What's Manhattan Worth?
A Land Values Index from 1950 to 2013[°]

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Abstract

Using vacant land sales, we construct a land value index for Manhattan from 1950 to 2013. We find three major cycles (1950 to 1977, 1977 to 1993, and 1993 to 2007), with land values reaching their nadir in 1977, two years after the city's fiscal crises. Overall, we find the average annual real growth rate to be 5.1%. 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 to be worth approximately $825 billion. This would suggest an average annual return of 6.3% 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 earth. Many American cities seemed poised for decades of economic success, as they reached population totals never experienced before. A thoughtful observer might have predicted 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 – Baltimore, Cleveland, Detroit, 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 cities have experienced a renaissance in the three and a half decades since 1980, few have returned to the population levels they experienced 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. More specifically, using a newly assembled data set that contains transactional data for vacant parcels of land on Manhattan, we are able to provide a first look at how these forces affected the price for vacant land (controlling for each parcel's key characteristics). Our results not only allow us to examine how the price of vacant land in Manhattan has changed over time, but we've also taken preliminary steps towards gaining an understanding of how neighborhood/location effects shaped land prices as well. Finally, we've used the results from our empirical work to construct a land value index for the entire period. The index has allowed us to compare the returns form investment in land in Manhattan with the returns from alternative investment options.

In summary, we find that the real index, based on the New York CPI, increased from 100 in 1950 to 2513 in 2013, which gives an average annual growth rate of 5.1%.[1] However, there have

[1] Throughout the paper, average annual growth rates are determined by $r_t=[ln(Index)_t-ln(Index)_{t-n}]/(t-(t-n))$

been three major land value cycles (1950-1977, 1977-1993 and 1993-2007). 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 entire value of Manhattan, our estimates range from $784 to $867 billion (with an average of $825 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 show that the land value index is co-integrated with employment and sales. Further, since 1950 land values have risen faster than the S&P stock index.

The rest of this paper proceeds as follows. The next section reviews the relevant literature. Section 3, reviews the data set. Following that, Section 4, gives the regression results. Section 5 reviews the index results. Then Section 6 discusses the major events in New York's history that affected its land values. Then Section 7 compares the land value index to other time series. Section 8 discusses 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 one hundred years. 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 better understand 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 property values may have a difficult (if not impossible) 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 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 value 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. 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 more complete 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, on average, been worth $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 New Jersey and New York counties surrounding the city. Interestingly for the same time period their index shows greater growth than ours. 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.

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

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[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.

economic profit condition. However, returns over the century have been highly volatile from decade to decade.

The results in Wheaton et al. (200) coupled with our results that indicate rising land values in Manhattan, suggest that housing market constraints—the kind discussed in Glaeser et al. (2005)—are the cause of this rise, given that about 48% of Manhattan's developable land is currently used for housing (see Appendix A for this calculation). In the second quarter of 2014, for example, the office vacancy rate was 10.3%, while the apartment vacancy rate was 1.64% (Cushman & Wakefield, 2014; Perlberg, 2014).

Building on the works of Atack and Margo (1998) as well as Nicholas and Scherbina (2013), our paper makes a contribution to the urban economics literature by creating and analyzing a new land value data set for Manhattan over a six-decade period. In addition, we have constructed a newly assembled index of land value sales.

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.[3] We collected all the bona fide vacant land transactions from each year from 1950 to 2013; all told we were able to collect data for 3,380 sales. For each entry, we then obtained latitude and longitude coordinates, and 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 was 58.3 (the median is 52). The standard deviation is 32 observations per year. The minimum was four in 1971; the maximum was 143 in 1986 (see Appendix A). We were unable to obtain vacant land transactions for the years 1969, 1970, 1973, 1975, 1981, and 1983. Index values for these years were interpolated from prior and future values (see Appendix B).

Figure 1 shows a map of the locations of all of the transactions in our data set. Also on the map are the Sanitation Districts (SDs). These 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, which roughly correspond to a large neighborhood. Since these designations remain reasonable neighborhoods measures, we

[3] 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 not reason to believe there is some systemic problem with the lots in our sample.

used them in the current analysis as well. They divide the island into 110 mutually exclusive zones, and therefore, allow for us to estimate and control for neighborhood fixed effects.[4]

{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 New York City metropolitan area Consumer Price Index, and, then we used the Gross Domestic Product Deflator. In each case we used 2013 as the base year.

{Table 1 about here—Descriptive Statistics}

For control variables we have a corner dummy (1 if lot was on a corner, 0 if 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 (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 – 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 Co. shared with us their vacant land values data. These observations constitute 11.6% 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 procedure 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.

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 rent values fell and real estate taxes rose, many landlords abandoned their properties when they found themselves in such tax 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.

[4] 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.

To account for the possibility that formerly abandoned are over-sampled in our data set, we took several steps. First, in several of the specifications, we included SD dummy variables to account for neighborhood fixed effects. This controls for specific, time-invariant neighborhood quality, and would capture the lower prices in these neighborhoods if they systematically have poor housing or neighborhood quality.[5]

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 rapid rebounding, in part, 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.[6] 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. Equation (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. Equation (1) also controls for time with the inclusion of a year variable. Equation (2) contains the same control variable as Equation (1) except that we now control for time using a series of dummy variables (1950 is the omitted year). Equations (3) and (4) mimic Equations (1) and (2) in that we use "year" in equation (3) and time dummies in Equation (4). However, these specifications use the log of the real price per square foot as the dependent variable.[7] Equations (5) and (6) follow the pattern we've established in Equations (3) and (4): Both specifications use the log of the real price per square foot as the dependent variable, Equation (5) controls for time with the "year" variable, and Equation (6) replaces "year" with time dummy variables. In these final two specifications of our model we control for neighborhood fixed effects by including Sanitation District (SD) dummy variables.

{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 less valued because of their awkward sizes, while lots that are quite large likely have "bulk discounts" attached to them (Colwell and Munneke, 1997). Based on Equation (1) the most valued lot size is about 7,627 square feet, on average. Standard lots in Manhattan are normally 25'*x*100'=2,500 square feet; so the optimal value is about three standard lots. Corner lots command a premium, but the magnitude of the effect is dampened from roughly 30% to

[5] 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.
[6] Results are available upon request.
[7] We used the real values we created using the NYC metropolitan area CPI.

15% when we include year dummy variables. A parcel's distance from Broadway and distance from the closest core negatively affect its value. The distance from Broadway exhibits diminishing marginal returns, 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. Not surprisingly, when we include SD dummy variables in the model the distance variables are no longer statistically (or economically) significant. That is, the neighborhood fixed effects capture the distance effects. Lastly, being close to more subway stops increases land values. We find that each additional subway stop within a half mile of the property raises prices by about 1-3% on average, though the effect is not statistically significant.

Of particular interest to our work are the coefficient estimates for the "year" variable. The estimate in Equation (1) suggests an 8.4% trend rate for Manhattan land values since 1950. When we use real values instead of nominal values in Equation (3), we estimate the trend over the 63-year period to have been 4.2%. And, finally, in Equation (6) the estimated trend coefficient remains nearly same at 4.5%.

5. Land Values in Manhattan, 1950 to 2013

Figure 2 shows our land value index for Manhattan from 1950 to 2013 (the index values and regression coefficients with standard errors are given in Appendix A). Figure 2 presents the index created using the NYC CPI; Table A.1 in Appendix A gives the results with both the NYC CPI and the GDP deflator. The results are broadly similar, but the Index using the CPI is generally lower given the price level has risen faster in the New York City area as compared to the nation as a whole.

{Figure 2 about here—Land Value Index}

We created the index by converting the coefficient estimates to index values via the formula, $Index_t = 100 * exp(\hat{\beta}_t)$, for each year, *t=1950,…,2013*. 1950 is the base value and the coefficient was zero since it was omitted from the regression. As mentioned above, the missing coefficient estimates were generated via interpolation from the years before and after a missing year (see Appendix B).

The index shows three major cycles in Manhattan land values since 1950. From trough to trough, the first one lasted from 1950 to 1977. The second cycle from trough to trough lasted from 1977 to 1993. Finally the third cycle is the one that started in 1993, peaked in 2007, and reached a trough in 2011. Since then land values have begun to return to 2007 values.

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

During each cycle, the upward trend appears to have different characteristics. From 1950 to the peak of 1970, the average growth rate in land values was 2.6%. The run up from 1979 to 1988 was much more dramatic, with an average annual growth rate of 22.9%. Finally the run up from 1993 to 2007 had an average annual growth rate of 15.8%. 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 5.1%.

Figure 3 shows the fixed effects coefficients for each of the Sanitation Districts. By and large they have the expected signs and magnitudes (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 also shows a particularly high value. The neighborhood values are lowest in parts of the Lower East Side and the area 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. A post-WW II office and apartment construction boom helped fuel land value growth in the city, though the historical tenement neighborhoods would lose value, fueled by increased poverty and white flight to the suburbs (Grebler, 1952). However, Manhattan went on a skyscraper building spree that lasted from the early 1950s to the late-1970s as new offices and apartment building were constructed (Barr, 2010).

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 population in that decade. Unlike other rust-belt cities, such as Buffalo, Cleveland, and Detroit, New York's population been rising since bottoming out around 1980. By 2000 the city had 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 168, an average increase of 2.5% per year. But the recession that hit the city in 1969 also affected land values. By the trough year of 1977, the index was down to 48.

Despite many of the lingering urban problems that plagued the city, prices from there began a steady climb until peaking in 1988. Under Mayor Ed. Koch the city begin to get its financial house in order; while the economic prospects of the country generally improved in the 1980s. The early 1980's 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 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 48 in 1977 the land value index rose to 510 by 1988, an average increase of nearly 23% 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, since the early 1990s, crimes rates in New York City steadily declined. 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 real estate or land, would be met by increased building, which would then reduce prices or price growth. Instead from 1993 to 2007, the index went from 107 to 2752, an average annual growth rate of 23% 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.[8] 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. While a detailed discussion of the supply restrictions are beyond the scope of this paper, it would appear that the combined effects of the city's zoning rules, rent regulations and real estate tax policies are discouraging the new construction needed to keep pace with economic growth (Glaeser, et al. 2005).

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 value index. Note these are building sales (not coops or condo units). Figure 5 presents the land value 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 value 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 cyclicality than the land value index, in that price drops during the downturn were less severe than with land values.

[8] 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.

As another comparison, we investigated the real value of the Standard and Poor's Stock Index since 1950 (excluding dividend reinvestments). (Shiller, 2014). The figure is presented in Appendix A. The results show that the real value of the S&P index grew at a much slower rate as compared to the land value index. The real value went from $100 in 1950 to 981 in 2013, compared to 2513 for the land values index (deflating both indexes by the New York CPI.)

We also employed time series and co-integration tests. If the land value 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. Two versions of the test are performed, 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 we also test for a unit root in the real value of the Standard and Poor's Stock Index; we find the index also has a unit root. Note the Phillips-Perron unit-root test 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 value index. To this end, we use the Johansen test for cointegration, and find that the real index is co-integrated with both employment and sales, when we include a time trend. However, it is not co-integrated with the S&P Index. This suggests a long run relationship between land values and real estate sales and employment, as one would expect.

8. What's Manhattan Worth?

The land value 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 this value with other important measures of wealth and income, and also determine the long run growth rate 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?

In addition, we can 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.[9]

[9] 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.

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 acres of each SD. To calculate a per square foot value for each SD, we use Equation (6) from Table 2. We first obtain a predicted value from the "basic" model, which is based on a specific set of assumptions and calculations. We then make some alterations to this basic model to get different estimates. 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 15.5% of their lots on corners, since 15.5% 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.[10] We set the CoStar dummy to zero., and we omit the distance to Broadway variables from the calculations because they were statistically insignificant. For each SD we add in the value of the SD fixed effect, and the 2013 year dummy coefficient. 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 predictive value is inconsistent (Wooldridge, 2012). We calculated the adjustment factor by regressing the price per square foot on the exponentiated predicted value (excluding a constant), and taking the estimated coefficient. Equation (1) summarizes how we calculated a predicted value for the i^{th} sanitation district:

$$\widehat{PPSF}_i = \hat{\delta} exp\left(\hat{\alpha}_0 + \widehat{\boldsymbol{\alpha}}\overline{\boldsymbol{x}} + \widehat{SD}_i + \hat{\tau}_{2013}\right), \qquad (1)$$

where $\hat{\delta}$ is the adjustment factor, $\hat{\alpha}_0$ is the estimated constant, $\widehat{\boldsymbol{\alpha}}\overline{\boldsymbol{x}}$ 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 $\hat{\tau}_{2013}$ is the year coefficient for the 2013 dummy variables.

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

$$\widehat{PPSD}_i = .6 * 43{,}560 * Acres_i * \widehat{PPSF}_i,$$

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 undeveloped land (see Appendix A for more information). Also note that we do not have land value data in two SDs. In these cases, we calculated the average price per square foot for each one by taking an unweighted average of the PPSF of the surrounding SDs.

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[10] We get virtually identical results if the centroid of each of SD is used as well.

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 is 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 15% of the lots are of the "CoStar" variety (i.e., we assume the CoStar variable is 0.15), and using the median lot sizes. The fourth iteration sets the CoStar variable to 0.15 and uses average lot sizes. Increasing the CoStar value raises the estimates since the CoStar coefficient is relatively large.

Across the four estimates, the value of Manhattan ranges from $784 to $867 billion. As comparisons, the total GDP of New York State in 2013 was $1.2 trillion. Using the formula *r=ln(value 2013/24)/(2013-1626)* to calculate the average annual return since 1626, gives a 6.3% return across all 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).[11] 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 value index for Manhattan from 1950 to 2013. 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 2007.

We find that the real index, based in the New York CPI, increased from 100 in 1950 to 2513 in 2013, which gives an average annual growth rate of 5.1%. However, there have been several noteworthy trends over the period. During the first cycle land values rose relatively slowly and between 1969 and 1977 land values plummeted to a value nearly 60% lower than in 1950. From their nadir in 1977 land values have shown dramatic growth, though the 1980s run-up proved unsustainable with a steep decline in the early 1990s.

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

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 findings 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 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 on Manhattan is about $820 billion, or a long run rate of return equal to approximately 6.3%.

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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)}

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 2013, the volumes were published by First American Real Estate Solutions or First American CoreLogic. 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 any less strong 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).For the years 1996 to 2006, volumes were not available for several years. CoStar generously provided its vacant land value data for Manhattan for this period. This data was from the same source as 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 Report. For the Index, for the years 1973, 1975, 1981 and 1983, we unable to obtain any sales data, thus we calculated the index by taking the average of the coefficient estimates for the year before and after, and then taking the exponent of the value and multiplying times 100. For the missing years, 1969 and 1970, we first calculated the average annual growth rate of the coefficients from 1968 to 1971, ($\hat{r}$), then we estimated each coefficient by using the formula $\widehat{\beta_t} = \hat{\beta}_{t-1} exp(\hat{r})$, for the years 1969 and 1970. Then we took the exponent of each estimated coefficient and multiplied it times 100.

-*New York Region Consumer Price Index*: Series Id: CUURA101SA0,CUUSA101SA0, New York-Northern New Jersey-Long Island, NY-NJ-CT-PA.

-*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 20013 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	1981.4	19.9	1950	2013	3380
Price ($)	3,111,405	15,400,000	500	345,000,000	3380
Lot Area (square feet)	7,476	15,425	200	500,000	3379
NYC CPI*	0.439	0.294	0.096	1.00	3380
GDP Deflator*	0.499	0.292	0.129	1.00	3380
Price per Square Foot ($)	334.7	1269.9	0.02	33,541	3379
Real Price per Square Foot* ($CPI)	466.4	1458.4	0.10	33,541	3379
Real Price per Square Foot** ($Deflator)	426.1	1392.4	0.09	33,541	3379
Corner Dummy	0.155				3380
CoStar Dummy	0.116				3380
Distance to Closest Core (miles)	2.86	2.09	0.08	9.37	3380
Distance to Broadway (miles)	0.68	0.48	0.00	1.92	3380
# Subway Stops w/in Half Mile	5.06	3.86	0	19	3380
Sanitation Districts Area (acres)	135.6	312.7	23	2343	107

*2013=1.00.

Table 2: Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(PPSF)	ln(PPSF)	ln(Real PPSF)	ln(Real PPSF)	ln(Real PPSF)	ln(Real PPSF)
ln(Lot Area)	1.291	1.491	1.303	1.487	0.982	1.146
	(3.36)**	(4.24)**	(3.31)**	(4.22)**	(2.94)**	(3.74)**
$ln(Area)^2$	-0.071	-0.079	-0.071	-0.079	-0.062	-0.068
	(3.31)**	(3.96)**	(3.24)**	(3.95)**	(3.34)**	(3.93)**
Corner Dummy	0.304	0.160	0.315	0.161	0.276	0.150
	(3.98)**	(2.24)*	(4.02)**	(2.26)*	(3.24)**	(2.02)*
Distance to Broadway	-2.262	-2.305	-2.251	-2.298	-0.212	-0.318
	(5.67)**	(5.25)**	(5.65)**	(5.24)**	(0.55)	(0.76)
$\text{Distance to Broadway}^2$	0.960	0.985	0.952	0.983	0.089	0.058
	(4.00)**	(3.64)**	(3.96)**	(3.63)**	(0.44)	(0.26)
Dist. to Closet Core	-0.437	-0.452	-0.433	-0.451	0.097	0.09
	(10.43)**	(11.27)**	(10.19)**	(11.26)**	(1.55)	(1.57)
CoStar Dummy	0.807	0.861	0.817	0.861	0.695	0.541
	(10.17)**	(6.55)**	(9.67)**	(6.55)**	(7.02)**	(4.30)**
# Subway Stops w/in .5 Mile	0.009	0.013	0.012	0.013	0.026	0.022
	(0.46)	(0.72)	(0.59)	(0.74)	(0.92)	(0.81)
Year	0.084		0.042		0.045	
	(44.47)**		(21.60)**		(26.47)**	
Constant	-166.9	-3.58	-82.2	-1.23	-88.8	-1.50
	(41.57)**	(2.35)*	(20.12)**	(0.80)	(22.94)**	(1.10)
Year Dummies		Yes		Yes		Yes
SD Fixed Effects					Yes**	Yes**
R^2	0.67	0.74	0.49	0.6	0.57	0.68

Note: Standard errors are clustered by Sanitation Districts. *significant at 5%; ** significant at 1%. All regressions have 3,375 observations. Real prices are based on the New York CPI. Graph of year dummy coefficients for Eq. (6) are given in Figure A.1.

Table 3: Time Series Tests

Augmented Dickey Fuller Test for Unit Root			
Variable	**No Trend**	**Trend**	**P-Val. for Trend in Reg.**
ln(Real Index)	0.94	0.65	0.03
ln(Sales)	0.88	0.07	0.00
ln(Employment)	0.88	0.96	0.18
ln(S&P)	0.61	0.59	0.14
Johansen Test for Cointegration (Rank selected)			
Pairs	**No Trend**	**Trend**	
Ln(Index) & Ln(Sales)	0	>1	
Ln(Index) & Ln(Employment)	0	1	
Ln(Index) & Ln(S&P)	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 with a unit root are co-integrated. The rank tells the number of cointegrating vectors. A rank of 0 suggests no co-movement. All price series are real, using the NYC CPI.

Table 4: Estimates for the Value of Manhattan (2013).

Est. #	Lot Size	CoStar Dummy Value	Manhattan Value ($Billion)	Avg. Annual Return
1	Median	0.0	800	0.06261
2	Average	0.0	784	0.06256
3	Median	0.15	867	0.06282
4	Average	0.15	849	0.06276

Note: Average annual return assumes that the Dutch purchased Manhattan for $24 in 1626. Return formula is *r=ln(value 2013/24)/(2013-1626).* See text for different assumptions for lot size and CoStar dummy value.

Figures

Figure 1: Vacant Land Locations in Manhattan, 1950 to 2013. Red Boundaries are Sanitation Districts.

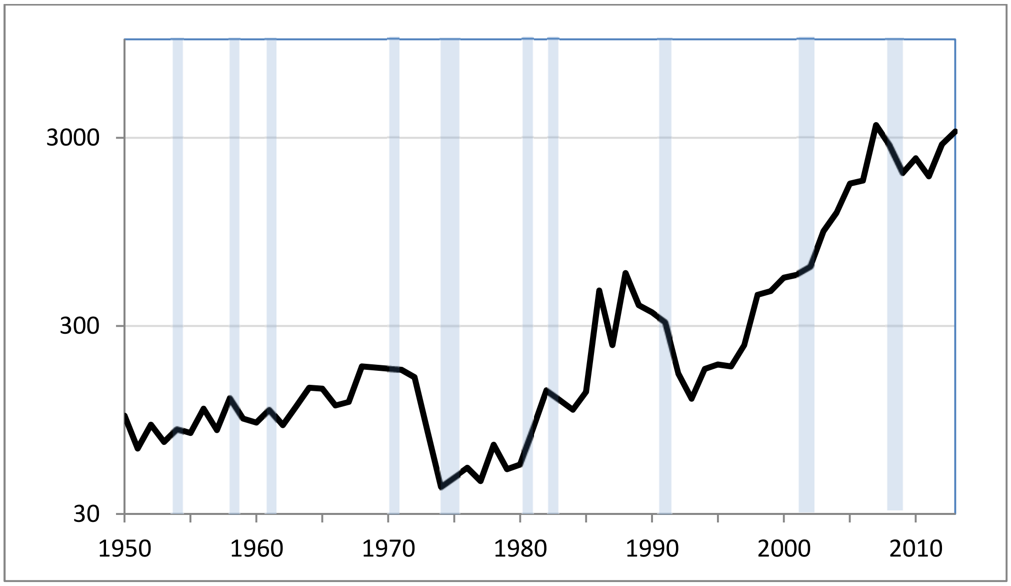

Figure 2: Real Land Value Index for Manhattan, 1950-2013, (1950=100). Note log(10) Scale. Blue Boxes are Approximate Recession Dates. Underlying Coefficients are From Table 2, Eq. (6).

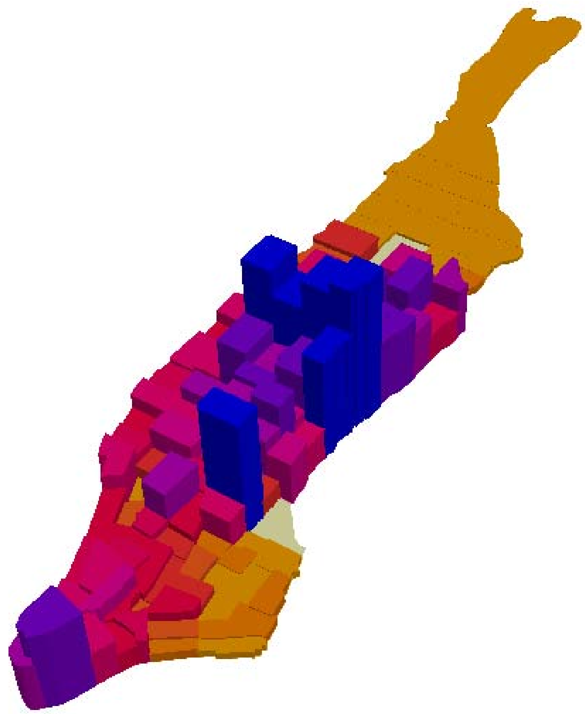

Figure 3: Exp(Real SD Fixed Effects Coefficients) from Table 2, Eq (6).

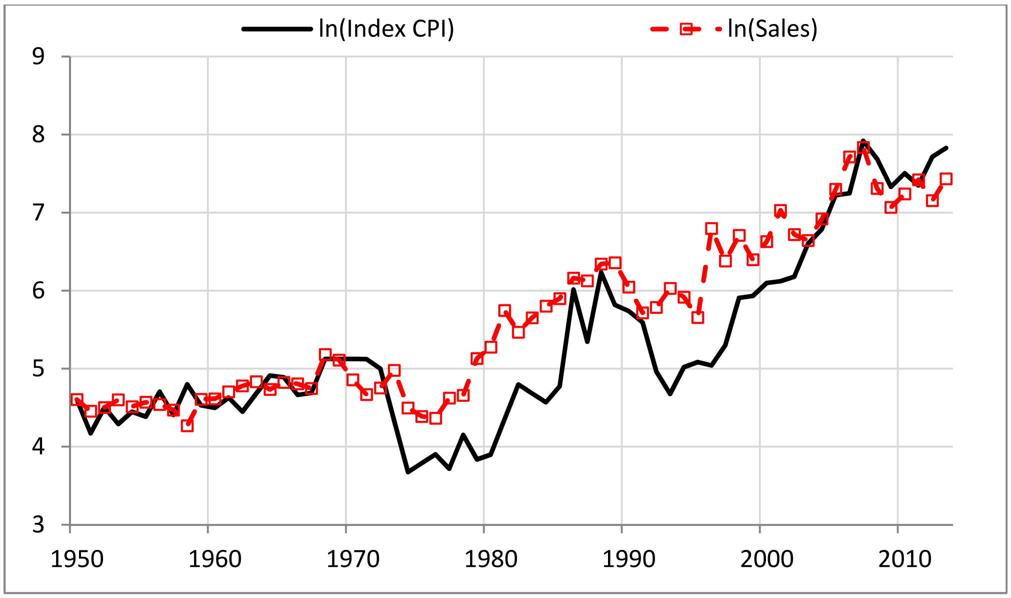

Figure 4: Land Value Index and Manhattan Real Estate Sales Price Index.

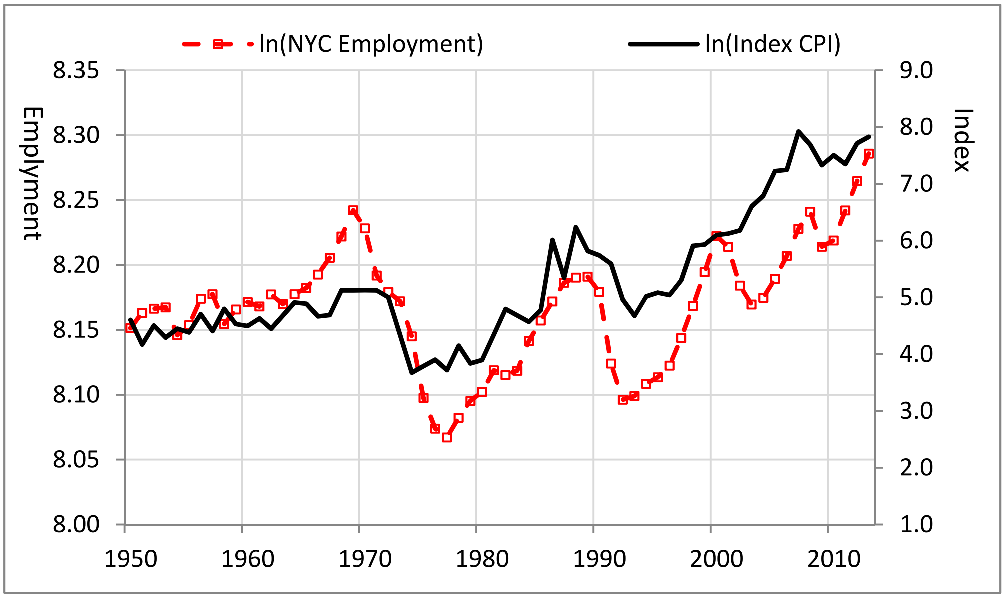

Figure 5: Land value Index and NYC Total Employment Index

Appendix A: Figures and Tables

Table A.1: Index Values

Year	Nominal Index	Real Index using Deflator	Real Index using NYC CPI	Year	Nominal Index	Real Index using Deflator	Real Index using NYC CPI
1950	100	100	100	**1982**	469	141	121
1951	70	67	65	**1983**	439	126	108
1952	99	90	91	**1984**	410	113	96
1953	80	72	73	**1985**	523	141	118
1954	95	84	86	**1986**	1868	496	409
1955	88	79	80	**1987**	1005	261	210
1956	123	104	110	**1988**	2559	639	510
1957	95	80	82	**1989**	1784	437	336
1958	144	119	121	**1990**	1750	410	311
1959	112	92	93	**1991**	1580	368	269
1960	110	89	90	**1992**	868	199	143
1961	127	104	102	**1993**	674	147	107
1962	107	86	85	**1994**	973	212	151
1963	139	109	108	**1995**	1064	225	161
1964	177	137	136	**1996**	1049	222	155
1965	176	135	133	**1997**	1390	290	200
1966	145	111	106	**1998**	2596	540	368
1967	153	115	109	**1999**	2714	567	377
1968	246	178	168	**2000**	3301	674	445
1969	261	178	168	**2001**	3465	700	456
1970	278	178	168	**2002**	3905	779	482
1971	297	178	168	**2003**	5921	1217	736
1972	275	162	148	**2004**	7420	1540	890
1973	154	84	77	**2005**	11817	2211	1371
1974	86	44	39	**2006**	12599	2307	1404
1975	103	49	44	**2007**	25318	4566	2752
1976	123	54	50	**2008**	20934	3653	2184
1977	107	46	41	**2009**	14674	2573	1524
1978	175	71	63	**2010**	17780	3109	1815
1979	139	52	46	**2011**	15650	2512	1554
1980	165	57	49	**2012**	23006	3723	2241
1981	278	89	77	**2013**	26171	4361	2513

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.

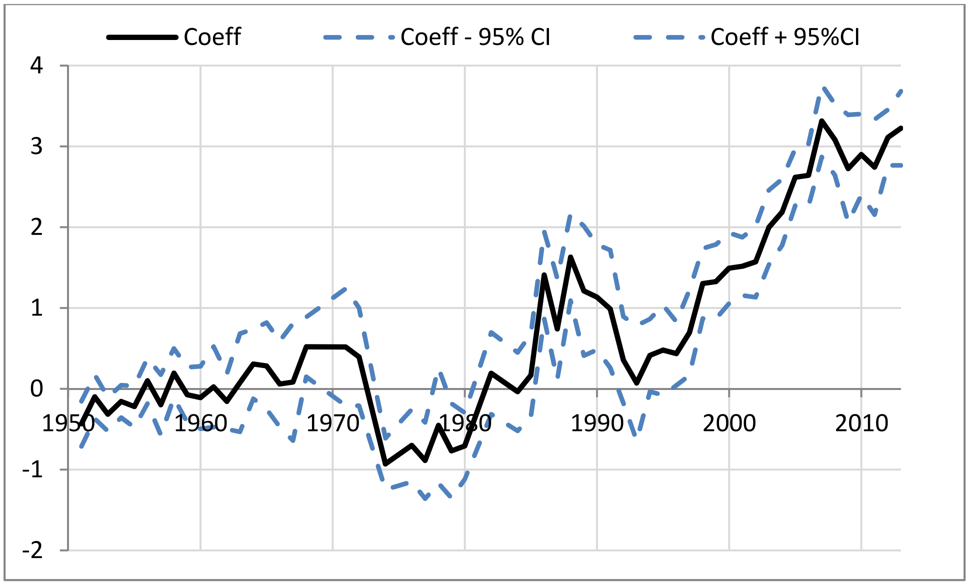

Figure A.1: Coefficient Estimates for Year Dummies, with Confidence Interval Bands, from Table 2, Eq. (6).

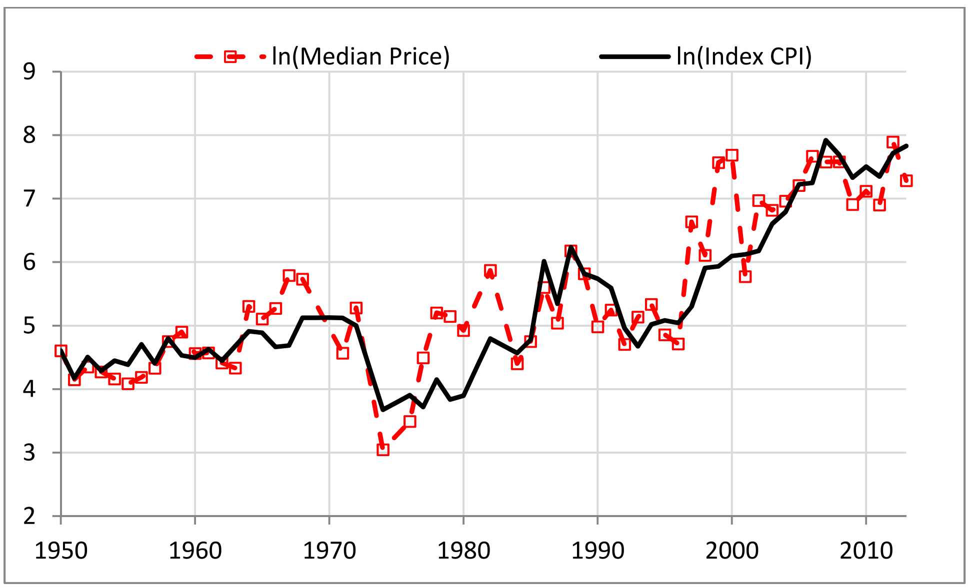

Figure A.2: Real Median Price Per Square Foot and the Land Value Index.

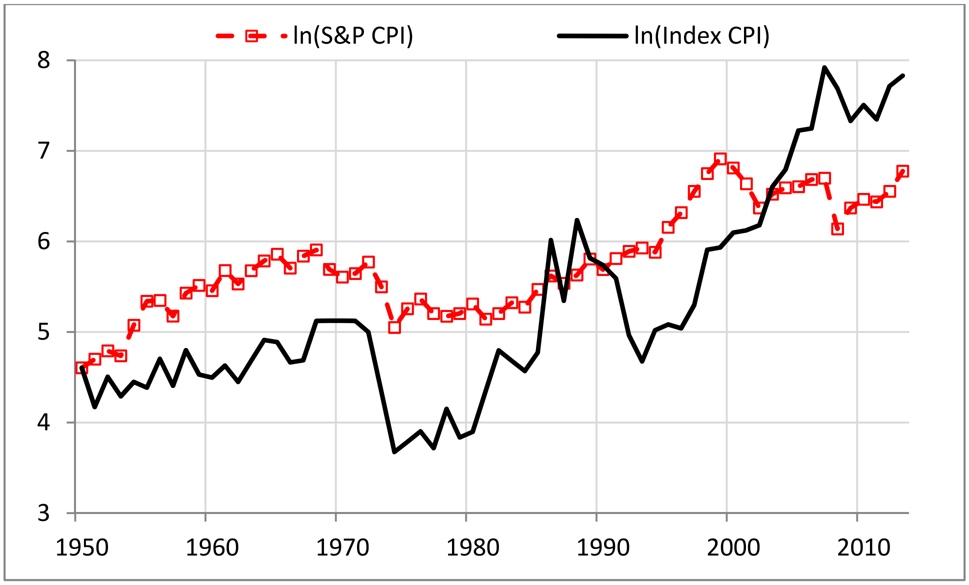

Figure A.3: Real S&P Index vs. Land Value Index