, Hudson River views, and convenience to Wall Street. Now that we understand theoretical underpinnings of the hedonic framework, I will now derive the econometric model I plan to use. The dependent variable must be some form of condominium price. At the most basic level:

$Y = f(S, N, L)$, where

Y = Condominium Price

S = Structural characteristics (ex: rooms, age, fireplace, floor)

N = Neighborhood Characteristics (ex: school district, historic designation)

L = Locational Amenities (ex: Proximity to Central Park, Wall Street)

I adopt the commonly applied semi-logarthmic functional form and collapse the condominium transactions into a single vector X to rewrite the price function as the following:

$$Y = e^{x\beta\varepsilon}$$

so that

$$\ln Y = X\beta + \varepsilon$$

expanded out

$$\ln Y = \beta_0 + S\beta_1 + N\beta_2 + L\beta_3 + \varepsilon$$

where β's are the coefficients corresponding to the hedonic prices. The log-linear form has many attractive features. For example, the coefficients are easily interpretable. The logarithmic transformation implies that the coefficients are essentially percentages. For example, an increase in the number of rooms from 1 to 2 would imply that the condominium price would increase by a percentage $\beta*100$. The dollar price of any single characteristic would vary with the level of the characteristic as well as with the level of other characteristics of the properties. Hence, it implies that prices are non linear. If we employed a purely linear model, the price of adding an additional room would be the same for both a cramped studio apartment and a 15-bedroom penthouse apartment. Such a conclusion is highly unlikely. The semi log approach allows condominium price to vary proportionally depending on the levels of existing characteristics.

In the initial regressions that I present later in this paper, I regress each amenity separately on condominium price. Common to all regressions are basic housing characteristics such as rooms, floor of unit, and total square footage. I originally included yearbuilt to account for the age of the building but very few observations included this variable, so I have excluded it from the regression. I also create year dummies for every year except 1985 which I treat as my base year. Within each regression, I interact the amenity variable with the year. By creating amenity-year interaction dummy variables, I can test the hypothesis that the effect of certain amenities may be stronger or weaker in certain years. Thus, the proposed regression not only can estimate the level effect of the amenity but also how the level effect might have changed over the time period from 1985 to 2002. Below is an example of the specification I use for each amenity:

$$\text{Ln } Y = \beta_0 + \text{Rooms}\beta_1 + \text{Unitsf}\beta_2 + \text{Floor}\beta_3 + \text{Amenity}\beta_4 +$$

$$\text{Amenity*Year1986}\alpha\ldots \text{ Amenity*Year2002}\alpha + \text{Year1986}\gamma\ldots\text{Year2002}\gamma + \varepsilon$$

By including year dummies, I also introduce a time fixed effects component. These additional dummies will eliminate omitted variable bias arising from unobserved variables that are constant across entities but evolve over time. For example, any unobserved bias caused by general trends in real estate and inflation that affect all real estate prices will therefore be controlled for in the regression. The estimated coefficients for the amenities interacted with year dummies will thus ostensibly translate into the effect of that amenity on price regardless of any time specific trends that may have occurred in a particular year.

Data

The data set that I will be using was obtained through Raven E. Saks of the Federal Reserve Board New York, originally compiled for a different study. The source of the data is the real estate research company First American Realty's RealQuestPro database. The data includes every condominium transaction on file from the New York Recorders office in 2002. The data is not a time series in that it does not observe specific properties over time. Rather it is a cross section of all condominium sales observed in individual years. Although Manhattan real estate is typically divided into two types of housing: cooperative and condominium ownership, I choose to limit my sample to only condominium transactions. Cooperative sales transactions are harder to implement because of the many rules and laws that the co-op board forces upon its residents, leading to distorted pricing. By only looking at condominiums, we also avoid having to account for the legal and tax implications of cooperative housing. Furthermore, condominiums have become an increasingly popular alternative to co-op housing in Manhattan, providing enough observations for a hedonic study. The observations in this data set span as early as 1922 and end at 2002 for a grand total of 44,774. With this data set, I then used the program ArcGis to geocode each individual condominium address to a digital map interface. With the help of GIS specialist Jeff Blossom at the Center for Geographical Analysis, we examined every observation for quality control to ensure that the addresses were connected to the correct location. Most problems encountered were mainly recording errors. For example an avenue might have been recorded as a street, confusing the computer program. After adjusting and accounting for these discrepancies, we were able to successfully geocode 37,979 addresses. Once geocoded, we began the proximity calculations. We included distances to Wall Street, Central Park, Park Avenue, Fifth Avenue, and any large water body (ex: Hudson River). Our proximity calculations were point-to-point measurements rather than the distance required for road travel. Since most people walk or use public transportation in Manhattan, a point-to-point calculation would be more relevant than a road network calculation. We also created binary variables to indicate whether the property was located at an address directly on Central Park or directly on a water body. Finally, we mapped every address into a Manhattan neighborhood map found online.

To get a better understanding of the data, I created five maps of the geocoded data (see appendix). Each map is divided into five year time periods (1980-1984, 1985-1989, 1990-1994, 1995-1999) except for the last time period, which is only three years (2000-2002). Each circle corresponds to the location of a condominium transaction. The size of the dot relates the location to the proportional monetary size of the transaction (use the legend as a guide to which size corresponds to which price ranges). These maps also show a relatively widespread spatial distribution of condominium sales. The results are also consistent with what one would expect given knowledge of Manhattan's residential real estate markets. Historically residential regions such as the Upper East and West side are the most consistently condo-populated areas. Midtown has historically been a space reserved for commercial office buildings and consequently people have chosen not to live there. Looking at the maps, one can also see which areas seem to have changed over time in terms of condominium sales. Midtown east has become more residential with the growth and development of Murray Hill and Sutton Place. Downtown has also seen an increase in condominium transactions both in terms of volume and price, especially in the West Village, Meatpacking and SOHO neighborhoods. As of 2002, condominium sales in the Financial District still seem limited compared to the rest of Manhattan.

In the entire time span of successfully geocoded observations, there were a total of 29,366 condominium transactions recorded that have a year attributed. For the purposes of this study, I only include transactions that occur between 1985 and 2002, thus bringing the total number of observations with year and price to 26,870. Prior to this time period, there were not enough annual transactions to estimate reliable coefficients (Refer to Table 1). With regards to the proximity variables, I adjusted the units on these distance measurements to larger units. The original calculations were in meters and I adjusted the measurements so that one unit equals 200 meters, the approximate width of an avenue in Manhattan. Refer to Table 2 for a complete summary statistics of variables included in my regressions.

Table 1: Number of condominium transactions by year

YEAR	No. of Obs.	Percent	Cum.
1922-1980	318	1.07	1.07
1980	57	0.19	1.28
1981	93	0.32	1.59
1982	346	1.18	2.77
1983	551	1.88	4.65
1984	737	2.51	7.16
1985	1,116	3.8	10.96
1986	1,374	4.68	15.64
1987	1,964	6.69	22.33
1988	2,197	7.48	29.81
1989	1,713	5.83	35.64
1990	1,087	3.7	39.34
1991	935	3.18	42.53
1992	945	3.22	45.74
1993	52	0.18	45.92
1994	99	0.34	46.26
1995	364	1.24	47.50
1996	1,712	5.83	53.33
1997	1,551	5.28	58.61
1998	2,699	9.19	67.80
1999	3,293	11.21	79.01
2000	2,677	9.12	88.13
2001	2,189	7.45	95.58
2002	1,297	4.42	100.00
Total	29,366	100	

Table 2: Summary statistics for included variables

Variable	Observations	Mean	Standard Dev.	Minimum	Maximum
Year	27264	1994.434	5.597832	1985	2002
Price	26870	565763.9	3762631	500	448,000,000
Structural Characteristics					
Rooms	18098	3.677423	10.5742	1	588
Unitsf	20001	4667.27	103846.8	101	9999999
Floor	24944	13.90543	11.57841	1	78
Locational Proximity Amenities					
Walldisblock	27264	31.02716	13.74555	0.3326873	102.4067
cenparkdis~k	27264	9.405288	9.920605	0.000256	46.40552
waterdisbl~k	27264	3.883345	1.95664	0.441747	8.261131
parkavedis~k	27264	5.303329	4.78967	0.003323	37.23326
_42nd_disb~k	27264	11.47	8.357434	0.0099036	73.82182
Locational Dummy Amenities					
Waterbin	27264	0.0133509	0.1147745	0	1
Cenparkbin	27264	0.0382923	0.1919044	0	1
Parkavebin	27264	0.0186693	0.1353567	0	1

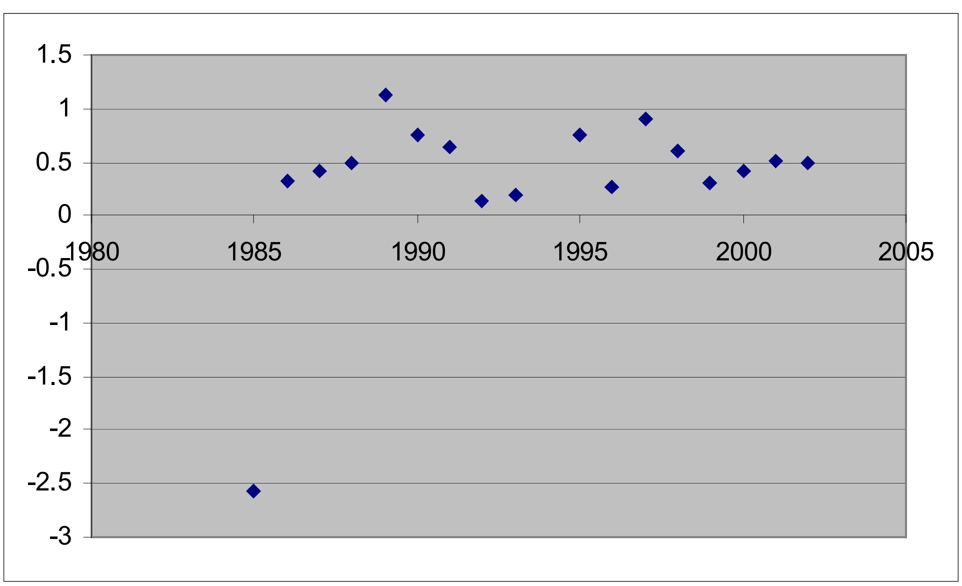
Empirical Results

At my advisor's suggestion, I first ran regressions on each amenity individually to understand how each amenity related to condominium price. The first amenity regressed is a Central Park Binary which equals 1 if the property is located on one of the four streets which border Central Park (Central Park West, Central Park South, Central Park North, and Fifth Avenue) and 0 if the property is located anywhere else in Manhattan. Structural characteristics I included in this regression were number of rooms and floor of the unit. I took out unit square feet after the first regression run because it was insignificant and the coefficient was very small (I plan to analyze this discrepancy in more detail later). As expected, the number of rooms has a large positive effect on condominium price. The coefficient of .1907 indicates that for every additional room, the condominium price increases by nearly 20%. The coefficient for the variable floor also has a significant effect on price, about 2.1% for any increase in the floor number. Both of these housing characteristics are statistically significant at the 1% level. To better understand the time component of this regression, I have graphed the combined estimated coefficients for the effect of CenParkBin by year. The results indicate that in year 1985, the effect of living on Central Park decreased a condominium sale price by 257%. This conclusion seems ludicrous and some anomaly in my data for 1985 must be driving this odd result (I plan to take a closer look at 1985 sales later this month). However, the effect of living on Central Park in year 1986 makes much more sense. The total effect in year 1986 is equal to the effect in year 1985 plus the coefficient on the amenity-year interaction term in 1986, or .326. In other words in year 1986, on average if the property was located on a street bordering Central Park, the condominium price would be 32.6% higher than otherwise. Looking at the significance levels however, all of the interaction terms and the base Central Park Binary term are statistically insignificant, thus implying that the effect of living on Central Park in all years is insignificant. However, despite these unpromising significance levels, the magnitude and signs except for 1985 all point in the correct directions. Refer to Table 1a and Graph 1a for more detailed results.

Table 1a: Central Park Binary Amenity (1985-2002) with Year Fixed Effects

Central Park Binary with Year Fixed Effects		
Number of Obs	17080	
R-squared	0.4429	
Lnprice	Coef.	Robust Standard Error
Rooms	0.190714*	0.0184726
Floor	0.0210765*	0.0005724
Cenparkbin	-2.578442	2.345376
cenparkbi~86	2.904305	2.345852
cenparkbi~87	3.001432	2.345113
cenparkbi~88	3.074304	2.346772
cenparkbi~89	3.708419	2.349307
cenparkbi~90	3.33718	2.353032
cenparkbi~91	3.217798	2.352544
cenparkbi~92	2.713661	2.351154
cenparkbin~93	2.768409	2.361277
cenparkbin~94	(dropped)	
cenparkbin~95	3.340366	2.365015
cenparkbi~96	2.849778	2.350728
cenparkbi~97	3.473077	2.344857
cenparkbi~98	3.173224	2.346344
Cenparkbi~99	2.886485	2.34671
Cenparkbi~00	2.990563	2.347363
Cenparkbi~01	3.091953	2.34678
Cenparkbi~02	3.07561	2.347469
_cons	11.27574	0.1269895

Graph 1a: Combined effect of CenParkBin by year



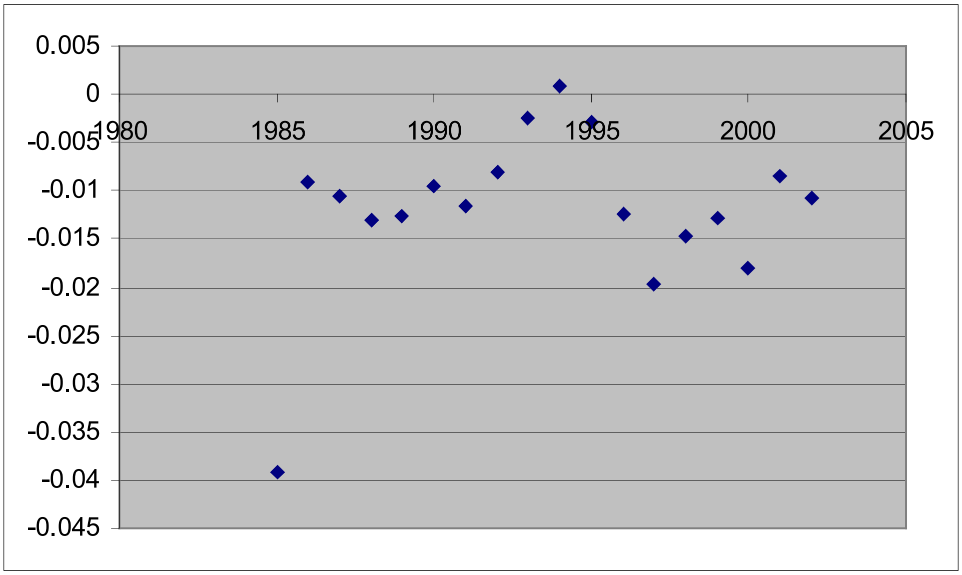
A few interesting points to note about Graph 1a. Disregarding year 1985 for right now, from 1986 to 2002, the graph seems to follow an unusually cyclical pattern. In fact, the effect of living on Central Park on price seems to increase significantly during economic boom years and decrease significantly during economic recession periods. The coefficients seem to approximate quite closely the business cycles during the late 1980s and 1990s, particularly the drastic real estate decline in the early 1990s. This conclusion is unexpected given that year fixed effects are included in this regression which should have accounted for any general real estate time-related trends. I will discuss the implications of this finding in more detail in the next section of this paper.

The next regression I show in this paper is the proximity effect of Central Park on condominium price. Whereas the Central Park Binary variable is more likely to account for direct views of Central Park, the proximity to Central Park is more likely to account for the Central Park's benefit as a recreational amenity. Because the coefficient is now continuous, the interpretation is a bit more complex. For every unit increase of CenParkBlockDis variable, the condominium is located a unit farther away from Central Park. Thus the interpretation of the coefficient is inversed. We would expect that the coefficient would be negative, implying that for every 200 meter unit increase in the distance to Central Park, there would be a corresponding negative hit to the condominium price. As expected, the coefficient on CenParkDis base year 1985 is negative with a magnitude of .039, implying that for every 200 meter increase in the distance from Central Park, the condominium price on average declines by approximately 4%. Furthermore, this coefficient is statistically significant at the 1% level. The structural characteristics, number of rooms and floor number continue to be statistically significant as well. Refer to Table 1b and Graph 1b for more details.

Table 1b: Central Park Proximity Amenity (1985-2002) with year fixed effects

Central Park Proximity with year fixed effects		
Number of Observations	17080	
R-Squared	0.4564	
Lnprice	Coef.	Robust Standed Error
Rooms	0.18821*	0.0186667
Floor	0.018782*	0.0005741
cenparkdis~k	-0.03916*	0.0038141
cenparkdi~86	0.029976*	0.0042934
cenparkdi~87	0.028616*	0.0039726
cenparkdi~88	0.026117*	0.0039306
cenparkdi~89	0.026547*	0.0041566
cenparkdi~90	0.029636*	0.004417
cenparkdi~91	0.027543*	0.0043094
cenparkdi~92	0.031004*	0.0044903
cenparkdis~93	0.036767*	0.0111719
cenparkdis~94	0.039969*	0.0074731
cenparkdis~95	0.03626*	0.0067088
cenparkdi~96	0.026727*	0.0046468
cenparkdi~97	0.019519*	0.004535
cenparkdi~98	0.024532*	0.0041067
cenparkdi~99	0.02622*	0.0041015
cenparkdi~00	0.02107*	0.0044117
cenparkdi~01	0.030768*	0.0043367
cenparkdi~02	0.028447*	0.0041688
_cons	11.3131	0.169673

Graph 1b: Combined effect of Central Park proximity by year



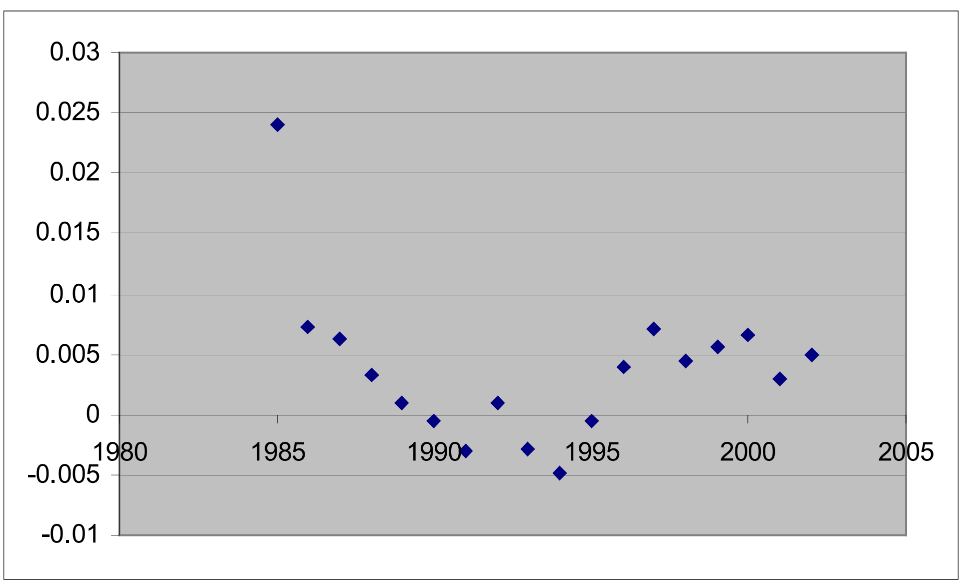
With regards to the effect of CenParkBlockDis over time, the similar inverse interpretation applies. An increase in the price of living closer to Central Park would imply that the price of living of further away from Central Park becomes greater in absolute terms, hence creating an increasingly larger negative hit on condominium price. As in the CenParkBin regression results, we see another abnormal effect in year 1985. In year 1985, the coefficient implies a 4% decline with a unit increase in CenParkDis. However, the combined effect in year 1986 jumps significantly to only a 1% effect on price. Again, the data in year 1985 must be examined more closely to understand the underlying drivers of such drastic differences between 1985 and 1986. Given the cyclical nature of coefficients in the CenParkBin regression, it is not surprising that we see a similar cyclical result in this proximity analysis. In fact, as you can see the cyclical nature seems to be magnified in this regression. Between the years 1986 and 1989, the effect of living further away from Central Park seems to increase in absolute value in the negative direction. In other words, this trend implies that the price of living closer to Central Park has increased. Between 1990 and 1994, the downward trend reverses, implying that the price of living closer to Central Park decreases. From 1995 to 1997, the price increases and from 1997 onwards the trend is more ambiguous. These up and down trends like the cycles found in the previous CenParkBin regression seem to reflect the economic booms and recession periods during these years. Also note that nearly all variables including the amenity-year interaction terms are significant at the 1% level. However, it also must be noted that the significance can partially attributed to the behavior in 1985. The T statistics on the amenity-year interaction variables tests whether that year in particular is significantly different from the base year. If there were abnormal behavior occurring in the base year, then it would follow that subsequent years would all be statistically different. I reran the regressions from 1986 onwards to see if the significance levels dropped and as expected they did but many were still significant.

Finally, the last regression I show here is one that focuses on proximity to Wall Street. The coefficients are interpreted in the exact same manner as the coefficients for the proximity to Central Park variables. Similarly, we use a base year of 1985 and interact the amenity with year from 1986 to 2002. All variables including the amenity-year interaction terms are statistically significant at the 1% level. We can interpret that the coefficient on WallStreetDis in the base year, .024 means for every 200 meters away from Wall Street the condominium price on average increases by 2.4%. In year 1986, the combined effect for living an additional 200 meters further away from Wall Street, implies a price increase of approximately .7%. Refer to Table 1c and Graph 1c for more details.

Table 1c: Wall Street Proximity Amenity (1985-2002) with year fixed effects

Wall Street Proximity with year fixed effects		
Number of Observations	17080	
R-Squared	0.4387	
Lnprice	Coef.	Robust Std. Errors
rooms	0.18766*	0.0186808
Floor	0.020807*	0.0005798
walldisblock	0.024006*	0.0027069
walldis~1986	-0.01678*	0.0030479
walldis~1987	-0.01781*	0.002941
walldis~1988	-0.02076*	0.0029252
walldis~1989	-0.02303*	0.002996
walldis~1990	-0.02457*	0.0030765
walldis~1991	-0.02709*	0.0033111
walldis~1992	-0.02297*	0.0035067
walldis~1993	-0.02683*	0.009448
walldis~1994	-0.02889*	0.0102329
walldis~1995	-0.02448*	0.0045308
walldis~1996	-0.02001*	0.0039324
walldis~1997	-0.01691*	0.0040345
walldis~1998	-0.01955*	0.0031083
walldis~1999	-0.0184*	0.0030526
walldis~2000	-0.01748*	0.0033821
walldis~2001	-0.02106*	0.0031466
walldis~2002	-0.01907*	0.00319
_cons	11.44918*	0.2462621

Graph 1c: Combined effect of Wall Street proximity by year



The trend for the Wall Street proximity effect across all years again is quite astounding. The effect in year 1985 seems drastically different and may be the result of abnormal data in that particular year. Nevertheless, from year 1986 to 1991 there is a clear downward trend in the implicit price of living further away from Wall Street, implying that the price of living closer to Wall Street increased during this period. The time period from 1991 to 1994 is more ambiguous. From 1994 to 1998, the is a clear increasing trend in the marginal price, implying that the price of living closer to Wall Street, decreased during this period.

In addition to the regressions discussed here, I also ran similar regressions for the following amenities: water binary, waterdis, parkavedis, midtown proximity, and floor. Many of these amenities showed a similar cyclical nature. However, the water binary regression acted very strangely across years and I think the reason for this was the simple lack of condominium transactions that bordered water bodies during the entire time period. The floor variable and corresponding year-floor interactions showed a downward trend, implying that the price of living on a higher floor has decreased consistently over the time period. I have included the results of these regressions in the appendix section.

Implications, Conclusions, Next Steps

The original hypothesis of this paper was that the implicit price of many of these urban amenities had increased substantially over the last two decades. Exclusive amenities such as views of Central Park and Hudson River were in short supply and highly sought after. The substantial increase in the wealth of Manhattan would drive large increases in demand for these types of amenities. Consequently, we believed that we would observe an increasing trend in the price of living directly on Central Park. The implications of the results however, indicate that the implicit prices for many of these amenities have remained constant. In addition to the amenity-year interaction variables, I also de-trended the data by creating a variable Year – 1985 and interacted the trend variable by each amenity. Not surprisingly, this interaction variable was insignificant in all specifications. Nevertheless, the results of the regressions do uncover some unexpected results. Perhaps the easiest to interpret regression is the Central Park Binary amenity. The hedonic prices of living directly on Central Park seem to follow the business cycles, even when time fixed effects are included in the regression. The hedonic price increases during economic boom periods and subsequently decreases during economic recession periods. Because these results are robust to year fixed effects, these findings imply that the condominiums located directly on Central Park show more price volatility than the rest of real estate in Manhattan. During economic booms, condominiums bordering Central Park seem to appreciate more than the rest of Manhattan. Correspondingly, during economic recessions such as the one in the early nineties, condominiums bordering Central Park seem to feel the effects of the housing downturn more than other condominiums in Manhattan. What are the drivers for these results? Because the hedonic price function equates both supply and demand simultaneously, it is very difficult to disentangle these two forces.

Unpacking and understanding the reasons for the cyclical nature of these implicit prices is one of the next steps for this study. Can it be explained by the types of buyers for Central Park condominiums? Perhaps buyers for these properties are more likely to speculate on the price of their homes hence driving up prices? However, when the stock market crashes, significantly depleting their wealth, they consequently have to sell their condominiums at a discount on the market. I hope to eventually include additional variables such as a stock market index or annual gross domestic product to disaggregate the different time effects that may be going on.

In addition, I hope to find more urban amenities to measure. I will look at proximity to subway stations in New York and how public transportation is capitalized into real estate prices. I will also conduct a thorough study of the role of neighborhoods in Manhattan. The effect of many of these urban amenities may vary spatially by neighborhood and I would like to study this effect. If results show that real estate in different neighborhoods do indeed appreciate at different rates, I will attempt to unpack this effect by examining what makes each neighborhood unique. I will look at variables such as school district, historical designation, business density, and proximity to cultural destinations.

With regards to the current specifications shown in this paper, some further research must be performed as well. I must get a better understanding of why my data in year 1985 is acting so strangely. I must also examine the variable unitsf and why it does not seem to be a good determinant of price. I also must tackle the complex problem of spatial autocorrelation and dependence. Hedonic price functions applied to housing markets are especially vulnerable to this econometric problem for a few reasons. Neighborhoods and condominiums in similar regions are often developed during the same time periods, with similar characteristics such as size and age. Furthermore, many of the condominiums in the same neighborhoods share similar locational amenities. Hence, the price of a condominium in Manhattan will inevitably depend on its neighbors. The result of this spatial dependency implies spatial autocorrelation in the residuals, thus breaking the ordinary least square's assumption that all observations are independent and identically distributed. Consequently, the model will systematically overestimate values in certain neighborhoods while underestimating values in other neighborhoods. These violations of the ordinary least squares model imply that parameter estimates may be inefficient with inaccurate confidence intervals. In the case of positive spatial autocorrelation, significance tests will look overly optimistic due to the underestimated standard errors of the coefficients. Basu and Thibodeau (1998) account for the role of spatial autocorrelation in their analysis of single-family home transactions in Dallas, Texas. They find evidence of spatial autocorrelation in all eight of the submarkets they analyze. They conclude that using statistical methods to account for spatial dependency significantly improves the accuracy of the hedonic price function. I hope to study the possible effect of spatial autocorrelation in my data set in the next coming weeks as well. A possible way to correct for spatial autocorrelation would be to cluster by neighborhood which would account for within group correlation in the standard errors.

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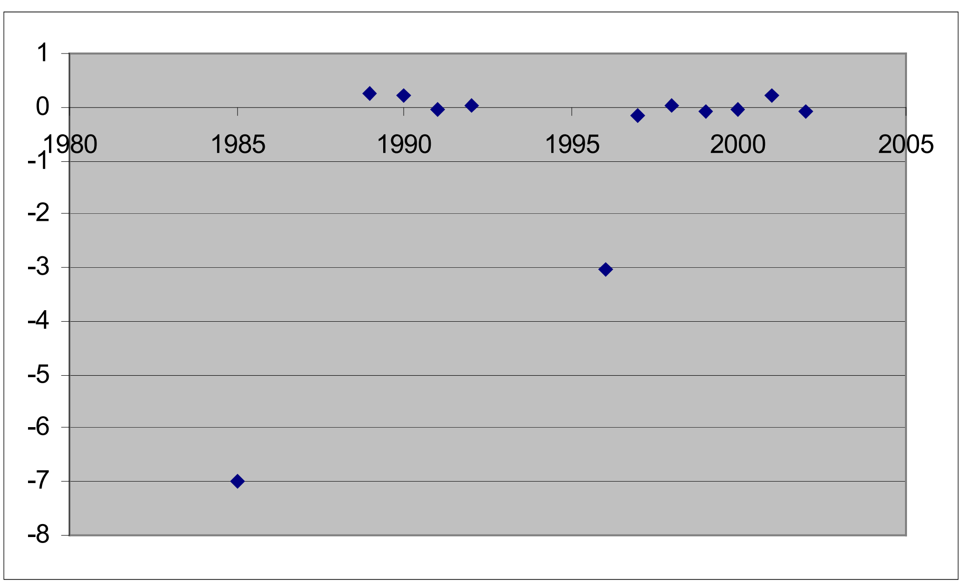
Appendix Section

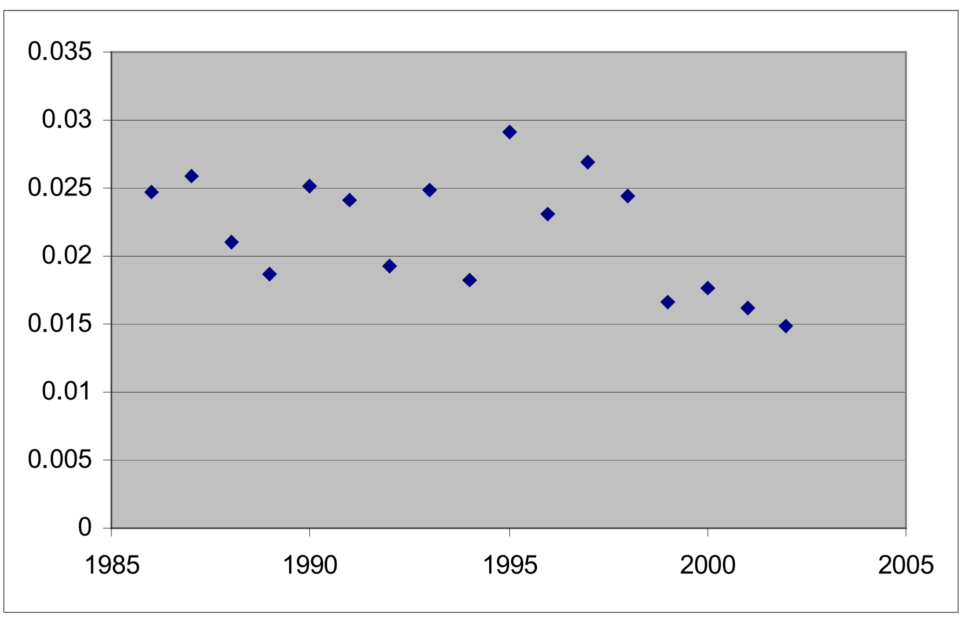
Water Binary

Water Binary with year fixed effects		
Number of Obs	17080	
R-Squared	0.4333	
lnprice	Coef.	Std. Err.
rooms	0.200152*	0.018821
floor	0.021039*	0.00059
waterbin	-7.00328*	0.750889
waterbin1986	(dropped)	
waterbin1987	(dropped)	
waterbin1988	(dropped)	
waterbin1989	7.275011*	0.754711
waterbin1990	7.234449*	0.753278
waterbin1991	6.958611*	0.743486
waterbin1992	7.027895*	0.753168
waterbin1993	(dropped)	
waterbin1994	(dropped)	
waterbin1995	(dropped)	
waterbin1996	3.97459*	1.915442
waterbin1997	6.830916*	0.752418
waterbin1998	7.019086*	0.751193
waterbin1999	6.93249*	0.756696
waterbin2000	6.971577*	0.792446
waterbin2001	7.219268*	0.757692
waterbin2002	6.923268*	0.761307
_cons	11.35833	0.09073



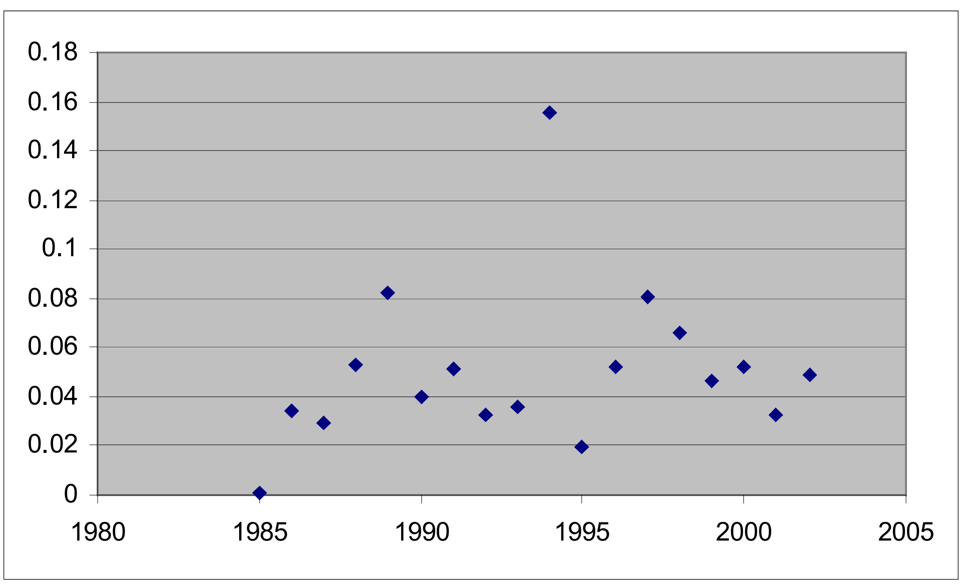
Floor Amenity

Floor with year fixed effects		
Number of Obs		
R-Squared		
lnprice	Coef.	Std. Err.
rooms	0.189037*	0.018737
floor	0.035431*	0.00224
floor1986	-0.01078*	0.003382
floor1987	-0.00957*	0.002525
floor1988	-0.01435*	0.002396
floor1989	-0.01674*	0.002381
floor1990	-0.0103*	0.003147
floor1991	-0.01126*	0.003944
floor1992	-0.01618*	0.002867
floor1993	-0.01064	0.010566
floor1994	-0.01715*	0.006614
floor1995	-0.00631	0.006478
floor1996	-0.0124*	0.002936
floor1997	-0.0085*	0.002979
floor1998	-0.01096*	0.002497
floor1999	-0.01876*	0.002436
floor2000	-0.01783*	0.002631
floor2001	-0.01926*	0.002506
floor2002	-0.02065*	0.00259
_cons	11.32493*	0.180173



Water Proximity

Water Proximity with year fixed effects		
Number of Obs	17080	
R-Squared	0.4443	
lnprice	Coef.	Std. Err.
rooms	0.193387*	0.018866
floor	0.019877*	0.000595
waterdisbl~k	0.000606	0.015605
waterdi~1986	0.033581*	0.017105
waterdi~1987	0.02908	0.016595
waterdi~1988	0.052267*	0.016375
waterdi~1989	0.08195*	0.017941
waterdi~1990	0.039573*	0.019395
waterdi~1991	0.050541*	0.019662
waterdi~1992	0.031736	0.019299
waterdi~1993	0.035273	0.04949
waterdi~1994	0.154865	0.0903
waterdi~1995	0.019298	0.0367
waterdi~1996	0.051339*	0.019219
waterdi~1997	0.080305*	0.02023
waterdi~1998	0.065469*	0.017362
waterdi~1999	0.045789*	0.016679
waterdi~2000	0.051843*	0.0174
waterdi~2001	0.031711*	0.017516
waterdi~2002	0.047959*	0.017646
_cons	10.71216*	0.426709



Park Avenue Proximity

Park Avenue Proximity with year fixed effects		
Number of Obs.	17080	
R-Squared	0.4417	
lnprice	Coef.	Std. Err.
rooms	0.189529*	0.018733
floor	0.01987*	0.000586
parkavedis~k	-0.05213*	0.008306
parkavedi~86	0.042346*	0.009012
parkavedi~87	0.04923*	0.008619
parkavedi~88	0.032477*	0.008502
parkavedi~89	0.040358*	0.008696
parkavedi~90	0.038284*	0.008983
parkavedi~91	0.029679*	0.009243
parkavedi~92	0.036187*	0.009745
parkavedis~93	0.039552	0.024613
parkavedis~94	0.037923	0.026563
parkavedis~95	0.062085*	0.01534
parkavedi~96	0.031806*	0.010702
parkavedi~97	0.024058*	0.010298
parkavedi~98	0.026172*	0.008884
parkavedi~99	0.033295*	0.008855
parkavedi~00	0.028611*	0.0093
parkavedi~01	0.047085*	0.009213
parkavedi~02	0.033283*	0.008906
_cons	11.37359	0.112751