Is a High-quality Park Worth the Cost? : Hedonic Analysis of Housing Market near the High Line, New York City

고급화 공원의 경제성 : 뉴욕 하이라인의 헤도닉 분석

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국문요약

이 연구는 뉴욕 하이라인의 부동산 가격 상승 영향 분석을 통해, 어메니티 고급화 전략이 부동산 시장 활성화를 유도할 수 있는지에 대한 해답을 모색함을 목적으로 한다. 먼저 Random-slope multilevel modeling (다층모형) 을 이용하여 하이라인 전, 후 기간의 부동산 가격 영향을 각기 분석한 뒤, 이를 이용해 재산세를 산출하여 비용 편익을 검토 하였다. 준공 후 하이라인에 의한 부동산 가격 상승 정도는 Census tract (인구 조사 표준 지역)에 따라 다르나, 100ft 접근당 최고 1.16% 으로 추산되며, 이는 준공 전 상황과 비교할 때 상당히 증가한 것이다. 이를 통해 환산한 재산세 증가는 2012 년 기준, 매해 미화 천팔백만 달러, 향후 20년간 이억 오천팔백만 달러가 회수될 것으로 예측되며, 이는 당초의 공사와 관리비를 상회한다. 그러나 이러한 경제적 가능성에도 불구하고, 유사한 전략을 전개하기에 앞서서는 경제적 영향 외에 사회적 영향, 그리고 적용가능성 분석이 선행되어야 한다.

키 워 드 ▪ 하이라인, 헤도닉 분석, 랜덤- 슬로프 다층모형, 재산세에의 영향
Keywords ▪ the High Line, hedonic price analysis, random-slope multilevel model, property tax implication

Ⅰ. Introduction- Park in the urban revitalization

In the post-industrial era, consumption-inducing economic sectors, such as tourism, entertainment and recreation industries, are considered alternative economic engines that filled the gap left by the loss of manufacturing (Hannigan, 2003; Clark, 2003; Clark, Lloyd, Wong & Jain, 2002; Judd & Fainstein, 1999). In addition to attracting tourists and visitors, these economic sectors are also expected to synergize the promotion of knowledge-intensive and creative industries, whose workforces are believed to favor certain urban atmospheres (Storper & Scott, 2009; Glaeser 2005; Florida, 2002).

Parks have gained attention in this new mission (Harnik, 2010). Cities such as Chicago and New York have developed destination parks to attract visitors and potential residents beyond the level that conventional parks normally did. The outstanding influence of such parks and open spaces generally depends on

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elaborately designed, upscale development, with higher than typical budgets. Chicago's former Mayor, Richard M. Daley, (in office; 1989 – 2011) conceived Millennium Park to reignite the dormant tourism industry, and employed a "shoot for the moon" strategy to maximize private donations to create the highest quality space (Gilfoyle & Chicago, p.97, 2006). Mayor Michael R. Bloomberg (in office; 2002 – 2013) also enlisted "unequaled amenities" (Brash, p.122, 2011) to distinguish New York City from other cities in the competition for the new elites, defined as creators of economic vitality.

The High Line, a public park converted from a former freight railway, is one of the "flagship parks" (New York City, 2007) that the city and its private partner, Friends of the High Line (FHL), actively used as a means to revitalize a declining neighborhood. According to the New York Times, the park has increased the visibility of the neighborhood, consequently inducing two billion dollars in private investment on real estate and creating 8,000 construction jobs, in addition to the non-monetary benefits of enhanced health and safety in the neighborhood (McGeehan, 2011).

The most direct benefits to the city, among many others, are higher property taxes, through the appreciation of existing properties and the addition of new ones. The increased tax revenue potentially equals the initial development costs of the park (Bolitzer & Netusil, 2000; Crompton, 2005), and also helps municipalities to continue improving the living and business environment of the city.

While the High Line's effect on the property market seems obvious from anecdotal evidence after the fact (Russell, 2011 among many), recent interest has not prompted quantitative research to corroborate such a claim. What is the magnitude of the proximity effect of the High Line on the nearby housing market, compared to the former state as an abandoned railway structure? What is the tax revenue implication of this transformation? And is it worth the cost?

In this study, I conduct a hedonic price analysis to answer these questions. Using random-slope multilevel modeling, I analyze the residential market transaction datasets from two time periods—"after" and "before"—further deducing the difference between the effects of the current High Line and of its preexisting condition, in order to reveal the amount of tax increment attributed to the High Line.

Ⅱ. Backgrounds

1. Historic background

The High Line is a 6.7-acre linear park nestled in West Chelsea and Meat Packing District, developed in parallel with a West Chelsea rezoning plan. West Chelsea-the former core of heavy manufacturing industry in New York- is located near the Hudson riverfront. The High Line used to be a part of West Side Freight Line, serving industries of the lower west side of Manhattan until 1980 (FHL, n.d.). After decades of abandonment, in 2004 the city government finally decided to pursue a public use of the High Line structure, and in 2005, approved the West Chelsea rezoning plan as a continuing endeavor to redevelop derelict manufacturing land for commercial and residential uses (New York City Department of City Planning, 2005).

The total development cost of the High Line was 152.3 million dollars for the first and second sections, currently in operation since 2009 and 2011, respectively. The third section is scheduled for completion in 2014 (FHL, n.d.), with a budget of 90 million dollars.

2. Methodological background : Random-slope multilevel modeling

Random-slope multilevel modeling is a primary analytical tool to derive a “park premium” in this study, as an alternative to traditional Ordinary Least Square (OLS) approach. Despite its common use in hedonic price modeling, the estimates of OLS strategy may be vulnerable to bias when certain assumptions are not satisfied. One of the most violation-prone assumptions is the rule of independence, in which individual cases are expected to be independent, and hence their corresponding residuals be random and uncorrelated. In many social science fields, however, the geographic location of cases interferes with meeting the independence assumption, due to autocorrelation between members in higher-level groups (Cohen & Cohen, 2003; Rabe-Hesketh & Skrondal, 2005).

Multilevel modeling addresses this issue. By organizing data into multiple hierarchical levels, this technique permits the within-group correlations, thereby relaxing the OLS assumptions of independence (Luke, 2004). Accordingly, residuals are split into multiple components that model individual and group variations, often called random effects. This random effect can be specified in intercept; called random-intercept multilevel model, or in both intercept and the coefficient of a parameter; called random-slope multilevel model. Therefore, in the former, each group has its own intercept, while the latter allows each group to have its own intercept and coefficient of a question parameter (Rabe-Hesketh et al., 2005).

Multilevel modeling has been used in hedonic studies. Using random-intercepts multilevel specification, Orford (2000) presented the factors that most affected housing prices in Cardiff, UK; the floor area and the neighborhood social classes. Kang and Cervero (2009) revealed the positive price impact on land value near a newly restored urban creek and linear park, Cheonggyecheon Stream, in Seoul, Korea. They also fit random-intercept multilevel models with parcel attributes at an individual level, and ward attributes at a group level.

The advantage of using a random-slope

multilevel model is that it estimates group-specific coefficients of a question predictor in addition to the intercepts. Considering the fact that an effect size of a park diminishes non-linearly with distance from the epicenter, one parameter cannot sufficiently depict the relationship between property value and the distance from a park. In many cases, the effect size of a park also differs by location. For example, some parts of a park are more favored by homebuyers of the nearby real estate market than others, especially when the park is large or long, with internal heterogeneous qualities. Also, neighborhood social characteristics, such as family structure, education attainment, occupation, and preference for leisure determine the level of appreciation for parks (Anderson & West, 2006).

While adding fixed-effect terms is normally done to cope with the issue of differential effect size by distance and/or location, it always involves the potential risk of increased degree of freedom that leverages the critical t-statistic of a given α level—i.e. a type-I error. Random-slope multilevel modeling, in contrast to the random-intercept model, allows variability in the coefficient of the question variable in group-level, not only in the intercept, and thus enables measuring the differing relationships between the question and outcome variables by group-level. Especially when the cases are not evenly distributed through the study area, thereby comprising some groups with only a small number of samples, the prediction of multilevel model (Empirical Bayes method) is superior to the OLS regression, because it precisely estimates overall parameters by heavily weighting the more reliable groups, within which relatively larger samples are contained (Bryk & Raudenbush, 1992; Hox, 2010; Mass & Hox, 2004).

Ⅲ. Research design

1. Research question

My research question is: whether, and, if so, how much, the High Line has exerted an influence on residential property value in the neighborhood. The analysis consists of two parts. The first is a cross-sectional approach, in that two datasets representing the “after” and “before” conditions are separately analyzed for comparison, using random-slope multilevel modeling. In the second part, I calculate the additional tax accrued by the effect of the High Line in the year 2012 and a projected amount for the next 20 years.

2. Site

The study area is a southwest part of Manhattan. This area is defined as embracing the full extent of the High Line effect as well as an unaffected area beyond the potential impact zone, as a control group. Figure 1 illustrates the locations of the High Line project and the boundary of the Special West

Chelsea district, designated as a special district under West Chelsea rezoning, and the study area with case distribution (total; n=10,478, before; n=4,467, after; n=6,011).

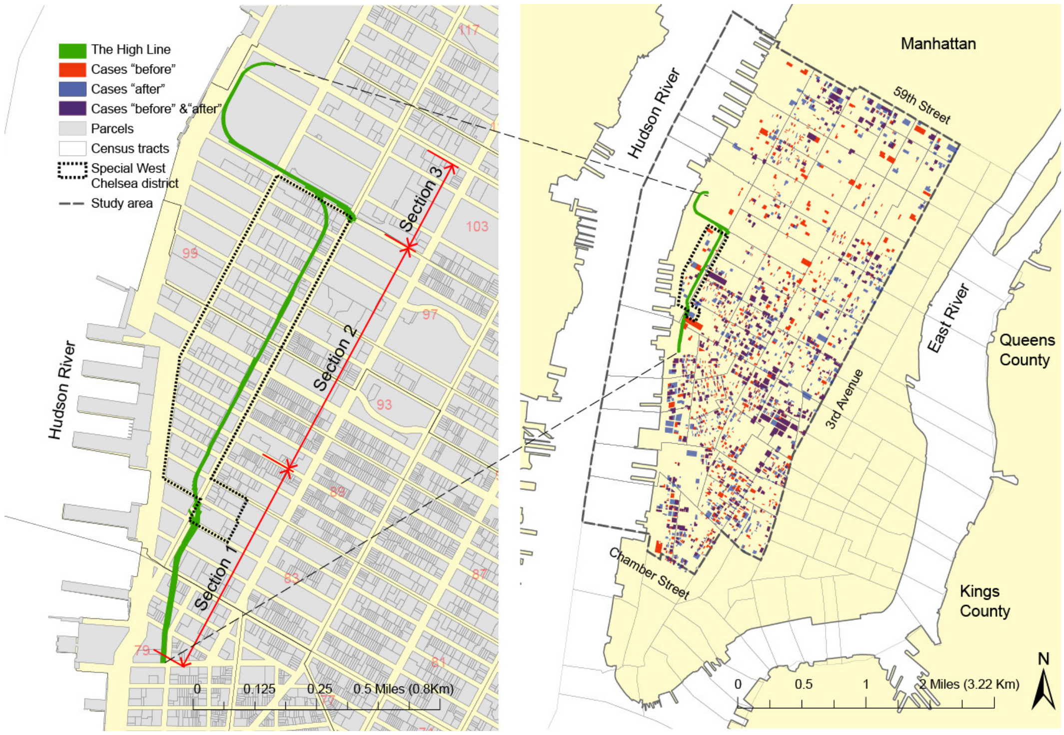

Figure1. Locations of the High Line and the boundary of West Chelsea rezoning (Special West Chelsea District), and the study area with case distribution (n=10,478)

3. Datasets and samples

The primary dataset is residential sales data from the City of New York, Department of Finance. The total sales transacted over four years is selected for this study: two years for the "after" and two years for the "before" periods, with all prices adjusted to 2012 based on the Consumer Price Index (Sahr, 2013). I chose the year 2011 and 2012 for the "after" condition, considering the completion year of the second section, the newest segment of the park. Although Section 2 was open in the summer of 2011, high expectations for the park, prompted by the success of Section 1 since its completion in 2009, had already influenced property values in West Chelsea (Clarke, 2011). I chose 2003 and 2004 as the "before" condition. Although it is ideal to select the years much prior to the announcement, data for the earlier years were not available. Therefore, it should be noted that the outcome of the subsequent comparison might be conservative, i.e. relatively understated. The total sample size is 10,478, contained in 70 census tracts. Community demographic attributes were obtained from US census, 2000 and 2011 ACS five-year on a census tract level. Zoning information is taken from PLUTO and MapPLUTO, published by New York City Department of City Planning in 2003 and 2011, respectively, to control the effect of land use and floor area ratio (FAR) changes on property values over the period. Locations of major urban features were gathered from the same source. The assessed values for the tax calculation were extracted from the 2012 tax assessment roll published by the City of New York, Department of Finance.

4. Measures

The outcome variable is log of market transaction value per square foot; Question predictor, *DHL100*, describes Euclidean distance to the High Line measured in 100-foot increments. Covariates are organized into three categories based on lessons from preceding studies (Crompton, 2005; Kang et al., 2009) – community factors, location factors and lot/building factors. Community factors imply common and often unobservable characteristics shared by community members. Demographic characteristics such as race, household income, educational attainment and occupation could be indicators if not driving factors of housing prices, thus should be controlled in the analysis (Mhatre, 2009). Because there is a greater tendency of multicollinearity between these factors in this dataset, for example higher education level tends to be correlated with higher income, principal component analysis is preceded for parsimony rule for the subsequent regressions. Twenty individual demographic factors are composited into three principal components (*PCs*), likewise eighteen industry and occupational predictors are composited into another three *PCs*, to catch simplified yet holistic dimensions of socio-economic positions of the neighborhood, while considerably reducing degrees of freedom. The original individual predictors, *PCs* and underlying constructs will be available upon request to the author.

Location factors refer to the distance to notable urban features that could affect housing price advantageously or disadvantageously. Among many others, general facilities such as schools, transportations, public service stations, and tourism spots are considered in this study. All distances were measured in 100-foot increments. Lot/Building factors indicate attributes of the buildings, units and their parcels. Built year, number of rooms, building amenities, lot geometry, ownership types and land uses are some of the examples (Descriptive statistics will be available upon request to the author).

5. Analytical methods

For random-slope multilevel modeling, two levels are structured; sold unit is designated as an individual level (level-1), and the census tract is designated as a group level (level-2). Location and lot/building factors are measured and retained as the level-1 variables, while community factors are collected only at an aggregated level of census tract and dealt as the level-2 variables. Although total number of household is obtained as the level-2, this indicates neither of PCs' constructs but related to residential density, thus included as an individual variable.

Census tract is a mutually exclusive and independent geographic unit by definition, thus can be a legitimate level-2 group for the multilevel modeling. While spill overs between census tracts are anticipated, intra-class correlation coefficient justifies the use of multilevel modeling, in that more than 25% of the variability in the sample is explained by differences across the census tracts, which falls into "Large" category of Cohen's squared effect size.

1) Analysis 1: Hedonic price model

Research Question: What percent of housing value is associated with the distance to the High Line when it is a public park, compared to its preexisting condition as an abandoned freight railway structure (Function 1). Dataset is split into two subsamples, "before" and "after" periods, and analyzed separately.

Level-1:

$$\ln(Marekt\ Transaction\ Value\ per\ Square\ Foot_{ij}) = \pi_0 + \beta_2 S_{ij} + \beta_3 D_{ij} + \pi_{4i} DHL100_{ij} + \epsilon_{ij}$$

Level-2:

$$\pi_0 = \theta_0 + \beta_1 N_i + \upsilon_{0i}$$

$$\pi_{4i} = \theta_4 + \upsilon_{4i}$$

Composite Model:

$$\ln(Marekt\ Transaction\ Value\ per\ Square\ Foot_{ij}) = \theta_0 + \beta_1 N_i + \beta_2 S_{ij} + \beta_3 D_{ij} + \theta_4 DHL100_{ij} + (\epsilon_{ij} + \upsilon_{0i} + \upsilon_{4i} DHL100_{ij})$$

N_i: a vector of community factors for census tract i

S_{ij}: a vector of lot/building factors for parcel or unit j in census tract i

D_{ij}: a vector of location factors for parcel or unit j in census tract i

$DHL100_{ij}$: a distance to the High Line from unit j in census tract i (100-foot increment)

ϵ_{ij}: Level-1 error

$\upsilon_{0i}, \upsilon_{4i}$: Level-2 error

(Function1)

2) Analysis 2: Tax calculation

Research Question: How much additional tax was generated as a result of the High Line's effect in 2012? And what is the present value of the tax benefit accumulated for the next 20 years?

Calculating the entire amount of a tax increment attributable to the High Line is ostensibly outside the scope of this study. In order to complete the calculation, first an equivalent study for the commercial, manufacturing and any other classes of taxable properties is required to assess the full extent of the effect in interest. Also, a longer time would need to pass before I can conclude the effect size in 2011/2012 represents the one for the coming 20 years, from 2013 onwards. 20 years is the timeframe of the initial feasibility study conducted in 2002, a fair time period within which the upfront cost and some profits can be returned. While different methods of calculation are also possible, the following estimation is based on reasonable assumptions accepted by public financing (Brueggeman & Fisher, 2011; Hyman, 2010), and would gives some perspective on how the present analytical results can be translated into tax revenue.

The calculation consists mainly of two parts: first, a summation of taxes on all residential properties in each census tract, of which the coefficient of *DHL100* was tested to be statistically and substantively significant; and second, an extrapolation of an average premium by the High Line per corresponding census tract. The product of these two sets of numbers becomes the additional tax amount generated by the High Line. First, the tax is estimated by multiplying the assessed property values with their tax ratios in tax class (New York City Department of Finance, n.d.). Second, the average premium was estimated based on the conceptual model structure. Since the effect of the park linearly decreases by distance within a census tract (due to the log-transformation), it is fair to assume that a premium accrued to the property at the midpoint of the census tract from the High Line can be a proxy of the census track-wide average ("Average distance increment in 100 feet" in Table 3). Therefore the premium is calculated by multiplying the "Average distance increment in 100 feet" and the "Difference in Coefficients", the coefficient of *DHL100* in "after" condition subtracted by the "before" condition as a net premium change attributed to the High Line in the year of 2012.

IV. Findings

1. Result 1: Hedonic price model

In general, I find a support for the prevailing hypothesis that the High Line

Table 1. Results the random slope multilevel models describing relationships between the distance to the High Line and market transaction value in "after" and "before" the completion of the High Line controlling for selective predictors.

Variable	"after" completion (2011, 2012)	"before" completion (2003, 2004)
Fixed Effect Parameters		
Distance to High Line (DHL100)	-0.0030***(0.001)	0.0025**(0.001)
Location Factors (Level 1)		
Distance to subway entrance	0.0030(0.002)	-0.0005(0.003)
Distance to transportation facilities	-0.0016(0.001)	-0.0008(0.002)
Distance to schools	-0.0043**(0.002)	0.0018(0.002)
Distance to Universities or Colleges	0.0023(0.001)	0.0017(0.002)
Distance to other parks	-0.0027*(0.002)	-0.0034(0.003)
Distance to Park Avenue	-0.0017**(0.001)	-0.0030***(0.001)
Distance to tourism spots	-0.0006(0.001)	-0.0032***(0.001)
Distance to Broadway Avenue	-0.0023*(0.001)	0.0028*(0.002)
Community Factors (Level 2)		
PC-Socioeconomic position 1	-0.0399***(0.008)	-0.0239***(0.007)
PC-Socioeconomic position 2	0.0052(0.009)	-0.0024(0.007)
PC-Socioeconomic position 3	0.0017(0.012)	0.0401***(0.010)
PC- Industry and occupation 1	0.0210**(0.009)	-0.0018(0.008)
PC- Industry and occupation	-0.0119(0.010)	0.0030(0.006)
PC- Industry and occupation 3	-0.0038(0.010)	-0.0093(0.010)
Total number of household	-0.0000(0.000)	0.0000(0.000)
Lot/Building Factors (Level 1)		
Lot front	-0.0002***(0.000)	-0.0001(0.000)
Lot depth	0.0003***(0.000)	-0.0001(0.000)
Lot area	-0.0000**(0.000)	0.0000(0.000)
Irregular lot	-0.0129(0.009)	0.0345**(0.015)
Building front	0.0002***(0.000)	0.0001(0.000)
Built FAR	-0.0038***(0.001)	-0.0129***(0.003)
Built year	0.0002***(0.000)	0.0004***(0.000)
Number of floors of the building	0.0058***(0.001)	0.0054***(0.002)
Number of bedrooms	0.0145***(0.004)	0.0006(0.000)
Number of bathrooms	-0.0124***(0.004)	-0.0010*(0.001)
Size of the unit (sf)	-0.0000***(0.000)	-0.0000***(0.000)
Garage	-0.0899***(0.013)	0.0133(0.026)
Doorman	0.0431***(0.011)	0.1003***(0.017)
Gym	0.0785***(0.012)	0.0822***(0.026)
Pool	0.0127(0.018)	-0.0130(0.040)
Available parking	0.0310***(0.009)	-0.0314(0.025)
Co-op	-0.2923***(0.010)	-0.1588***(0.017)
Townhouse	0.2536***(0.037)	0.0641(0.046)
In commercial land use	-0.0854(0.083)	-0.1262(0.161)
In residential land use	-0.0203(0.080)	0.2881*(0.159)
Constant	6.9966***(0.183)	5.5956***(0.321)
Random-effects Parameters		
Level 1:	0.0824	0.1722
Level 2:	0.1371	0.1040
Level 2:	0.0000	0.0000
corr (DHL100, cons)	-0.9338	-0.9948
Intraclass Correlation	0.2928(0.0351)	0.2623(0.0391)
Summary and Goodness-of-fit		
Observations	6,011	4,467
Number of groups	70	70
-2LL	2,344	4,928
Degree of Freedom	36	36

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2. Predicted coefficients of *DHL100* by census tract in "after" and "before" condition, and their differences. The table is sorted by the average distance to the High Line, and census tracts that express statistically and substantively significant relationship between the High Line and their property is presented for simplicity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CT	Coefficient *DHL100* "after"	Random effect of (1):υ_{4i}	*s.e.* of (2)	Coefficient *DHL100* "before"	Random effect of (4):υ_{4i}	*s.e.* of (5)	(1)-(4)	z-score of (7)
99	-0.0080**	-0.0050	0.0023	0.0004	-0.0021	0.0012	-0.0084***	-3.31
79	-0.0087**	-0.0056	0.0025	-0.0005**	-0.0029	0.0012	-0.0082***	-3.02
93	-0.0116***	-0.0086	0.0023	-0.0001**	-0.0026	0.0011	-0.0115***	-4.44
89	-0.0097***	-0.0067	0.0024	-0.0011***	-0.0036	0.0013	-0.0086***	-3.19
83	-0.0115***	-0.0084	0.0024	-0.0013**	-0.0038	0.0016	-0.0102***	-3.52
77	-0.0095**	-0.0065	0.0027	-0.0024***	-0.0048	0.0013	-0.0072**	-2.37
73	-0.0103*	-0.0072	0.0033	0.0003	-0.0021	0.0016	-0.0106***	-2.94

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

has added location premium to nearby residential properties. In Table 1, I present the estimates of the multilevel modeling for two different subsamples in "after" and "before" conditions, and in Table 2, I present the Empirical Bayes predicted coefficients of *DHL100*, by census tract level in those two different periods (column (1)~(6)). As described, predicted coefficients and their standard errors of the question variable can differ depending on the group-level units, thus census tracts that exhibit statistically significant relationship with the outcome variable are subject to interpretation exclusively (marked in red in Figure 2).

In the "after" condition, the population-mean slope of *DHL100* is estimated as -0.0030 (p=0.003) considering a 5% statistically significant level. Census tract-specific estimates of *DHL100* range from -0.0116 (Census tract (CT) 93) to 0.0135 (CT 112.01). The results can be interpreted to mean that residential properties located 100 feet closer to the High Line are associated with an average 0.30%, and up to 1.16% higher market transaction value depending on the census tract holding all other predictors constant, while some census tracts show the reverse relationship. By contrast, in the 'before" condition, population-mean slope of *DHL100* is estimated as 0.0025 (p=0.021), considering a 5% statistically significant level. Census tract-specific estimates of *DHL100* range from -0.0065 (CT 54) to 0.0125 (CT 112.01). This result signifies that being 100 feet closer to the High Line

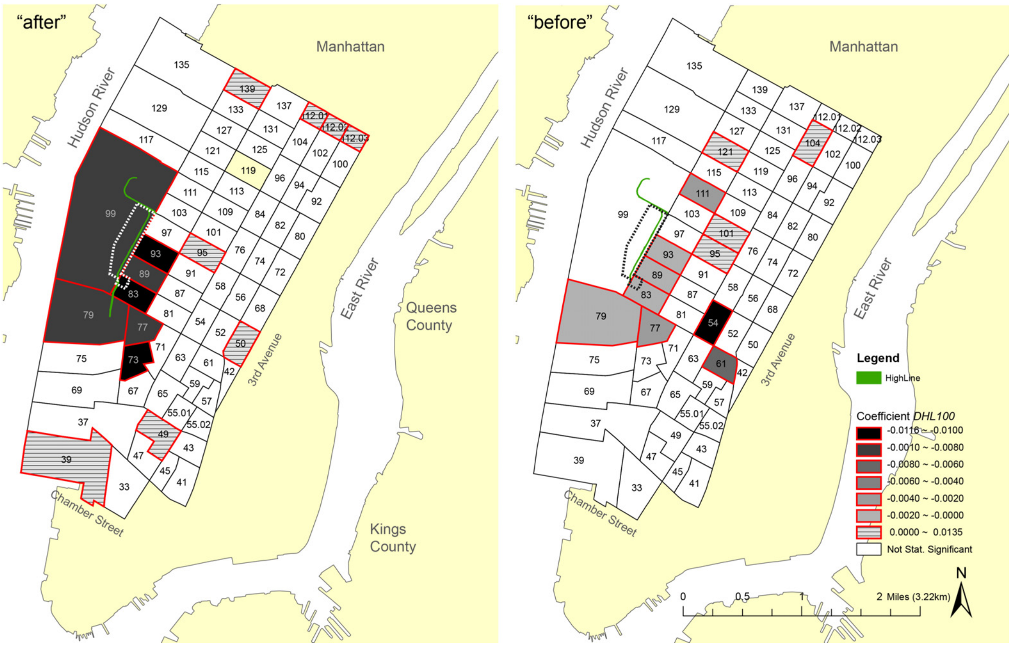

Figure 2. Distributions of the High Line proximate effect for "after and "before" periods.

explains 0.25% lower market transaction value on average, which ranges up to 0.65% higher or 1.25 % lower incremental change depending on the census tracts.

15 and 13 out of 70 census tracts hold statistically significant relationships between property values and the distance to the High Line in the "after" and "before" conditions, respectively, where the Empirical Bayes prediction was heavily relied upon, and consequently, statistical inferences can be drawn. Theoretically, beneficiaries of the largest proximity effect would be properties closer to the subject feature, while the effect size approaches zero over a distance of 1,500ft to 2,000ft away from it, according to preceding studies (Crompton, 2000, 2005; Mhatre, 2009; Sanders, Polasky & Haight, 2010). Estimated coefficients of *DHL100* in "after" condition are congruent with the theoretical understandings of a park's impact. By visual examination of Figure 2 ("after"), census tracts with larger negative predictions of *DHL100* mostly agglomerate near the High Line, and the intensity fades as the distance from the High Line increases, signifying that the High Line is regarded as a positive amenity for the neighboring real estate market.

In the "after" condition, CT 93 (Coeff. = -0.0116, p=0.000) has the largest magnitude of *DHL100*, explaining a greater sensitivity of housing value to distance from the High Line. Because the census tract in this area saw an immense surge of new constructions and renovations has been induced (Kershaw, 2010) by the spill-over from the adjacent block with highly increased FAR through rezoning (DCP, n.d.), the park may have greater influence on this part of real estate submarket. The magnitude of *DHL100* in CT 83 (Coeff. = -0.0115, p= 0.000) is the second largest, and neighboring census tracts, such as CT 89, CT 79 and CT 99, also share the positive impact. When translated to the block scale, residential properties a block closer to the High Line have an appreciation of up to 10.44% in market transaction value, depending on the census tracts, assuming Manhattan's standard 900-foot block width (e.g., blocks in CT93, 89, 83).

In general, the larger impacts concentrate more in the southern part of the park than the north. The north part of the High Line, especially the census tracts on the east side, does not hold statistically significant relationships in interest. This difference might be a consequence of the multi-phased construction of the park. The southern part (Section 1) was completed in 2009 and has been open to the public for two more years longer than the northern part (Section 2), creating a positive effect on the housing market.

In addition, property types of the host neighborhood might hold a clue. The northern section of the High Line is surrounded by a greater number of low-income housing and units under rent stabilization than the other side (PH&A, 2005), possibly making property values relatively unresponsive to the location factors compared to the normal market units. Also, the transaction rate for these units is slower than for the market units, therefore the number of cases in this area is inevitably lower and sparsely distributed in the study area compared to the southern part.

While the positive effects of the High Line are evident in census tracts within its hypothetical impact zone, unexpected outcomes are also found, mostly at the margin of the study area. Eight census tracts, for example, CT39, 112.03 and 112.02, show positive signs of the fitted value *DHL100*, implying a price drop associated with the proximity to the High Line. This may reveal that either the High Line has adversely affected the property values of those census tracts or that the estimates are convoluted by uncontrolled location factors nearer to those census tracts, i.e. due to an omitted variable bias. Although confirming the reason is difficult in this analytical setting, it is more likely that the latter supposition is true, considering the remoteness of those census tracts from the High Line. They are located farther than 5,000ft~6000ft away from the High Line, thereby the effect of the High Line does not seem active, either positively or negatively.

In the analysis of the “before” condition, although overall mean coefficient of *DHL100* is reversed from the “after” condition, census tracts located near the High Line still show a positive relationship between the distance to the High Line and the unit price of residential properties, considering a 5% statistically significant level. The impact distributions in the “before” condition resembles the one of the “after” condition, however, the magnitudes of the *DHL100* coefficient are comparatively smaller. The result shows that the High Line was a favorable location factor even in 2003/2004 when it was an abandoned industrial remnant; or perhaps, the prospective park already boosted the housing market of the neighborhood (Ouroussoff, 2006).

With these estimates from the two cross-sectional analyses, I calculate the net effect size of *DHL100* by subtracting the estimated value of “before” from the “after” condition for the census tracts of which the housing values are related to the High Line statistically and substantively. Then I conduct a z-test to examine the statistical validity of the differences (Cohen, 1983; Paternoster, Brame, Mazerolle & Piquero, 1998).

Seven census tracts were subject to the calculation (CT73, 77, 79, 83, 89, 93 and CT99). In CT 73 and CT99, while the census tract-specific coefficient of *DHL100* does not reveal preference associated with the distance to the High Line in the “before” period, they favor proximity to the High Line in the “after” condition at 5% statistically significant level. In CT 77, 83, 89, 79, 93, the proximity effect of the old High Line is already observed in “before” period, but the preference gets intensified in the “after” condition. The magnitude of the differences ranges from -0.0072 to -0.0115, supported by a 5% statistically significant level (Table 2, column (7)). Substantively speaking, the conversion of the High Line to a public park has indeed positively shifted the housing market of the neighborhood.

2. Result 2: Tax calculation

In Table 3, I present the additional amount of tax revenue explained by the introduction of the High Line to the neighborhood. The estimated value is $18,694,394 in 2012, and 20 years of this revenue stream totals $258,577,660 of present value in 2012 dollars, using a 3% inflation rate and a New York’s customary 6.25% discount rate, which can be adjusted to $241,511,534, in 2009 dollars. This already exceeds the capital cost and would be substantially larger if the other types of properties were included in the calculation.

Table 3. Additional property tax amount generated by the effect of the High Line in 2012, and the present value of the tax revenue for the next 20 years, unit is US dollar.

CT	Difference in Coeff.	Average Distance increment in 100ft	Average premium	Assessed Value in 2012 (Tax rate and tax in parentheses)			Additional Tax Revenue
				Class1 (18.569%)	Class 2 (13.181%)	Class4 (10.288%)	
73	-0.0106	7.28	7.72%	$20,663,222 ($3,836,954)	$289,869,001 ($38,207,633)	-	$3,152,671
77	-0.0072	6.91	5.00%	$19,257,526 ($3,575,930)	$290,047,285 ($38,231,133)	$1,206,000 ($124,073)	$2,086,158
79	-0.0082	6.01	4.92%	$9,246,868 ($1,717,051)	$262,547,369 ($34,606,369)	$15,176,250 ($1,561,333)	$1,867,036
83	-0.0102	10.00	10.2%	$896,208 ($166,417)	$142,874,863 ($18,832,336)	$28,695,600 ($2,952,203)	$2,238,998
89	-0.0086	8.99	7.73%	$11,277,610 ($2,094,139)	$211,634,718 ($27,895,572)	-	$2,318,625
93	-0.0115	6.31	7.26%	$4,939,202 ($917,160)	$416,561,225 ($54,906,935)	-	$4,050,875
99	-0.0084	4.58	3.85%	$68,648,895 ($12,747,413)	$322,847,676 ($42,554,552)	$253,020,600 ($26,030,759)	$2,980,031
Total							$18,694,394
Present value of the tax revenue for the next 20 years			$PV=\sum_{t=1}^{20}\{18,694,394(1+i)^t/(1+r)^t\}$ i=3% (inflation), r=6.25% (discount rate)				$258,577,660

V. Threat to validity

Random-slope multilevel modeling is one of the most suitable techniques used for hedonic price analysis, both as a statistical and substantive measure. Even with this advantage, however, it still suffers from the general drawback of regression approaches: omitted variable bias. In spatial application, such as hedonic analysis, this threat is particularly problematic since researchers can't control every location factor that could possibly affect the housing prices. The extent of the High Line's impact zone could be more clearly delineated by this analysis if the bias was not present.

Additionally, a relatively sparser case density near the High Line might have affected the statistical inference for certain census tracts. The group-specific coefficients of *DHL100* for census tracts in the northern part of the High Line do not express its statistical significance, presumably for the reasons based on the site context that I noted above. In any event, the small sample size of those census tracts poses a restriction in statistical inference even though the real effect of the High Line exists.

VI. Discussion

The current study supports the prevalent hypothesis: the High Line has exerted proximity-based economic advantages on the residential properties of its neighborhoods. The analysis of market transaction values reveals that, on average, an appreciation of up to 1.16% in residential property is associated with locations 100ft closer to the High Line depending on the census tract, controlling for selective location, community and lot/building factors. To reiterate this outcome on a block scale, one block closer to the High Line explains a premium of up to 10.44% for residential property value in certain census tracts.

Based on the difference in the preferences conferred by the High Line in “after” and “before” conditions, it is learned that additional tax of $18 million per annum and $258 million for the next 20 years are to be collected due to the High Line effect, measured in 2012 dollars. This exceeds the tax benefit projected by HR&A's feasibility study in 2002, even though the real cost of the High Line was higher than estimated at the time-the accurate number cannot be revealed due to non-disclosure agreement.

The study proves that the High Line project was worth the cost, at least from an economic point of view. Although the reported initial cost stirred public opposition concerned about fair distribution of public resources (Jaffe, 2011), this high-quality strategy seems effective at producing an outcome commensurate with the initial use of public funds. This high impact is attributable to the quality of the park, made possible by a sufficient budget, but also amplified by the increased FAR contained in the West Chelsea rezoning plan. The development momentum and the emergence of new buildings may together synergize with the effect of the park in raising the desirability of West Chelsea, further attracting property development. As mentioned in the introduction, the park spawned two billion dollars of real estate development in its surrounding. Without this increased amount of base assessed property, the tax benefit would have been much less than the amount that this study presents.

Besides the higher budget and the integration with the rezoning, some other factors such as a long development period, unique site context, respect for the design, and active marketing and fund raising also helped the High Line become an exceptional destination, unlike other New York parks.

This study has several policy implications. The magnitude of the proximity impact shown in the study supports the idea that well conceived parks can be used as urban revitalization mechanisms. In addition to the increased tax revenues, the anticipated impact of such projects is holistic. They can introduce new businesses and reinvigorated cash flows into existing businesses. These types of outcomes are typically expected from and seen with “spatial activity generators” such as cultural venues (Frey, 1998; Plaza, 2006), convention centers (Sanders, 2002), and sports facilities (Robertson, 1995; Siegfried & Zimbalist, 2000).

However, mimicking a successful precedent does not always guarantee an equal result in a different context. Physical projects tend to be extremely specific to locale, and lessons from one project are not easily applied to others. In research, there is a growing interest in examining the conditions under which parks induce a “willingness-to-pay” in homebuyers and renters. Higher maintenance levels, private park ownership, characteristics of the host neighborhoods, and good designs are identified as only a few reasons that parks promote higher property value (Anderson & West, 2006; Cho, Poudyal & Roberts, 2008; Irwin, 2002). Certainly, the factors contributing to the High Line could be also essential for the economic success of other projects. Therefore, a careful investigation of similar kinds of projects should precede new development initiatives, particularly when parks are created with the mission of economic revitalization. If well thought out, this strategy could be adopted in many different cities.

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