What's Manhattan Worth?
A Land Values Index from 1950 to 2014°

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Abstract

Using vacant land sales, we construct a land values index for Manhattan from 1950 to 2014. We find three major cycles (1950 to 1977, 1977 to 1993, and 1993 to 2009), with land values reaching their nadir in 1977, just after the city's fiscal crisis. Overall, we find the average annual real growth rate to be 5.5%. Since 1993, land prices have risen quite dramatically, and much faster than population or employment growth, at an average annual rate of 15.8%, suggesting that barriers to entry in real estate development are causing prices to rise faster than other measures of local well-being. Further, we estimate the entire amount of developable land on Manhattan in 2014 was worth approximately $1.47 trillion. This would suggest an average annual return of about 6.4% since the island was first inhabited by Dutch settlers in 1626.

Key words: Land Values, Manhattan, Price Index

JEL Classifications: R1, N9

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1. Introduction

In 1950, the United States was the richest nation on planet Earth. Many American cities seemed poised for decades of economic success, as they reached population totals never experienced before. A thoughtful observer might have foreseen some of the challenges that American cities would confront in the coming decades, but few could have predicted the strength of the economic and cultural forces that were about to reshape the urban landscape. Many of America's largest cities, such as Baltimore, Cleveland, Detroit, and St. Louis, would never again have as many residents as they had in the 1950s. The combined forces of a decentralizing economy, a reduction in manufacturing employment, a rise in the number of two earner households, and urban unrest in the 1960s, left many American cities looking wholly different in 1980 than they had just three decades earlier. While some of these places have experienced a renaissance since the 1980s, few have returned to the population levels they achieved previously.

Given the dramatic changes in the urban spatial structure of the U.S. during the post-World War II period, it remains surprising that so little work has been done to understand how these forces affected the markets for property and land. Moreover, given its special place in the U.S. and international economies it is especially surprising that very little work has been done to examine the changes in the property or land markets in New York City.

While New York was not immune to the economic and cultural forces that affected all American cities, it remained at the center of the global financial community and is still America's largest metropolis. Indeed, New York has experienced a comeback that few other American cities have enjoyed. After being on the edge of a fiscal cliff and losing hundreds of thousands of residents in the 1970s, New York's population is now larger than ever. Since New York experienced failure followed by a dramatic recovery, it is especially important to better understand how the city's spatial structure has evolved since 1950.

In this paper, we contribute to the effort to better understand how the forces that have affected American cities over the past 65 years have affected New York's land market, with a focus on the city's most important borough, Manhattan. More specifically, using a newly assembled data set that contains transactional data for vacant parcels of land on Manhattan Island, we are able to provide a first look at how these forces affected the price of land, controlling for each parcel's key characteristics. Our results not only allow us to examine how the price of land in Manhattan has changed over time, but we've also taken first steps towards gaining an understanding of how neighborhood/location effects shaped land prices as well.

In particular, we construct a land values index for the entire period. We can then use the index to compare the returns from investment in Manhattan land with the returns from alternative investment options. In summary, we find that the real index increased from 100 in 1950 to 3,384 in 2014, which gives an average annual growth rate of 5.5%.[1] However, there have been three major land value cycles (1950-1975, 1975-1993 and 1993-2009); and since 1993, land values have grown at an average annual rate of 15.8%. Based on the regression results, we are able to create predicted values for the entire value of developable land on Manhattan. For 2014, our estimates range from $1,541 to $1,948 billion, with an average of $1,740 billion. Furthermore, we compare our index to three other times series: total New York City employment, an index of Manhattan real estate sales, and the S&P stock index. Our results suggest that the land values index is co-integrated with employment and sales. Since 1950 land values have risen faster than stock prices, as measured by the Standard & Poor's Index.

The rest of this paper proceeds as follows. The next section reviews the relevant literature. Section 3 discusses the data set. Following that, Section 4 presents the regression results that we use to construct the land values index. Section 5 reviews the index results. Then Section 6 discusses the major events in New York's history that affected its land values. Section 7 compares the land values index to other time series. Section 8 provides our estimates for the value of Manhattan Island. Finally, Section 9 offers concluding remarks. Two Appendixes provide information on data sources and additional tables and graphs.

2. Literature Review

Urban economists and economic historians have written about the markets for land and property for more than a century. Over time, the literature has developed along several different tracks. Two of the earliest works on urban spatial structure are descriptive in nature, yet remain impressive nonetheless. Homer Hoyt's (1933) *One Hundred Years of Land Values in Chicago, 1830 - 1933* gives a comprehensive view of how the market for land in Chicago changed over several distinct periods—the canal boom, the railroad boom, the Civil War and post-war era, the skyscraper era, and finally the WWI and post-war era. Edwin Spengler (1930) examines the market for land in New York City in *Land Values in New York in Relation to Transit Facilities*. As the title suggests, Spengler's study focuses on the effect that transportation improvements had on New York land values. Spengler's work was timely in light of the dramatic expansion of New York's transit network caused by the construction of the city's first subway lines.

Given the era in which they were writing, it is not surprising that neither Hoyt nor Spengler use econometric techniques to investigate the forces affecting land values. Recent work has used econometric methods to better understand land values and spatial structure. However, economists have faced several challenges. In particular, there are two important questions to resolve. First, should one use land value data or data for an entire property—land and the structure on it? Second, should one use sales data or rely on assessed values? Addressing these questions separately can prove problematic. For example, a researcher using sales data for

[1] Throughout the paper, average annual growth rates are determined by $r_{t,t-n}=[ln(Index)_t - ln(Index)_{t-n}]/n)$. Also, unless otherwise noted, real values were based on using the U.S. Consumer Price Index for urban consumers, all items less shelter.

property values may have a difficult time disentangling the value of the structure from the value of the land. Alternatively, assessed valuations may list separate assessments for the land and the structure, if so provided by the municipality. The difficulty, of course, is that the assessed value may not be close to the true market value. In some cities and time periods, assessed values are accurately calculated and can be used in econometric work. In other times, this is not the case.[2] Our paper overcomes these issues by using vacant land prices, which do not have a structure on them.

Atack and Margo (1998) examine historical sales data for vacant parcels of land in New York City. Their data set covers five-year intervals from 1835 to 1900. Smith (2003), on the other hand, uses assessed land values to look at the evolution of Cleveland's spatial structure between 1915 and 1980. And, as a noteworthy example of a paper that makes excellent use of Hoyt's Chicago data, McMillen (1996) studies the changes in Chicago's urban spatial structure over the course of the 19th and 20th centuries. All three of these authors make use of historical land value data to understand changes in urban spatial structure, and Atack and Margo (1998) and Smith (2003) make contributions by introducing new data sets. However, none of these papers attempts to create a property/land values index that will help to explain how property/land values have changed over time.

There have been many contributions to the land/property value index literature. The papers in this literature typically focus on studying time periods or locations that have not previously been studied in depth, or they focus on improving our understanding of the econometric methods that we should employ in creating indexes of this type (Butler, 1982; Clapp et al, 1991; Haurin, and Hendershott, 1991). Nicholas and Scherbina (2013) assemble and analyze a data set of residential properties sales in New York City to create a property index for the years 1920 to 1939. Their work gives us a much greater understanding of how property values changed in the years during and leading up to the Great Depression. Moreover, they use financial market data to compare the value of investments made in financial instruments to investments made in real estate. They find that one dollar invested in Manhattan real estate would have been worth, on average, $0.71 in 1939. By contrast, the same dollar invested in the stock market would have been worth $3.68 (Nicholas and Scherbina, 2013).

Haughwout et al. (2009) study recent land values in the New York metropolitan area. Like our study, they use vacant land sales to create an index. However, their study investigates a relatively shorter time period (1996-2006) and land values throughout the entire region, including some New Jersey and New York counties surrounding the city. For the same time period their index for residential land shows very similar movement as ours; but they show slower price growth for

[2] New York City presents an interesting case in this regard. Starting in 1905, the city began providing assessment values for both land and for the entire property. Until, at least, the early 1940s, all indications suggest that the assessed values were relatively accurate, on average. Starting in the 1950s, however, assessed values and market values began to diverge dramatically, so that today, assessed values are a poor indicator of market values. We leave the investigation of the political economy of assessment process for future work.

commercial and industrial land. Been et al. (2009) investigate land prices in New York from 1994 to 2006 by studying the value of properties that were torn down immediately after purchase. They also find a considerable rise in prices over the period; however, their results for Manhattan must be viewed with caution given they have a very small sample for this borough. Davis and Palumbo (2008) provide residential land values estimates for the New York metropolitan region since 1984.[3] While our index shows a positive correlation with theirs (0.457), we find that Manhattan land values (for all uses) over the same period have shown much greater variation.[4]

Wheaton, et al. (2009) study the return to commercial real estate in Manhattan from 1899 to 1999 and find that the long run return to commercial buildings is consistent with the zero economic profit condition. However, returns over the century have been highly volatile from decade to decade. The results in Wheaton et al. (2009), coupled with our results, suggest that the dramatic rise of Manhattan land values are due to housing market constraints—the kind discussed in Glaeser et al. (2005)—that cause housing supply in New York to be inelastic. As another indicator of this, in the second quarter of 2014, for example, the Manhattan office vacancy rate was 10.3%, while the apartment vacancy rate was 1.64% (Cushman & Wakefield, 2014; Perlberg, 2014).

3. The Data

The data were collected from a series of annual volumes that publish all bona fide, open market sales in Manhattan (see Appendix B for more information on the sources and the data processing). Each entry lists the price, date of sale, address, type of structure (if any) or if the lot is vacant, and the lot dimensions.[5] We collected all the bona fide vacant land transactions from each year from 1950 to the first quarter of 2015; all told we were able to collect data for 3,591 sales. We obtained latitude and longitude coordinates for each entry, and then we consulted Google Maps and Sanborn Land Books to determine if the lot was on a corner or not.

The average number of observations per year is 56 (the median is 52). The standard deviation is 32.3 observations per year. The minimum was four in 1969 and 1971; the maximum was 143 in 1986. We were unable to obtain vacant land transactions for 1975 and the second half of 2014 (but we did obtain values for the first quarter of 2015). Index values for these years were interpolated from prior and future values (see Appendix B).

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[3] For their data set up to the present see http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp.

[4] See Appendix A for a comparison of our Manhattan index with those of Haughwout et al. (2009) and Davis and Palumbo (2008).

[5] Note that we do not have information on why the parcels were vacant. We leave this investigation for future work. But, as we discuss below, we have parcels from throughout the island so there's no reason to believe there is some systemic problem with the lots in our sample.

Figure 1 shows a map of the locations of all of the transactions in our data set. Also on the map are the borders of Sanitation Districts (SDs). The SDs were used for demographic and health related analysis in the 1890 Census (Billings, 1893). In short, each of the 22 political wards that existed in 1890 was divided up into one or more Sanitation Districts, each of which roughly corresponds to a large neighborhood. Since these designations remain reasonable neighborhoods measures, we used them in the current analysis as well. They divide the island into 109 mutually exclusive zones, and, therefore, allow for us to estimate and control for neighborhood fixed effects.[6]

{Figure 1 about here—Map of Vacant Land Sale Locations}

Table 1 gives the descriptive statistics for the sample. The dependent variables were either the log of nominal price per square foot or the log of the real price per square foot. We created real values using two different price-level indices. First, we used the U.S. Consumer Price Index for Urban Consumers (CPI-U), all items less shelter, and we used the Gross Domestic Product Deflator. In each case, 2014 is the base year.[7]

{Table 1 about here—Descriptive Statistics}

For control variables we have a corner dummy (1 if a lot was on a corner, 0 if it was an interior lot); the distance to Broadway in miles (due to its central location and importance in the city's history); and the number of subway stops within a half mile (as a measure of access to public transportation). We also used each parcel's latitude and longitude coordinates to calculate its distance in miles to the closest core – either downtown or midtown. Downtown is centered at Wall Street and Broadway, and midtown is centered at Grand Central Station. For the years 1996 to 2006, CoStar shared with us their vacant land values data. These observations constitute 10.9% percent of the sample. Thus, we created a CoStar dummy variable to account for the different sources of the data and the possibility that our respective sampling procedures might have been different.

4. Regression Results

To create the indexes, we estimated several different regression models to compare results and find the best functional form. We used hedonic pricing models that regressed the log of price per square foot on several controls, including the square footage of the plot, the location to the closest core, and access to public transportation.

[6] Marble Hill is also included in the data, but not shown on the map. This area used to be geographically part of Manhattan, but was severed and joined with the Bronx when the Harlem River Ship Canal was constructed in 1914.
[7] Note that the Bureau of Labor Statistics (BLS) does not have data for the New York City area CPI less shelter for the entire period. However, for the overlapping years that the BLS does have data (1976 to 2014), the U.S. CPI and the NYC CPI, both excluding shelter costs, were virtually identical. The correlation coefficient for the growth rates of each is 0.983; thus, the relatively rapid rise in the NYC CPI since 1950 appears to have been due to the rapid increase in the price of residential real estate.

As Figure 1 shows, some neighborhoods appear to have been "oversampled" because of the problem of abandonment in the 1970s and 1980s. For example, lots in East Harlem and the Lower East Side are in the historic tenement districts of Manhattan. As New York City lost population in the 1970s, many of these older neighborhoods suffered tremendous economic and social dislocations. As housing rent values fell and real estate taxes rose, many landlords abandoned their properties when they found themselves in such arrears that the tax bills were greater than market values of the properties. In these cases, landlords walked away from the properties and they were taken over by the city (Scafidi, 1998). While we don't have specific information on why these properties were vacant, the combined forces of disinvestment and rampart arson likely served to remove habitable structures from these properties. As the city's economy rebounded in the 1980s and 1990s, these properties were put back on the market as vacant land sales.

We took several steps to account for the possibility that formerly abandoned properties are over-sampled in our data set. First, in several of the specifications, we included SD dummy variables to account for neighborhood fixed effects. These control for location specific, time-invariant neighborhood quality, and would capture the lower prices in these neighborhoods if they systematically have poor housing or neighborhood quality.[8]

We also estimated equations including Harlem and Lower East Side variables interacted with the year and year squared to see if these neighborhoods had different price trajectories over time, as compared to the rest of the island. These neighborhoods appear to have experienced rapid decline and then a rapid rebound due to gentrification starting in the mid-1990s. In the end, these additional variables did not have large effects on the year dummy variables, and so they were excluded from presentation here.[9] Finally, we clustered the standard errors by SD in all of our specifications to account for possible neighborhood heterogeneity in the standard errors.

Table 2 gives the results for six specifications of our empirical model that we estimated using ordinary least squares. Specification (1) is our base model in which we regress the log of the nominal price per square foot on control variables, including lot characteristics (lot size, corner dummy), locational characteristics (distance to Broadway, distance to the closest core), and access to public transportation. Specification (1) also controls for time with the inclusion of a year variable. Specification (2) contains the same control variables as specification (1) except that we now control for time using a series of dummy variables (1950 is the omitted year). Specifications (3) and (4) mimic (1) and (2) in that we use the year variable in model (3) and time dummies in model (4), respectively. However, these specifications use the log of the real price per square foot as the dependent variable. Specifications (5) and (6) follow the pattern we've established in models (3) and (4): both specifications use the log of the real price per square foot as the dependent variable. Specification (5) controls for time with the year variable;

[8] The SD effects are also likely to capture the effects of zoning regulations on land values. We leave for future work a more detailed treatment of the role of zoning on land prices.
[9] Results are available upon request.

and specification (6) replaces the year with time dummy variables. In these final two regressions, however, we control for neighborhood fixed effects by including Sanitation District (SD) dummy variables.[10]

{Table 2 about here—Regression Results}

The results show coefficient estimates that largely have the expected signs. Lot area shows an inverted "u" shaped relationship with prices, as we included the square of the log of lot sizes. Small lots are likely less valued because of their awkward sizes, while lots that are quite large likely have "bulk discounts" attached to them; it's important to control for non-linearity with respect to lot size (Colwell and Munneke, 1997). Corner lots command a premium, but the magnitude of the effect varies from roughly 13% to 27% across specifications. A parcel's distance from Broadway and distance from the closest core negatively affect its value. The distance from Broadway exhibits diminishing marginal effects, as evidenced by the positive coefficient for distance to Broadway squared. Land values drop at a rate of about 43% per mile away from the core.[11] When we include the neighborhood fixed effects, statistical significance on the distance variables tends to diminish or go away. In short, these neighborhood fixed effects capture the important distance effects.[12] Lastly, while we find that access to subways has a positive coefficient, it is not statistically significant; this is likely to due to the fact that the effect of access to public transportation is also being picked up by the distance to Broadway and distance to core variables.

Of particular interest to our work are the coefficient estimates for the year variable. The estimate in specification (1) suggests an 8.5% nominal trend rate for Manhattan land values since 1950. When we use real values instead in specification (3), we estimate the trend over the 65-year period to have been 4.6%. And, finally, in specification (6), when we include neighborhood fixed effects, the estimated trend coefficient is 4.9%.

5. Land Values in Manhattan, 1950 to 2014

In this section, we now turn to our estimated land values index, which is generated from the coefficients from the year dummy variables from Equation (6) in Table 2. Figure 2 shows the index for Manhattan from 1950 to 2014 (the index values and regression coefficients with standard errors are given in Appendix A). Figure 2 presents the index created using the U.S. CPI

[10] While we did not have complete data on whether the plots were irregularly shaped or not, we did have data on this variable for a subset of observations (a dummy variable equal to one if the lot was not square or rectangular, 0 otherwise). A subsample regression with the dummy variable yield an insignificant coefficient (though positive), and little change in the value of the other coefficients.

[11] This value is similar (in absolute value) as that found in Haughwout et al. (2008), who find a gradient of -0.95 per kilometer away from the Empire State Building in general (though steeper for residential land).

[12] Interestingly, when we include the neighborhood fixed effects, the distance to core variable switches signs to be positive (though not statistically significant). One possible interpretation is that controlling for average distance, plots further away from the core, within the neighborhood, are likely to have less congestion, cet. par.

excluding shelter; Table A.1 in Appendix A gives the results with both the U.S. CPI excluding shelter and the GDP deflator; the results are broadly similar.

{Figure 2 about here—Land Values Index}

We created the index by converting the year dummy variable coefficient estimates to index values via the formula, $Index_t = 100 * exp(\hat{\beta}_t)$, for each year, *t=1950,…,2014*. 1950 is the base value, and the coefficient is zero since it was omitted from the regression. As mentioned above, the missing coefficient estimates were generated via interpolation from the period before and after (see Appendix B).

The index shows three major cycles in Manhattan land values since 1950. Measured from trough to trough, the first one lasted from 1950 to 1977. The second cycle lasted from 1977 to 1993. Finally the third cycle is the one that started in 1993, peaked in 2007, and reached a trough in 2009. In 2014, land values surpassed the 2007 values.

Our results suggest that land values have moved in long cycles that last several decades. While land prices in the city haven't been immune to fluctuations in the business cycle, it appears that some downturns in the business cycle had greater effects on the city as compared to the rest of the nation.

During each cycle, the upward trends appear to have had different characteristics. From 1950 to the peak of 1971, the average growth rate in land values was 2.8%. The run up from 1977 to 1988 was much more dramatic, with an average annual growth rate of 23.5%. Finally the run up from 1993 to 2007 had an average annual growth rate of 23.6%. However, because of the sharp declines during the city's downturns, $100 invested in the index in 1950 would have produced an average annual rate of return equal to 5.5% by 2014.

Figure 3 shows the fixed effects coefficients for each of the Sanitation Districts. By and large they have the expected magnitudes (the base neighborhood is Marble Hill). The greatest neighborhood effects are in midtown, near Grand Central Station, and in lower Manhattan, near Wall Street. Interestingly the area around Union Square is also particularly valuable. The neighborhood values are lowest in parts of the Lower East Side and the areas north of Central Park.

{Figure 3 about here—3D Map of Fixed Effect Coefficients}

6. Major Economic Events Influencing Land Values since 1950

After World War II, New York City was ascendant. It was the largest city in the world's most prosperous country. But the decades following the war produced mixed results for Manhattan's land values. While New York was able to retain its centrality as the capital of American finance, it was battling against a tide of wholesale realignment of resources and investment throughout the country, which created a great shakeout of America's older urban centers.

Manufacturing jobs, which had been a mainstay of New York's economy for over a century, were leaving the city for more profitable locations. The increased demand after World War II drove an office and apartment construction boom, which helped fuel land value growth in the city, though the historical tenement neighborhoods would lose value, fueled by increased neighborhood poverty levels and white flight to the suburbs ((Barr, 2010; Grebler, 1952).

As a whole, the city's employment grew until 1969, at which point the economy took a decided turn for the worse. From 1969 to 1977, New York City lost over 600,000 jobs or 16% of its workforce. Although the city began to recover, its economic base was changing. From 1977 to 1980, for example, the city lost 40,000 manufacturing jobs, while adding 106,000 service sector jobs. All told, between 1950 and 1980, the city lost over a half million manufacturing jobs (Ehrenhalt, 1981).

New York City's population plateaued in 1950 at just shy of eight million people. For the next 20 years the total population remained stable because an influx of African Americans and Puerto Ricans offset the loss of white residents. But, starting in the early 1970s, the city's population began a dramatic decline—losing approximately 10% of its residents in that decade. Unlike other rust-belt cities, such as Buffalo, Cleveland, and Detroit, New York's population has been rising since bottoming out around 1980. By 2000, the city set a new population record.

The 1950s and 1960s were periods of great experimentation by governments at all levels. In New York City, new, expensive policies were being implemented although the city's tax base remained relatively unchanged. Between 1956 and 1966 the New York City budget increased from $1.74 billion to $3.875 billion. Adjusted for inflation, the city's real expenditures increased 82% in the decade despite its population increasing by a mere 1.5% (David, 2012).

Starting in the 1960s, the city government began using short term financing to fund day-to-day operations. Short term debt tripled in the four years between 1971 and 1974 to $3.4 billion. By the spring of 1975, under the mayoralty of Abraham D. Beame, Wall Street was no longer willing to finance the city's mounting debt, putting the city on the brink of default. To avoid this scenario, a series of reforms were instituted. The government would cut back its expenditures, and no longer result to budget gimmicks or deficits; in return, the state promised assistance with financial restructuring. One of the lasting effects of this plan was the creation of the state Financial Control Board (FCB). If the city was ever unable to balance its budget, the FCB was authorized to take over the budgeting process. This credible threat for the loss of autonomy forced the city to keep its fiscal house in order.

Manhattan's land values reflected the post-War boom and the economic collapse in the 1970s. Between 1950 and 1971, land value growth was positive, growing from an index value of 100 to 182, an average increase of 2.8% per year. But by the trough year of 1977, the index was down to 43.

Despite many of the lingering urban problems that plagued the city, prices from there began a steady climb until peaking in 1988. The economic prospects of the country generally improved in the 1980s, and under Mayor Ed Koch the city begin to get its finances in order. The early 1980s also began to see a great bull market in stocks. In 1979, the S&P Index was at about 100, and it hit 500 by mid-1994, and average rate of increase of approximately10% per year. The run up in stock prices was, of course, a boon to Wall Street, which saw its employment rise. Important innovations on Wall Street, such as junk bonds and leveraged buyouts, also helped fuel the Street. The 1980s also saw a tremendous office building boom in both the city and the U.S. This boom helped to boost land values in the city. From a low of 43 in 1977 the land values index rose to 572 by 1988, an average increase of about 23.5% per year. New York's recovery was nothing short of remarkable. The recession of the early 1990s, as well as overbuilding, put the brakes on land value growth for a few years.

Since 1993, Manhattan has witnessed a great inflation in its land values. Part of this is due to New York's renaissance, which can be tied to several local and global factors. First, locally, crimes rates in New York City steadily declined in the 1990s. Murders across the city precipitously dropped thanks to an improving economy, higher incarceration rates, a drop in the youth in the population, and more aggressive and proactive crime fighting strategies. Some of the rise in real estate values across the city can be attributed to the improved quality of life and security that comes with less crime in the city (Schwartz, et al., 2003).

But perhaps just as importantly, after the great wave of decentralization in the U.S. subsided, New York retained its attractiveness as a city in which to live and do business. The nation's largest city has been able to grow because of the tremendous forces of agglomeration, and its ability to add buildings to the skyline (Barr 2010).

Given the renewed popularity of New York and Manhattan we would, of course, expect sharp land value growth. But, in a relatively open market extreme growth would be met by competition. A rise in prices, either in properties or land, due to an increase in demand, would be met by increased building, which would then reduce prices or price growth. Instead from 1993 to 2007, the index went from 122 to 3,317, an average annual growth rate of 23.6% per year. Dividing the index by the population of New York City or Manhattan shows a very similar trend; land value growth since 1993 has far outstripped population growth.[13] Fifteen years of nearly uninterrupted growth at such an unprecedented rate is consistent with the conclusion that the demand to work and live in Manhattan is far greater than developers' ability to supply real estate to meet this growing demand; as a result landowners appear to reaping some monopoly rents. While a detailed discussion of the supply restrictions are beyond the scope of this paper, our results suggest that the supply of housing is very inelastic. The combined effects of the city's zoning rules, rent regulations, NIMBYism, and real estate tax policies, appear to discourage new

[13] For brevity we don't show per capita index values since they are quite close to the actual index levels. But the data is available upon request.

construction (Glaeser, et al. 2005); as discussed in the Literature Review, the supply of office space in New York appears to be relatively more elastic

7. Comparison Indexes

For the sake of comparison and as robustness tests, we compare our results to other relevant benchmarks. Figure 4 shows the log of the real average price of all real estate building sales in New York over the same time period. That is to say, each year we have the log of the total value of all bona fide real estate transactions divided by the number of transactions, along with the log of the land values index. Note these are building sales (not coops or condo units). Figure 5 presents the land values index along with total New York City employment, both in logs.

{Figure 4 about here—The Land Index vs. Real Estate Prices)}

{Figure 5 about here—The Land Index vs. NYC Employment}

Generally speaking, the land values index and the sales and employment index show similar trends: growth until the 1970s, sharp declines after that, and then rapid growth since the 1990s. Employment data shows a much steeper drop in the 1970s, and much more cyclicality than land values. Sales overall have shown less volatility than the land values index, in that price drops during the downturn were less severe than with land values.

As another comparison, we investigated the real value of the Standard and Poor's Stock Index since 1950, excluding dividend reinvestments (Shiller, 2014). Figure A.3 in the Appendix shows the two indexes over time. The results show that, over the period, the real value of the S&P index grew at a slower rate as compared to the land values index. The real value went from 100 in 1950 to 1,107 in 2014, compared to 3,384 for the land values index.[14]

We also employed time series and co-integration tests. If the land values index is co-integrated with sales and employment, then it suggests that our land values index is reasonably accurate and that land values are also tied to the health of the economy more broadly. To this end, using the augmented Dickey Fuller test, we checked to see if the three series contained a unit root. We perform two versions of the test, one where we exclude a time trend and another where the trend is included. The tests show that for land values and employment we cannot reject the null hypothesis of a unit root. For the sales index, the results are inconclusive. Finally a test for a unit root in the real value of the Standard and Poor's Stock Index suggests there is one. Note the Phillips-Perron unit-root tests gives virtually the same results (not shown).

{Table 3 about here: Time Series Tests Results}

Given that all three series likely have a unit root, we next test for pair-wise cointegration to see if there is long run co-movement with the land values index. To this end, we used the Johansen test

[14] Note if the land values index was calculated using the US CPI the index value in 2014 would be 4197.

and the Engle-Granger test; we also include the p-values for the χ^2-statistic for the cointegrating equation. If the two series are co-integrated, we are likely to find the χ^{2-}statistic to be statistically significant.

The results are summarized in Table 3. We find that the real index is co-integrated with sales, and is likely co-integrated with employment; however, the results are dependent on the type of test and the specifications. These findings do suggest a long run relationship between land values and real estate sales and employment, as one would expect. For the S&P index, while we find that the cointegrating equation is statistically significant, we do not find that the cointegration tests are significant, so it's likely that these two series are not, in fact, cointegrated.

8. What's Manhattan Worth?

The land values index, as shown in Figure 2, gives the relative value of Manhattan land since 1950. In this section we perform the exercise of estimating the value of all developable land on the island. We can compare then this value with other important measures of wealth and income, and also determine the long run growth rate of the aggregate value of the island. One way to think of the exercise is to imagine that all landlords were to collectively sell their ownership claims to the land beneath the structure on the island. How much would one party be willing to pay to own those claims and collect ground rents? To estimate the long run growth rate of the price of Manhattan, as a kind of benchmark we can use the fictional price of land in 1626, when Peter Minuit "bought" the island from the Lenape Indians at the constructed price of $24 worth of trinkets and hardware.[15]

To this end, we first create a predicted value for the price per square foot for each of the island's Sanitation Districts (SD). Then, we multiply the per square foot value by the number of square feet of land in each SD. To calculate a per square foot value for each SD, we use specification (6) from Table 2. We first obtain a predicted value from a "basic" model, which is based on a specific set of assumptions and calculations. We then change some of the assumptions to this basic model to get different estimated values. Table 4 provides the different estimates we get from the different set of assumptions.

{Table 4 about here: Estimates for the Value of Manhattan}

For the basic model, we make the following assumptions: First, we take the median lot size for all observations in each SD. Next, we calculate the average number of subway stops within a half mile by taking the average value for each lot in the SD. As a simplification we assume that all SDs have 16.1% of their lots on corners, since 16.1% is the percent of lots on a corner for our entire sample. For each SD, we calculate the average distance to the closest core for each property, and the average distance to Broadway. We set the CoStar dummy to zero. For each SD

[15] In 1626, Peter Schaghen, a liaison between the States General and the Dutch West India Company, wrote a letter to the States General containing the earliest known reference to the company's purchase of Manhattan for a price of 60 guilders. Nineteenth century historian Edmund O'Callaghan estimated that it was equivalent to $24.

we add in the value of the SD fixed effect, and the 2014 year dummy coefficient.[16] Since the dependent variable is the log of the price per square foot, we exponentiate the predicted value. We then multiply the exponent of the predicted value by an adjustment factor since without it the predicted value is biased downward (Wooldridge, 2012, p. 207). We calculated the adjustment factor by the formula $\hat{\delta} = \exp(\hat{\sigma}^2/2)$, where $\hat{\sigma}$ is the standard error of the regression. Equation (1) summarizes how we calculated a predicted value for the i^{th} Sanitation District:

$$\widehat{PPSF}_i = \hat{\delta} exp\left(\hat{\alpha}_0 + \boldsymbol{\hat{\alpha}\bar{x}} + \widehat{SD}_i + \hat{\tau}_{2014}\right), \quad (1)$$

where $\hat{\delta} = 1.99$ is the adjustment factor, $\hat{\alpha}_0$ is the estimated constant, $\boldsymbol{\hat{\alpha}\bar{x}}$ are the average or median values for the right hand side variables for each SD times the respective estimated coefficients, SD_i is the fixed effects coefficient for the i^{th} SD, and $\hat{\tau}_{2014}$ is the year coefficient for the 2014 dummy variable.

Given $\widehat{PPSF}_i$, we then get a total price per sanitation district using the formula:

$$\widehat{PPSD}_i = 0.6 * 43{,}560 * Acres_i * \widehat{PPSF}_i,$$

where $Acres_i$ is the number of acres in the i^{th} SD. There are 43,560 square feet in an acre. 0.6 is our estimate of amount of land on Manhattan that is developable, i.e. usable for real estate. That is to say, 40% of Manhattan is used for streets, avenues, parks, docks, and other undevelopable land (see Appendix A for more information). Also note that we do not have land values data within two SDs. In these cases, we calculated the average price per square foot for each one by taking an unweighted average of the predicted PPSF of the surrounding SDs.

We estimate the value of Manhattan by summing up the value of all the Sanitation Districts, i.e., $Manhattan\ Value = \sum_i^N \widehat{PPSD}_i$, where $N=109$, the total number of SDs on the island.

The altered versions of our basic model uses the same methodology described above, but each alteration changes one key component of the model. The first alteration uses the average lot size instead of the median for each SD. The second alteration is based on the assumption that 10.9% of the lots are of the “CoStar” variety (i.e., we assume the CoStar variable is 0.109), and using the median lot sizes. The fourth iteration sets the CoStar variable to 0.109 and uses average lot sizes. Increasing the CoStar value raises the estimates since the CoStar dummy coefficient is relatively large.[17]

Across the four estimates, the value of Manhattan for 2014 ranges from $1,541 billion to $1,948 billion. As a comparison, the total GDP of New York State in 2014 was $1404.5 billion (recognizing this is a flow, whereas the land values is a stock) (FRED Economic Data, 2015).

[16] Note that since we had missing data for the second half of 2014, the year dummy coefficient was determined by taking the average of the 2014 coefficient for the first six months and the coefficient for the first quarter of 2015.
[17] As we describe in Appendix B, we believe the size of the coefficient reflects the different way that CoStar collects its data.

The combined stork market capitalization of the three largest U.S. corporations, Apple, Exxon Mobile, and Microsoft in the last quarter of 2014 was about $1,422 billion (Financial Times, 2015). Using the formula *r=ln(Est. total value 2014/24)/(2014-1626)* to calculate the average annual return since 1626, gives a range of 6.414% to 6.474% across the specifications.

One caveat is in order. Our results, of course, are based on the price of vacant land. Thus, our estimates for Manhattan's value implicitly assume that all land is "unencumbered" in the sense that landlords who wish to build on these lots do not have to abide by price controls or other restrictions (other than the standard zoning rules). Presently, about half of the rental units in Manhattan are rent stabilized (Furman Center, 2014); as such this would likely put downward pressure on land values for these properties. Furthermore, about 10% of developable land in Manhattan falls within a landmarked district, possibly lowering land values there (Been, et al. 2014).[18] However, if these regulations cause land values in unrestricted neighborhoods to be even higher, then the net effect for Manhattan as whole remains ambiguous. In short, our results represent a first estimate for the value of Manhattan.

9. **Conclusion**

We create a land values index for Manhattan from 1950 to 2014. By calculating an index over such a long period we have been able to trace how the island fared after the great wave of decentralization following World War II. We find that the island's land prices since 1950 have shown several important characteristics. First, we observe three major cycles. The first was from 1950 to 1977, the second from 1977 to 1993, and the third was from 1993 to 2009.

We find that the real index, based in the U.S. CPI, excluding shelter, increased from 100 in 1950 to 3,384 in 2014, which gives an average annual growth rate of 5.5%. However, there have been several noteworthy trends over the period. During the first cycle land values rose relatively slowly; but between 1971 and 1977 land values plummeted; at the trough prices were 57% lower than in 1950. From their nadir in 1977, land values have shown rapid growth, though the 1980s run-up proved unsustainable with a steep decline in the early 1990s.

Since 1993, however, land values have shown such a dramatic rise that it reinforces the idea that there are strong barriers to entry in the real estate development market. Both the index and index values per capita show a similar result. Our findings are similar to other works that study the price of urban and residential land, including Davis and Palumbo (2008), Haughwout et al. (2008) and work cited in Gyorko and Malloy (2014).

Our estimates suggest that increased real estate and land use regulations have limited the supply of new construction, which, in turn, confers a benefit to land owners, who can accrue monopoly rents from lack of entry in the real estate market. Glaeser et al. (2005) find that regulations in

[18] Authors' estimate based on the New York City's PLUTO file (NYC Dept. of City Planning)

residential construction in Manhattan are able to account for the large deviation of housing prices from the marginal costs of construction.

Finally, using our regressions to create predicted values for land prices, we estimate that the value of developable land in 2014 on Manhattan was about $1,740 billion, or a long run rate of return equal to approximately 6.4%.

References

Atack, J., and Margo, R. A. (1998). "'Location, Location, Location!' The Price Gradient for Vacant Urban Land: New York, 1835 to 1900." The Journal of Real Estate Finance and Economics, 16(2), 151-172.

Barr, J. (2010). "Skyscrapers and the Skyline: Manhattan, 1895–2004." Real Estate Economics, 38(3), 567-597.

Barr, J (2012). "Skyscraper Height." Journal of Real Estate Finance and Economics, 45(3), 723-753.

Been, V., I., E., and M. Gedal, M. (2009) "Teardowns and Land Values in New York City." Lincoln Institute Working Paper, ID WP09VB2.

Been, V., Ellen, I. G., Gedal, M., Glaeser, E., & McCabe, B. J. (2014). "Preserving History or Hindering Growth? The Heterogeneous Effects of Historic Districts on Local Housing Markets in New York City." NBER Working Paper #w20446.

Billings, J. S. (1894). "Vital Statistics of New York City and Brooklyn: Covering a Period of Six Years Ending May 31, 1890." U.S. Census Office: Washington DC.

Butler, R. V. (1982). "The Specification of Hedonic Indexes for Urban Housing." Land Economics, 96-108.

Clapp, J. M., Giaccotto, C., and Tirtiroglu, D. (1991). "Housing Price Indices Based on All Transactions Compared to Repeat Subsamples." Real Estate Economics, 19 (3), 270-285.

Colwell, P. F., & Munneke, H. J. (1997). "The Structure of Urban Land Prices." Journal of Urban Economics, 41(3), 321-336.

Cushman & Wakefield. (2014) "Market Beat Office Snapshot." Second Quarter.

David, G. (2012). Modern New York: The Life and Economics of a City. New York: Palgrave MacMillan.

Davis, M. A. & Palumbo, M. G. (2008). "The Price of Residential Land in Large US Cities." Journal of Urban Economics, 63(1), 352-384.

Ehrenhalt, S. M. (1981). "Some Perspectives on the New York City Economy in a Time of Change." In: Eds. Benjamin J. Klebaner. New York City's Changing Economics Base. New York: Pica Press.

Financial Times (2015). FT Global 500. FT.com (June 19).

First American Real Estate Solutions (various years). Manhattan Realty Report. Weehawken.

NYU Furman Center (2004). “Profile of Rent-Stabilized Units and Tenants in New York City.”

Glaeser, E. L., Gyourko, J., and Saks, R. (2005). “Why is Manhattan so Expensive? Regulations and the Rise of Housing Prices.” Journal of Law and Economics, 48(2), 331-369.

Grebler, L., (1952). Housing Market Behavior in a Declining Area: Long-term Changes in Inventory and Utilization of Housing on New York's Lower East Side. New York: Columbia University Press.

Greene, W. H. (2008). Econometric Analysis, 6th ed. New York Pearson Prentice Hall.

Gyourko, J, and Molloy, R. (2014). “Regulation and Housing Supply.” NBER Working Paper No. 20536.

Haurin, D. R., and Hendershott, P. H. (1991). “House Price Indexes: Issues and Results.” Real Estate Economics, 19(3), 259-269.

Haughwout, A., Orr, J, and David Bedoll, D. (2008). “The Price of Land in the New York Metropolitan Area.” Current Issues in Economics and Finance, 14(3).

Hoyt, H. (1933). One Hundred Years of Land Values in Chicago: The Relationship of the Growth of Chicago to the Rise of Its Land Values, 1830-1933. BeardBooks: Washington DC.

McMillen, D. P. (1996). “One Hundred Fifty Years of Land Values in Chicago: a Nonparametric Approach.” Journal of Urban Economics, 40(1), 100-124.

Nicholas, T., and Scherbina, A. (2013). “Real Estate Prices during the Roaring Twenties and the Great Depression.” Real Estate Economics, 41(2), 278-309.

Perlberg, H. (2014). “Manhattan Apartment Rents Jump as Vacancy Rate Tumbles.” Bloomberg News, July 20.

Real Estate Board of New York (various years). Manhattan Open Market Sales. New York.

REDI Real Estate Information Service. (1990-1992) REDI Realty Report. New York.

Scafidi, B. P., Schill, M. H., Wachter, S. M., & Culhane, D. P. (1998). “An Economic Analysis of Housing Abandonment.” Journal of Housing Economics, 7(4), 287-303.

Schwartz, A. E., Susin, S., & Voicu, I. (2003). “Has Falling Crime Driven New York City's Real Estate Boom?” Journal of Housing Research, 14(1), 101-136.

Shiller, R. (2014). Standard and Poors Stock Index Data Set. URL: www.econ.yale.edu/~shiller/data/ie_data.xls. Accessed. November, 2014.

Smith, F. H. (2003). “Historical Evidence on the Monocentric Urban Model: A Case Study of Cleveland, 1915–1980.” Applied Economics Letters, 10(11), 729-731.

Spengler, E. H. (1930). Land Values in New York in Relation to Transit Facilities.” AMS Press: New York.

TRW REDI Property Data (1993-1998). TRW REDI Realty Report. Weehawken.

Wheaton, W. C., Baranski, M. S. and Templeton, C. A. (2009) “100 Years of Commercial Real Estate Prices in Manhattan.” Real Estate Economics 37(1), 69-83.

Williamson, S. H. (2014) “What Was the U.S. GDP Then?” MeasuringWorth. URL: http://www.measuringworth.org/usgdp/.

Wooldridge. J. (2012). Introductory Econometrics: A Modern Approach, 5th edition. Mason: Southern-Western

Appendix A: Additional Tables and Graphs

{Table A.1. about here—Index Values}

{Figures A.1., A.2. A.3. about here}

To calculate the total developable land and the total land dedicated to housing, we used the PLUTO file from the New York Department of City Planning. This database lists every lot of land, the lot size, and the current structure type and use. From this we added up the total land dedicated to the 14 major categories listed in PLUTO, and which are given in Table A.2. The total land for all uses is 11,063 acres. All of Manhattan is 14,528 acres (22.7 square miles), or 76%. To calculate all developable land we removed specific subcategories: Parks, Beaches, Bridges, Tunnels, Highways and Land under water); this gave 60% of all of Manhattan. To calculate land use for housing we added up total from categories 2, 3, 7 and 9, and divided by *.6xtotal Manhattan land area* to get 48% of developable land is used for buildings that contain housing.

{Table A.2. about here -- Land Uses for Manhattan}

Figure A.4 compares our index to three other indexes. The first is the average annual land values index for housing in the New York metropolitan area from 1985 to 2014 from Morris and Palumbo (2008), as posted on http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp. The second set are indexes are from Haughwout, et al. (2008) using vacant land sales from New York City and northern New Jersey from 1999 to 2006. They give two separate indexes, one for residential land and one for commercial land. The graphs here are the average of the quarterly values for each year. Figure A.4 shows that all four indexes generally show similar movements for the respective overlapping years. From 1996 to 2006 our index and the Haughwout et al (2008) index for residential land are nearly the same. Overall, the Morris and Palumbo (2008) index is smoother and less volatile than our index.

{Figure A.4 about here}

Appendix B: Data Sources and Preparation

-Land Value Data: The data are collected from several sources. For most years, the data are from volumes that list all real estate transaction in Manhattan for a given year. From 1950 to 1992, the volumes were published by the Real Estate Board of New York. From 1990-1992 REDI Real Estate Information Service; from 1997 to 2015, the volumes were published by First American Real Estate Solutions or First American CoreLogic. For the years 1969, 1970, 1973, 1981 and 1983 we obtained data from *The Record and Guide Quarterly*. From these volumes we typed all transactions that were coded as vacant. In general, from each entry we able to obtain the price, the lot size, address, block and lot number, and the date of the sale. We omitted all transactions less than $500, because anything less strongly suggested it was not a bona fide open market sale. Note, for example, that in the year 2013, there were 26,715 transfers of title. Of those, 6,402 had a price of zero. In other words, a large fraction of title transfers are not open market sales; thus it's often difficult to distinguish arms-length transactions at the low end of the price scale. Also note that in our data set in several cases more than one lot was sold as part of the transaction (these were noted in the sales volumes with a * next to the price). In these cases, we looked up the lot and block numbers in Sanborn Land Book atlases (in years before the sale) to get the size of all the lots in the transaction. While we can't say with perfect certainty that we have the exact size of all the lots, we are did our best to ensure their accuracy. As noted in the text, we used Sanborn land books and Google maps to determine if the lot was on a corner or not. Each lot was then geocoded in ArcGis to obtain latitude and longitude to calculate the distance to important locations. Non-identified locations were then found via http://itouchmap.com/latlong.html. The distance formula was the same one used in Barr (2012), which is the straight line distance between two points in miles. For several years in the period 1996 to 2006, volumes were not available. CoStar generously provided its vacant land value data for Manhattan for this period. This data was from the same source for the index in Haughwout et. al. (2009). Note that based on a comparison of the two dataset for overlapping years, it seems that they oversample land in midtown and downtown versus the data in the real estate volumes discussed above. It's also likely that they also included land that had a teardown structure. As a result average land values from the CoStar are significantly higher than from the Realty Reports. Also for the index, for the year 1975, and the second half of 2014, we unable to obtain any sales data, thus

we calculated the index by taking the average of the coefficient estimates for the period before and after, and then taking the exponent of the value and multiplying times 100.

- *Consumer Price Index for All Urban Consumers: All items less shelter*: Series Id: CUUR0000SA0L2.

-*Subway stops*: http://spatialityblog.com/2010/07/08/mta-gis-data-update/

-*GDP Deflator*: Williamson (2014).

-*Sanitation District Boundaries*: Billings (1894).

-*Real Estate Sales Index*: 1950-1992: *Manhattan Open Market Sales (1992).* 1993-2002: Data provided directly from New York City Department of Finance 2003 to 2013: http://www1.nyc.gov/site/finance/taxes/property-annualized-sales-update.page. Note for 1993 to 20014 data is bona fide building transactions of $10,00 or more.

-*New York City Employment*: Total non-farm: 1990-2013: http://labor.ny.gov/stats/cesemp.asp

-*Land use and lot sizes for all Manhattan*: PLUTO file New York Department of City Planning. http://www.nyc.gov/html/dcp/html/bytes/dwn_pluto_mappluto.shtml.

Tables

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.	# Obs.
Year	1981.8	19.7	1950	2015	3,592
Price ($)	3,132,659	15,500,000	500	345,000,000	3,591
Lot Area (sq. ft.)	7,595	15,520	196	500,000	3,591
# of Transactions per Year	56.35	32.31	4	143	63
CPI-U, No Shelter**	0.44	0.31	0.10	1.00	66
GDP Deflator**	0.49	0.30	0.13	1.00	66
Price per Square Foot ($)	341.56	1,264.57	0.02	33,540.85	3,591
Real Price per Square Foot ($USCPI-U, No shelter)	476.87	1,462.83	0.10	33,982.62	3,591
Real Price per Square Foot ($Deflator)	438.21	1,402.36	0.09	34,051.62	3,591
Corner Dummy	0.16				3,592
CoStar Dummy	0.11				3,592
Distance to Closest Core (miles)	2.82	2.07	0.08	9.37	3,592
Distance to Broadway (miles)	0.68	0.40	0.00	1.93	3,592
# Subway Stops w/in Half Mile	5.11	3.89	0.00	19.00	3,592
Sanitation Districts Area (acres)	115.23	22.30	23	2,343	107

**2014=1.00.

Table 2: Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	**Ln(PPSF)**	**Ln(PPSF)**	**Ln(Real PPSF)**	**Ln(Real PPSF)**	**Ln(Real PPSF)**	**Ln(Real PPSF)**
ln(Lot Area)	1.42	1.61	1.39	1.61	1.07	1.32
	(3.82)**	(4.61)**	(3.72)**	(4.61)**	(3.39)**	(4.22)**
ln(Lot Area)^2	-0.078	-0.086	-0.076	-0.086	-0.067	-0.077
	(3.79)**	(4.35)**	(3.66)**	(4.35)**	(3.81)**	(4.40)**
Corner Dummy	0.261	0.149	0.273	0.149	0.237	0.132
	(3.38)**	(2.15)*	(3.42)**	(2.15)*	(2.94)**	(1.90)
Dist. to Broadway (miles)	-2.15	-2.23	-2.15	-2.23	-0.358	-0.485
	(5.55)**	(5.38)**	(5.55)**	(5.38)**	(0.90)	(1.14)
Dist. to Broadway^2	0.906	0.942	0.899	0.942	0.188	0.161
	(3.80)**	(3.60)**	(3.76)**	(3.60)**	(0.95)	(0.71)
Dist. to Closest Core (miles)	-0.427	-0.449	-0.423	-0.449	0.080	0.067
	(9.60)**	(10.67)**	(9.39)**	(10.67)**	(1.20)	(1.13)
CoStar Dummy	0.826	0.863	0.847	0.863	0.723	0.534
	(10.67)**	(6.47)**	(10.41)**	(6.47)**	(7.59)**	(4.21)**
# Subway Stops w/in 0.5 Mile	0.013	0.016	0.015	0.016	0.024	0.021
	(0.70)	(0.89)	(0.80)	(0.89)	(0.87)	(0.78)
Year	0.085		0.046		0.049	
	(45.10)**		(24.12)**		(28.82)**	
Constant	-169.6	-4.1	-92.0	-2.0	-98.1	-2.3
	(42.36)**	(2.67)**	(22.80)**	(1.26)	(25.65)**	(1.66)
Year Dummies		Yes		Yes		Yes
SD Fixed Effects					Yes	Yes
R^2	0.67	0.74	0.50	0.62	0.58	0.69

Note: Standard errors are clustered by Sanitation Districts. *significant at 5%; ** significant at 1%. All regressions have 3,587 observations. Real prices are based on the U.S. CPI-U excluding shelter. Graph of year dummy coefficients for Eq. (6) are given in Figure A.1. PPSF=price per square foot. Note the f-statistics for joint tests of the year dummies coefficients and the SD fixed effect dummy coefficients, respectively, are all statistically significant at less than the 1% level.

Table 3: Time Series Tests

Augmented Dickey Fuller Test for Unit Root			
Variable	**No Trend**	**Trend**	**P-Val. For Trend**
ln(Real Index)	0.92	0.52	0.02
ln(Sales)	0.89	0.06	0.00
ln(Employment)	0.95	0.98	0.13
ln(S&P)	0.67	0.61	0.12

Cointegration Tests					
	Johansen Test (Rank selected)		**Engle-Granger (p-value)***		**C.E.**
Pairs	**No Trend**	**Trend**	**No Trend**	**Trend**	**P>chi2****
Ln(Index) & Ln(Sales)	0	>1	<0.05	<0.05	0.0
Ln(Index) & Ln(Employment)	0	0	>0.10	<0.01	0.0
Ln(Index) & Ln(S&P)	0	0	>0.10	>0.10	0.0

Note that the null hypothesis for the Augmented Dickey Fuller test is that there is a unit root. p-values are given, and values<0.1 suggest a rejection of the null hypothesis. The p-value for the trend in ADF regression shows if a trend should be included in the test. The Johansen Test tests to see if two variables are co-integrated. The rank tells the number of cointegrating vectors. A rank of 0 suggests no co-integration. The null hypothesis for Engle-Granger test is no co-integration. A rejection of the null (i.e., p-values less than 0.10) suggests cointegration. The p-value for the cointegrating equation is from a vector error correction model and suggests if the error correction terms needs to be part of the VAR equation or not (see Greene, 2008, chapter 22). All price series are real, using the US CPI excluding shelter.

Table 4: Estimates for the Value of Manhattan (2014).

Est. #	Lot Size	CoStar Dummy Value	Manhattan Value ($Billion)	Avg. Annual Return
1	Median	0.000	1,838	0.0646
2	Average	0.000	1,541	0.0641
3	Median	0.109	1,948	0.0647
4	Average	0.109	1,633	0.0643

Note: Average annual return assumes that the Dutch purchased Manhattan for $24 in 1626. Return formula is *r=ln(est value 2014/24)/(2014-1626).* See text for different assumptions for lot size and CoStar dummy value.

Figures

Figure 1: Vacant Land Locations in Manhattan, 1950 to 2014. Red Boundaries are Sanitation Districts from 1890.

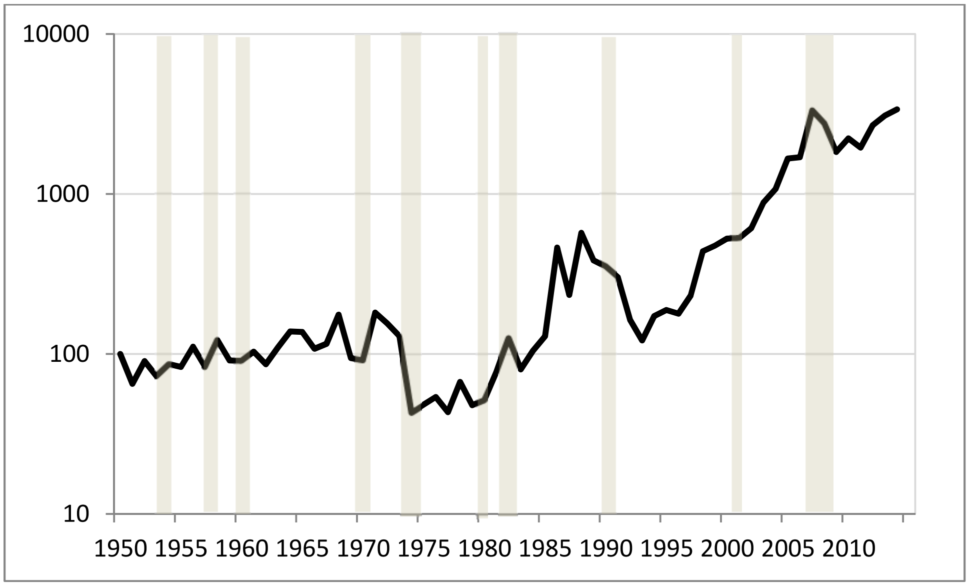

Figure 2: Real Land Values Index for Manhattan, 1950-2014, (1950=100). Note $\log_{10}$ Scale. Gray boxes are approximate recession dates. Underlying coefficients are From Table 2, Eq. (6).

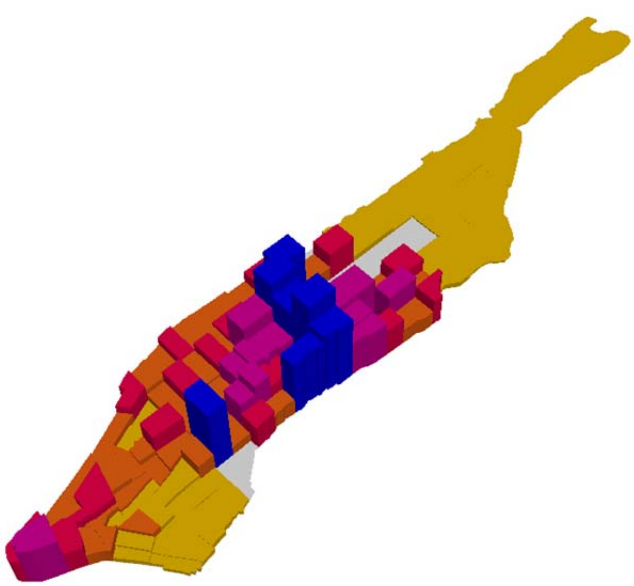

Figure 3: Exp(Real SD Fixed Effects Coefficients) from Table 2, Eq (6).

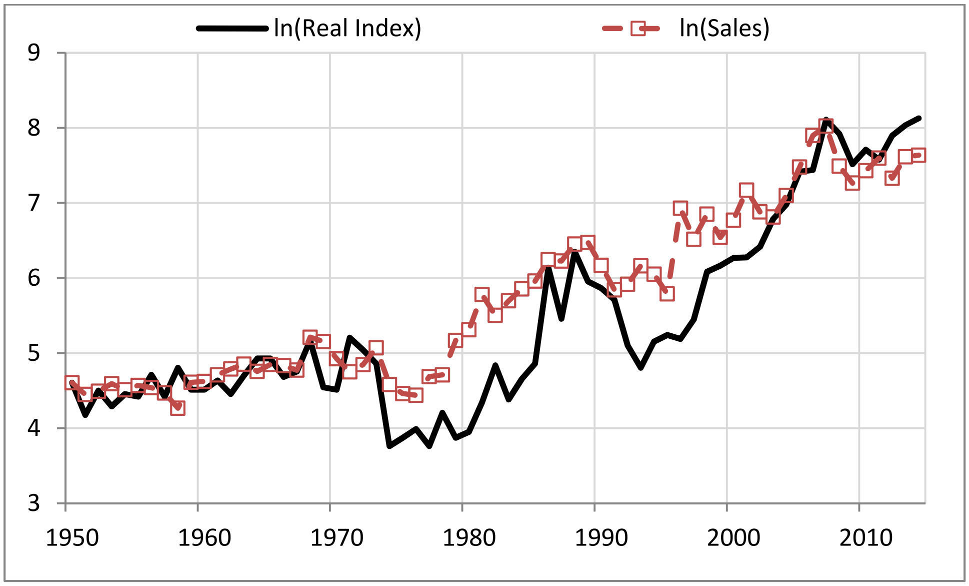

Figure 4: Land Values Index and Manhattan Real Estate Sales Price Index, 1950-2014

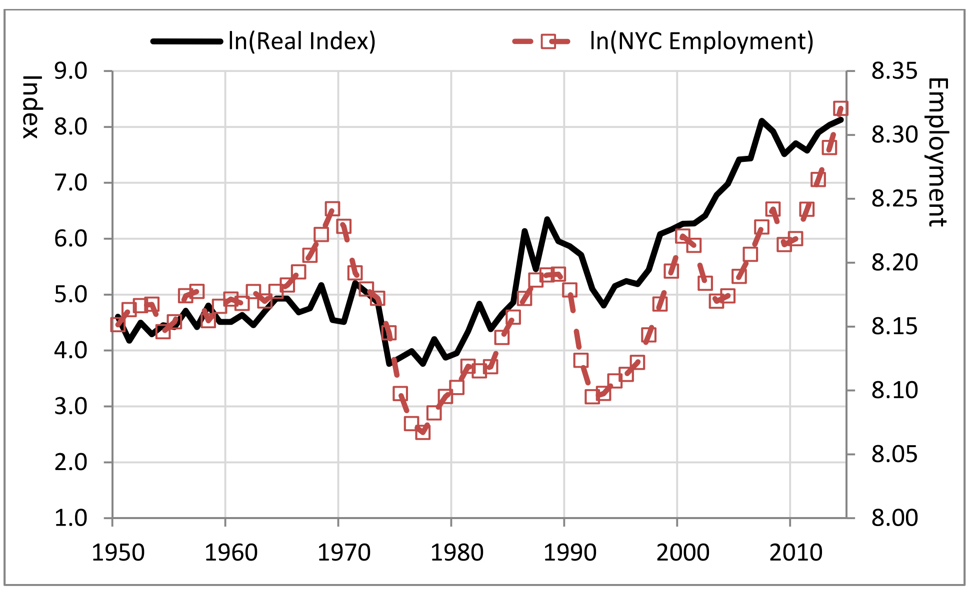

Figure 5: Land values index and NYC total employment. Note axes are adjusted to show relative co-movements of two series. The ratio of land values to employment has a positive trend since 1950.

Appendix A: Figures and Tables

Table A.1: Index Values

Year	Nominal Index	Real Index CPU-U No Shelter*	Real Index Deflator*	Year	Nominal Index	Real Index CPU-U No Shelter*	Real Index Deflator*
1950	100	100	100	**1983**	311	80	80
1951	71	65	66	**1984**	423	105	105
1952	100	90	92	**1985**	538	129	129
1953	81	73	73	**1986**	1946	463	459
1954	96	86	86	**1987**	1017	234	233
1955	92	83	81	**1988**	2581	572	573
1956	124	111	106	**1989**	1820	385	389
1957	96	83	79	**1990**	1760	353	363
1958	146	122	118	**1991**	1569	302	313
1959	110	91	88	**1992**	876	164	171
1960	110	91	87	**1993**	669	122	127
1961	127	103	99	**1994**	972	173	181
1962	107	86	83	**1995**	1090	189	199
1963	139	110	106	**1996**	1063	179	191
1964	177	138	132	**1997**	1405	232	248
1965	178	138	131	**1998**	2685	439	468
1966	144	108	103	**1999**	2969	476	510
1967	159	116	110	**2000**	3397	527	571
1968	251	176	168	**2001**	3499	530	575
1969	141	94	90	**2002**	4062	611	657
1970	143	91	87	**2003**	6007	884	952
1971	297	182	171	**2004**	7499	1075	1157
1972	261	155	144	**2005**	12053	1665	1803
1973	232	129	121	**2006**	12683	1698	1841
1974	86	43	41	**2007**	25376	3317	3585
1975	104	48	46	**2008**	21977	2749	3047
1976	124	54	52	**2009**	14508	1834	1996
1977	106	43	42	**2010**	18084	2228	2459
1978	175	67	64	**2011**	16478	1951	2194
1979	138	48	47	**2012**	23174	2689	3031
1980	167	52	52	**2013**	26904	3089	3469
1981	273	77	78	**2014**	29482	3384	3739
1982	472	126	126				

*2014 Price Indexes=1.00

Table A.2: Land Use Types in Manhattan, 2013

Type #	Real Estate Type	Total Lot Area (Acres)	Percent
1	Open Space & Outdoor Recreation	2,781.6	25.1
2	Multi-Family Elevator Buildings	1,771.9	16.0
3	Mixed Residential & Commercial Buildings	1,477.8	13.4
4	Public Facilities & Institutions	1,291.4	11.7
5	Commercial & Office Buildings	1,186.9	10.7
6	Transportation & Utility	809.4	7.3
7	Multi-Family Walk-Up Buildings	780.6	7.1
8	Vacant Land	350.4	3.2
9	One & Two Family Buildings	160.0	1.4
10	Parking Facilities	153.6	1.4
11	Industrial & Manufacturing Buildings	150.8	1.4
12	Other	140.3	1.3
13	Land under Water	7.8	0.1
14	Easements	0.5	0.0
	Total	**11,062.9**	**100**
	Manhattan Island	**14,528.0**	

Source: NYC PLUTO File, New York City Department of City Planning (2013).

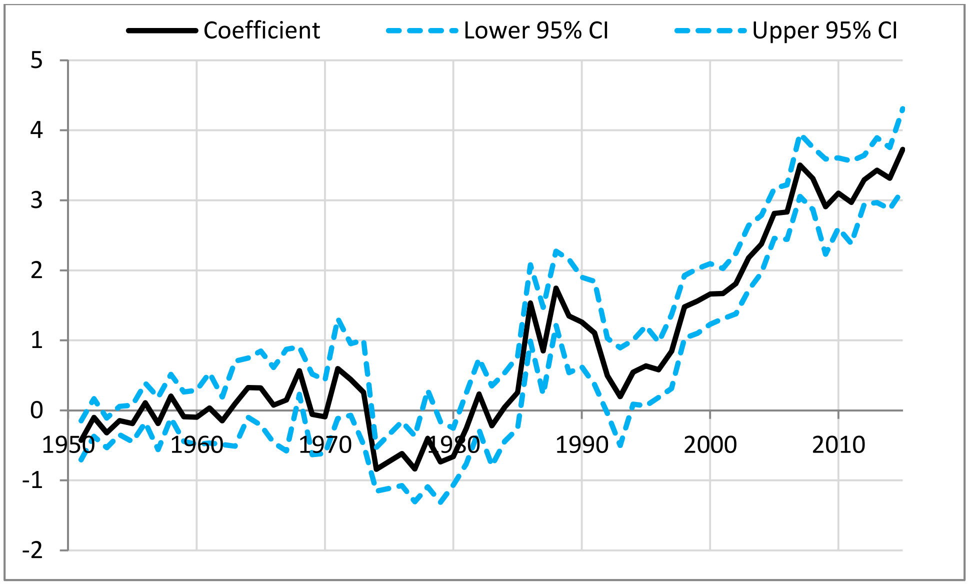

Figure A.1: Coefficient estimates for year dummies, with 95% confidence interval bands, from Table 2, Eq. (6).

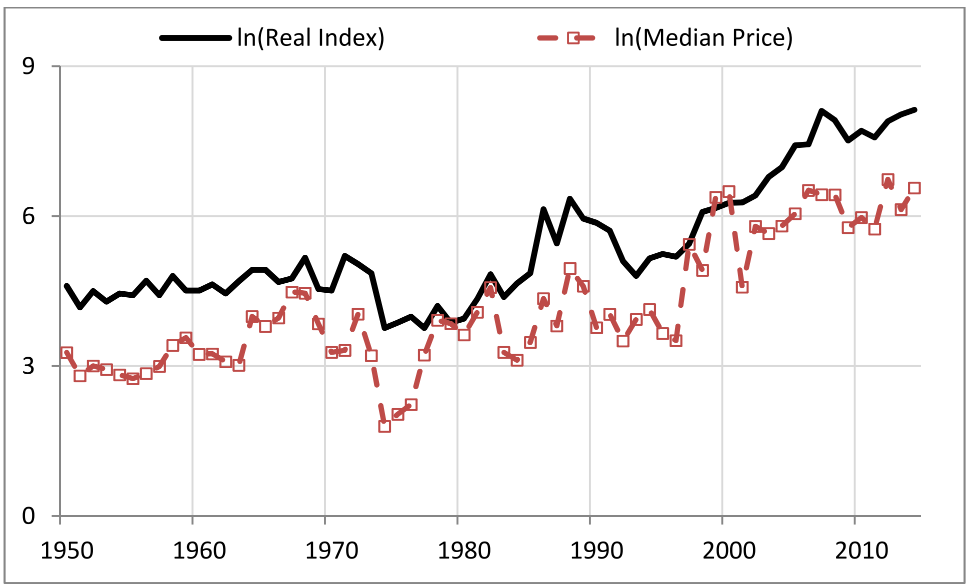

Figure A.2: Real median land price per square foot and the land values index, 1950-2014.

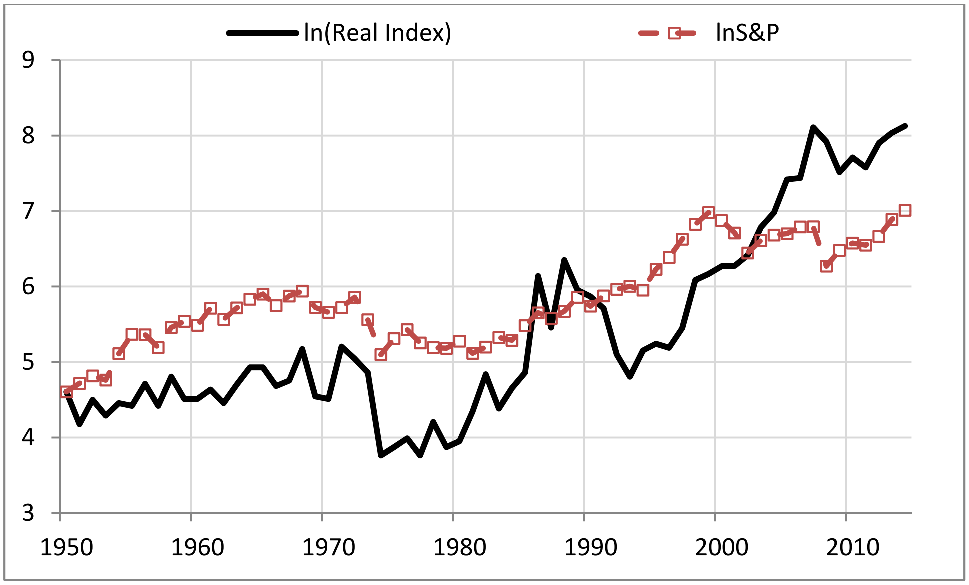

Figure A.3: Normalized real S&P index vs. land values index, 1950-2014.

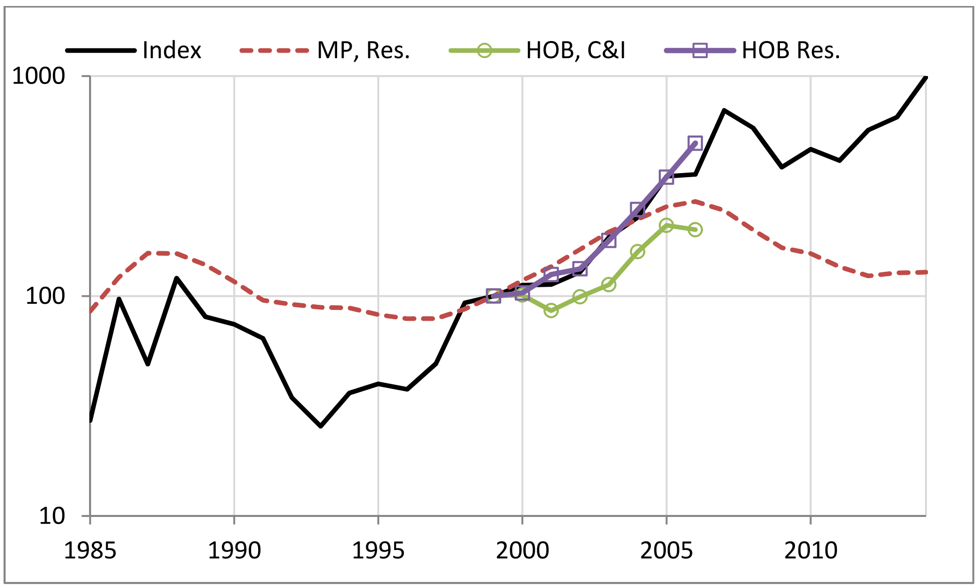

Figure A.4: Comparison of different land values indexes. The black line is the index from this paper. The red line is from Morris and Polumbo (MP) (2008). The purple line is from Haughwout et al. (HOB) (2008) for residential land; the green line is for commercial and industrial land. 1999=100. Note: $\log_{10}$ scale.