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Abstract
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Cornell University
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Commercial real estate indices play an important role in performance evaluation and overall investment strategy. However, the issue of how representative they are of the price appreciation on individual commercial real estate properties is an open issue. Our study addresses this topic by analyzing a sample of 8864 repeat sales transactions between 1998 and 2010. We find that aggregate real estate indices do a modest job of explaining individual property price appreciation. We find some evidence that this performance is improved by very tightly focused indices. However, controlling for property level cash flow, nearly half the variation in property price appreciation is still unexplained. Our findings cast some doubt on the applicability of these indices for performance evaluation and as a vehicle to hedge commercial real estate.

1 Introduction

Commercial real estate indices have been the source of a great deal of attention in the academic and practitioner literature. An extensive body of research has focused on the relation between returns on these indices and REIT returns. The relevant research includes Giliberto (1990), Seck (1996), Zeiring, Winograd and McIntosh (1997), Clayton and MacKinnon (2003), Ling and Naranjo (2003), Mulhoefer (2011) and Boudry, Coulson, Kallberg and Liu (2011). In general, these studies suggest a weak link between the returns on these indices and REIT returns.

Another important strand of literature deals with the construction of real estate indices. The studies include the seminal papers by Rosen (1974) on hedonic methods based on homeowners' derived utility from specific house attributes and Bailey, Muth and Nourse (1963) on repeat sales indices (RSI). Case and Shiller (1989) provide further major modifications to the RSI. While earlier research on housing indices focused on how to account for quality changes when constructing price indices, later research has dealt with various pricing biases and refinements arising from the representativeness of the sample (see for example, Clapp and Giaccotto (1992), Gatzlaff and Haurin (1994, 1997)), instability of house attributes (Dombrow, Knight and

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Sirmans (1997), heterogenous appreciation rates (Goodman and Thibodeau 2003) and shifting reservation prices (Goetzman and Peng 2006), among several others.

This study focuses on a related, but quite distinct issue: How closely does actual property-level price appreciation correspond to commercial indices? This question is important for a number of reasons. First, if these indices are to be used in evaluating the performance of a particular commercial real estate portfolio we need to be confident that the indices accurately represent the "typical" behavior of the market. Second, these indices have a potential application for hedging. For example, the MIT Center for Real Estate website's description of their RCA index notes the following: "The index has been developed with the objective of supporting the trading of commercial property price derivatives."[2]

An important issue then is the magnitude of the basis risk: how well will the index correlate to the behavior of the properties being hedged? Third, are there systematic patterns or biases in the mismatch between the index and the property-level price appreciation? Finding significant missing factors could be useful in refining the index construction (for example by creating sub-indices that more accurately match real returns) or its applications.

Our study uses a sample of 8864 repeat sales from 1998 to 2010. We match these transactions over the same holding period to price appreciation indices. To briefly summarize our key findings, we find that the magnitude of the R^2s from the regression of property-level price appreciation on the indices is modest. They are typically in the 10-20% range. The one exception to this is a very tightly focused type/location index where the R^2 is 40%. Nonetheless, our results suggest that the majority of the variation in the property-level price appreciation is not captured by these indices.

Secondly we find that there are several factors that contain explanatory power over and above the repeat sales indices. The growth rate in the property's cash flow over the holding period is strongly related to the property's price appreciation. This is robust to all indices used. We also find that larger properties tend to have lower price appreciation.

Overall we find that even after including repeat sales indices, property characteristics and property-level cash flows, we are only able to explain approximately half of the cross-sectional variation in property price appreciation. This highlights the large degree of heterogeneity in property price performance, but also hints that if investment managers are able to understand these property-level differences, they should be able to outperform the market even in tightly focused investment universes.

The remainder of this study is organized as follows. Section 2 describes the repeat sales sample and repeat sales index estimation. Section 3 describes our estimation results and Section 4 presents our conclusions.

2 Data

We estimate repeat sales indices using repeat sales transactions data from CoStar. In any index construction, some judgment is required for both the repeat sales transactions employed in the estimation and also the econometric technique used. The goal of this paper is not to design an optimal index, rather our goal is to examine the usefulness of indices that one is likely to observe in practice. To this end we employ what would be considered standard filters in our sample selection and also standard econometric estimation techniques.

[2] http://web.mit.edu/cre/research/credl/rca.html.

2.1 Repeat Sales Filters

Our sample of repeat sales from the CoStar database consists of repeat sales occurring in the 1998 to 2010 period. This restriction is imposed because at the sub-National level it becomes difficult to reliably estimate repeat sales models prior to this period due to sparse transactions data. The second filter we impose is that properties must have a purchase price greater than $2m. The choice of this cutoff is somewhat arbitrary, but the motivation was to exclude extremely small assets while still maintaining a robust sample for estimation.

We include only apartment, office, industrial and retail properties in our sample. While other property types exist, they tend to be small in sample size making estimation of a type specific index problematic and as such would likely just add noise to our sample. CoStar also records a myriad of secondary property types for each primary property type. We exclude non-standard secondary property types from our sample. For example, apartments include affordable housing, student housing, senior housing, rent stabilized housing, subsidized housing and manufactured homes. We classify these as non-standard and do not include them in our sample.

To be included in the sample, non-apartment properties must be greater than 2,500 square feet and apartment properties must have greater than 10 units. This once again is to exclude economically unimportant assets from the sample. We also exclude all distressed and non-arm's length transactions and portfolio sales.

We create repeat sales pairs by matching sales at the same property address over time. We exclude repeat sales where property characteristics have changed. As is conventional, we also exclude properties that have a resale window of less than 1 year. Properties that have annual price appreciation of less than -40% and greater than 50% are also excluded as are the top and bottom 1% of transactions based on gross price appreciation.[3]

2.2 Index Construction

To estimate market level price appreciation, we employ the standard three step generalized least squares model of Case and Shiller (1989).[4] Our estimation methodology is similar to that employed by CoStar in estimating their repeat sales indices.[5]

The log of a property's price appreciation between purchase and sale can be expressed as

$$y_i = \ln\left(\frac{P_{i,s}}{P_{i,b}}\right) = \sum_{t=b+1}^{s} \ln(1+r_t) X_{i,t} = \sum_{t=b+1}^{s} \beta X_{i,t}, \tag{1}$$

where $P_{i,s}$ is the price of property i at sale, $P_{i,b}$ is the price of property i at purchase, r_t is the appreciation rate in period t and $X_{i,t}$ is a dummy variable taking the value 1 if $b < t \leq s$ and 0 otherwise. This can be written in standard matrix notation as:

$$Y = X\beta + \varepsilon. \tag{2}$$

[3] An examination of a sample of these "extreme" observations suggests they are much more likely to be data errors than actual transactions.

[4] We have also tried the ridge regression model of Goetzmann (1992). Given the results are similar we simply report results using the GLS estimates.

[5] http://www.costar.com/ccrsi/index.aspx

Assuming a normal disturbance term ε, β can be efficiently estimated using ordinary least squares. In this case β has the familiar form:

$$\beta = \left(X'X \right)^{-1} X'Y. \tag{3}$$

Case and Shiller (1989) note that the variance of the error term may be dependent on the time between purchase and sale. Under such assumptions, a more efficient estimation technique is generalized least squares. They propose a simple three step estimation procedure. Step 1: estimate (2) above using OLS. Step 2: model the variance of the error term from Step 1, $\hat{\varepsilon}^2$, as a linear function of the holding period *n,* and calculate the fitted values, $\hat{\hat{\varepsilon}}^2$

$$\hat{\varepsilon}^2 = \alpha + bn + e$$
$$\hat{\hat{\varepsilon}}^2 = \hat{\alpha} + \hat{b}n.$$

In Step 3 the inverse of the fitted values are used as weights to re-estimate (2). This yields the GLS estimate of β_{GLS}:

$$\beta_{GLS} = (X'\Omega^{-1}X)^{-1} X'\Omega^{-1}Y,$$

where the diagonal elements of Ω^{-1} are $1/\hat{\hat{\varepsilon}}^2$.

We estimate eight quarterly indices using this repeat sales methodology. The broadest index is the National index that is estimated using all available repeat sales between 1998 and 2010. Apartment, Office, Retail and Industrial are property type indices including only properties of those particular property types. We also estimate two geographic indices, one for the Los Angeles MSA and one for New York City MSA.[6] The final index we estimate is a Los Angeles Apartment index. This is the most granular location/property type index we were able to reliably estimate given the volume of repeat sales required.

Table 1 reports descriptive statistics for the each of the repeat sales indices estimated. Data is quarterly price appreciation for each index over the period Q1 1998 to Q4 2010. For the national sample we have a total of 11261 repeat sales underlying the index. There are 4695, 2849, 1448 and 2249 for the apartment, office retail and industrial subsamples respectively. The New York MSA has the lowest number of underlying repeat sales at 995, while the Los Angeles MSA and Los Angeles apartment subsamples have 2001 and 1034 repeat sales respectively.

Over the sample period, the average quarterly price appreciation for each index is between approximately 1 and 2%. As expected, given that the sample period includes both boom and bust periods, the maximum and minimums observed for any given index are quite large. Typically in the -15 to -25% and 15 to 25% range. The volatility of the indices tends to increase as the index becomes more granular. This particularly evident for the New York subsample, which has the fewest underlying repeat sale observations. Overall the indices appear quite similar to other reported repeat sales indices.

[6] These two MSAs were chosen as a matter of practicality. Both had enough repeat sales each quarter to estimate the repeat sales models reliably, and in economic terms they represent markets in which a user of repeat sales indices is likely to own assets.

2.3 Property Price Appreciation

Our final sample of repeat sales consists of 8864 repeat sale transactions over the period 1998 to 2010. This is slightly smaller than the sample used to estimate the indices because we require each observation to also have property characteristics and for some observations these are missing in the CoStar database.[7]

To make price appreciation comparable across different holding periods, for each property we calculate the annualized price appreciation (APA). Annualized price appreciation is calculated as $\left(\frac{P_t}{P_{t-i}}\right)^{\left(\frac{1}{i}\right)} - 1$, where i is the number of years between sales. Table 2 reports descriptive statistics for the repeat sales in the estimation sample. The average APA in the sample is 10.14%, with a minimum of -39.11% and a maximum of 49.80%. As expected, the highest volume of transactions occur between 2004 and 2007 during the strong real estate market. We then observe a marked decline in transaction volume during the global financial crisis.

Because this study focuses on the variation in property price appreciation, it is interesting to observe the dispersion in APA at the property level. In terms of both standard deviations and ranges, we observe large variations in realized property price appreciation. This reflects the cross-sectionally heterogeneous nature of commercial real estate.

We match the APA at the property level to the benchmark indices. To do this, we calculate the daily price appreciation implied by the quarterly indices.[8] We then calculate the holding period annualized price appreciation over the dates matching the property's holding period.

Table 3 reports descriptive statistics for the national index APA on a sample matched to the repeat sales of Table 2. In this sense Table 3 provides the national benchmark for the property APA reported in Table 2. The average annualized price appreciation in the index was 7.2%, with a minimum of -23.2% and a maximum of 15.2%. On average, the index appreciation is significantly lower than the price appreciation observed at the property level. The distribution of the index appreciation also appears to be far less dispersed. Interestingly, we observe transactions in the sample where the index price appreciation is significantly negative. This is especially evident in the last two years of our sample period. The fact that we observe both positive and negative annualized price appreciation in the index over differing holding periods suggests that the sample includes transactions over all parts of the real estate cycle.

Table 4 reports descriptive statistics of the property APA and matched sample index APA for each of the samples used in our analysis. Each row represents one of the samples used in our estimations. Examining Table 4, we observe a pattern similar to Tables 2 and 3. For each sample, property level appreciation appears to be on average higher, but also more volatile. The fact that the indices are less volatile is not unexpected given that these indices are estimating the experience of the "average" property in the market. The fact that the property level appreciation is more volatile than the index leads to the obvious question of how much of the variation at the property level is explained by the index?

3 Estimation

[7] There are 11,261 repeat sales used to estimate the national index and only 8864 transactions in the estimation sample. The main reason for this is that we require the assessed tax value of the property in the estimation sample.

[8] In effect we are assuming that in the quarter of purchase and sale that daily returns are constant.

To examine the variation in property level APA we hypothesize that the price appreciation at the property level can be explained by 4 components. First, it is logical to expect that there is some common component to all properties. That is, there is some national factor at least partially driving all property price fluctuation in the US. Second, given the segmented nature of real estate markets, it is also plausible that there is a common factor that drives price appreciation at the property type or geographic level. That is, an apartment factor driving apartments and a Los Angeles factor driving prices in Los Angeles. Third, it has been shown in residential markets that property atypicality can affect pricing. Properties that are atypical do not exhibit the same performance as the "average" property.[9] This suggests that price appreciation may be related to time invariant property characteristics. Finally, it is expected that property level time varying characteristics such as cash flows, should affect property level price appreciation. It is an empirical question as to how much each of these factors influences price appreciation and also how much of the total variation they can explain.

Examining these hypotheses requires empirical proxies for each of these components. To measure the national factor that is common to all properties we use the national repeat sales index. National is the APA on the national index matched to the property's holding period. We expect that the property APA will have a positive loading on National.

We examine property type and geographic factors in two ways. First, in subsamples where we have either a property type focus (Apartment, Office, Industrial and Retail), or a geographic focus (NYC and Los Angeles), or both (LA Apartments), we orthogonalize the subsample index to the national index. For example, for the apartment subsample we estimate Apartment, which is the residual of the regression of the apartment index APA on the national index APA. In this sense we are examining how much additional explanatory power a type, location or type/location factor has over the national factor.

Because we only have a limited number of type and location indices, we also employ other variables to measure these effects. When dealing with the national sample, we include property type dummy variables. Miles, Cole and Guilkey (1990) argue that local macroeconomic variables such as employment should drive property valuations. Employment Growth, is the percentage change in the rate of county employment between purchase and sale. Thus a positive change indicates a decrease in the unemployment rate, or an improvement in economic conditions.[10] County-level employment data were obtained from the Bureau of Labor Statistics web page.

To examine the issue of atypicality, we select a set of property characteristics that are likely to affect pricing. For each property we collect information on building age, size, land area, location, land leverage and price.

Age is the age of building at the time of sale. Colwell, Munneke and Trefzger (1998) find that building age and building age squared are significant determinant of office building sales prices. Building size has also been found to be an important factor in property pricing.[11] Size is the size of the building in millions of square feet.

Having a location as a corner lot may provide a premium location for a building. Corner Lot is a dummy variable equal to 1 if the property is a corner lot.

[9] See, for example, Bourassa, Haurin, Haurin, Hoesli and Sun (2009).
[10] The BLS reports employment data at various geographic levels (county, MSA, state etc.). The county level is the finest geographic partitioning for which we can obtain data going back to 1998.
[11] See, for example, Lockwood and Rutherford (1996), Hoag (1980) and Frew and Jud (2003).

Land leverage has been found to be an important determinant of property prices in the residential literature. Both Bostic, Longhofer and Redfearn (2007) and Bourassa, Haurin, Haurin, Hoesli and Sun (2009) find that land leverage has a positive impact on price appreciation. They argue that land values are likely to increase at a faster rate than building values. Thus properties that have relatively more of their value in land are likely to experience faster price appreciation than the average property. We capture this effect using Land Leverage, the ratio of the property's assessed land value to total assessed value. Assessed values were taken at the most recent assessment prior to purchase.

Land area has also been studied as a driver of property valuation.[12] We measure Land as the property's lot size in acres.

We examine the size of the building along two other dimensions than total square feet. Footprint is the typical floor plate of the building in millions of square feet.[13] Floors is the number of floors in the building. In both cases tenants may be attracted to a particular building because of its floor plate size or number of floors, so buildings with unusual floor plates or floors may perform differently from the average property.

Real estate markets may be segmented by property value. "Institutional" quality real estate tends to be more expensive than non-institutional quality real estate. To control for this, we include Buy Price, the property value at the first transaction in the repeat sale pair.

It is intuitive to expect that property level cash flows will affect property valuations. The problem with examining this issue is that property level cash flows are not readily available. For a limited sample of properties we have the cap rate at which the property was purchased and sold. Combining this with the purchase and sale price we can infer what net operating income (NOI) was at sale and purchase. To make this variable comparable to our annualized price appreciation, we compute NOI Growth, the annualized NOI Growth over the holding period. It is expected that this will have a positive relationship to price appreciation.

We also include Holding Period, the number of years between purchase and sale of the property in the regressions.[14] Given data limitations it is impossible to completely characterize all the pertinent characteristics of a commercial property. Ideally we would have an income statement for each property at all points in time, since commercial real estate is going to be priced off of these cash flows. Notice also that due to staggered leasing structures, the cash flows from the property will not be perfectly correlated with local economic conditions. We hypothesize that annualized price appreciation may differ by holding period, because the economic fundamentals of the properties differ.[15] That is, properties held for shorter periods of time may well be opportunistic or unstabilized assets, while properties held for longer periods of time are likely to be more stabilized assets.[16] In this sense we are not proposing that holding period drives price appreciation, we simply believe that holding period may be correlated with unobservable property characteristics that are related to price appreciation.

[12] See, for example, Lockwood and Rutherford (1996), Hoag (1980) and Colwell, Munneke and Trefzger (1998).
[13] Notice that these are typical floor plates not average. So Floors*Footprint does not equal Size.
[14] See Collett, Lizieri and Ward (2003) for a discussion of commercial property holding periods in the U.K.
[15] See also Muhlhofer (2011).
[16] While we follow convention and remove properties from the sample that have repeat sales windows of less than one year, this cutoff is rather arbitrary and is probably based on analyses of the residential market. While a one year cutoff is reasonable for residential markets, given that commercial properties are priced based on past cash flow, it is likely that a longer window may be required in a commercial real estate setting to filter unstabilized assets.

Table 5 reports property characteristics for the 8864 repeat sales transactions in the sample. Table 5 demonstrates the great degree of heterogeneity between properties in the sample. For every characteristic we observe a great degree of cross-sectional variation. The average age of a property at sale is between 38.27, with a minimum of 5 years and a maximum of 170.

Property size also varies greatly in the sample. The average property size is 100,000 square feet, with the largest property being 2.65 million square feet and the smallest 3000.

Land Leverage indicates that on average 31% of a property's value is in land. In terms of physical amounts of land, the average block of land is 5.25 acres, while the average building has 3.22 floors and an average footprint of 50,000 square feet.

In terms of property value, we observe that the average purchase price of a property in the sample is $10.36 million. The $2 million minimum purchase price filter is obviously binding and the sample also includes very large assets, with a maximum Buy Price of $745 million.

The average holding period for a transaction in the sample is 3.75 years. The minimum and maximum observations for this variable are obviously affected by the sample filter imposed to exclude "flippers" and also the sample period itself.

For the subsample of observations where NOI Growth is available, we observe quite varied experiences. On average, annualized net operating income growth was 6%. However, at the extremes we observe large negative and positive annualized growth in net operating income. Although this data is only available for a small subsample of properties, it does not appear that it is a biased sample.

3.1 National Sample

Table 6 reports regression results for the national sample. This is the broadest sample of repeat sales used in our analysis and includes 8864 repeat sales transactions between 1998 and 2010. The dependent variable is the property APA. National is the national index APA matched to the property's holding period. Property characteristics are Age, Size, Corner Lot, Land, Floors, Floorprint, and Buy Price. Apartment, Office and Industrial are dummy variables equal to 1 if the property is of that property type and 0 otherwise.[17] To capture geographic effects we include Employment Growth and to capture time variant property characteristics we include Holding Period and NOI Growth.

Column 1 of the Table 6 examines the relationship between property APA and the national factor. National is statistically significant and positive as expected, but the adjusted R^2 from the regression is quite low at 14%. This suggests that while a national factor is at play in property pricing, there is still a great deal of variation in property-level price appreciation to be explained.[18]

To examine what other factors may affect pricing, in Column 2 we regress property APA on property time invariant characteristics including property type dummies. Two results are noteworthy. First, most of the property characteristics are statistically significant. Size, Land Leverage, Land, Floors Footprint and Buy Price are all significant. The result for Land Leverage is consistent with the work of Bourassa et al. (2009) and Bostic, Longhofer and Redfearn (2007) for the residential market. Second, the amount of variation explained

[17] We omit retail as the base group.
[18] Results are similar if we use the NCREIF TBI or the Moody's REAL index.

by these variables is quite small. The adjusted R^2 from the regression is only 2%. So in and of themselves, property time invariant characteristics explain little of the variation in property price appreciation.

In Column 3 we add Employment Growth and Holding Period to the Column 2 regression. We expect that Employment Growth should be positively related to property APA. In line with our expectations, Employment Growth is highly significant. This is not surprising given that Coulson, Liu and Villupuram (2010) document that local economic conditions can impact commercial real estate pricing. It suggests that location specific indices may be more appropriate benchmarks for indexing. Holding Period is significantly negative. This is consistent with the idea that properties that are held for short periods of time may be unstabilized assets. Once again, we do not interpret this as holding period driving returns, but that holding period is correlated with unobservable characteristics that are related to performance. This suggests that these aggregate indices are likely only appropriate for properties that are *ex ante* going to be held for long holding periods. The overall adjusted R^2 for the regression also improves to 21%.

In Columns 4 and 5 we reintroduce National into the regression and in Column 5 we add state and sale year fixed effects. In both Columns 4 and 5 it is interesting to observe the decline in both the coefficient estimates of National and Employment Growth. While both are statistically significant, it is apparent that they contain some overlapping information. However, the fact that Employment Growth remains significant after the introduction of National confirms the intuition that location specific indices may be more useful than a national index in explaining property APA.

For a limited sample of observations we are able to obtain the annualized growth rate in NOI between purchase and sale. We introduce NOI Growth in Column 6. Several results are noteworthy. First, NOI Growth is highly significant and positively related to property APA. In the stand alone regression in column 7, we observe that is explains a significant proportion of the variation in property APA. Second, after the inclusion of NOI Growth, most of the time invariant property characteristics are insignificant. Only Size and Buy Price remain significant. This suggests that the property characteristics may just be capturing factors that were related to cash flow growth. Third, even after controlling for cash flows, National is still positive and statistically significant in the regression. Finally, the adjusted R^2 from the regression is 47%. Even after including a myriad of explanatory variables related property pricing, we are only able to explain approximately half the variation in property APA. This suggests that there is a large idiosyncratic component to property price appreciation. This may not be surprising given that real estate assets are heterogeneous in nature.

3.2 Property Type Samples

The results in Table 6 suggest that it may be beneficial to employ property type indices instead of just a national index. In Tables 7, 8 ,9 and 10 we explore this by repeating the analysis from Table 6 on property type subsamples. Table 7 is an apartment subsample consisting of 3880 repeat sales, Table 8 is an office subsample consisting of 2268 repeat sales, Table 9 is a retail subsample consisting of 1068 repeat sales and Table 10 is an industrial subsample consisting of 1648 repeat sales. All repeat sales are in the 1998 to 2010 window.

To isolate the incremental benefit of using a property type index over a national index, for each subsample we create a property type specific factor. This factor is the residual of the regression of the property type index APA on the national index APA. By orthogonalizing the property type index to the national index we can examine the incremental explanatory power of the property type over the national index. Intuitively we would expect each index to load positive on the property type specific factor.

Examining Columns 1 and 2 from Tables 7 through 10 we observe a consistent pattern. National explains between 10 and 15% of the variation in property APA, and the orthogonal property type factor explains an additional 3 to 4%. While statistically significant, it suggests that at least economically, using either a national or a property type index makes little difference. In either case the index is not explaining the majority of the variation we observe in property APA.

Similar to the result in Table 6, we observe that property characteristics, while statistically significant, explain little of the variation in property APA. And once again, as we add time variant property characteristics the statistical significance of the time invariant characteristics declines.

NOI Growth once again appears to be an important explanatory variable in the analysis. By itself it explains anywhere from 25 to 42% of the variation in property APA and it is highly significant in every regression.

Local economic conditions appear to play an important role in pricing, especially for apartment and office properties. Once again suggesting that examining location specific indices may be a fruitful exercise.

Examining the adjusted R^2 in Columns 7 and 8 in Tables 7 through 10, we observe that matching at the property type level explains more of the variation in property APA than we were able to at the national level. However, comparing Columns 7 and 8 we observe that the benefit tends to be marginal. The subsample with the largest adjusted R^2 is the industrial sample, and for that sample the high explanatory power is related to NOI Growth, not the indices.

3.3 New York MSA and Los Angeles MSA Samples

To examine the explanatory power of location based indices we consider MSA level indices in two markets: New York City and Los Angeles. Similarly to the analysis of property type indices, we once again orthogonalize the MSA index to the national index. The New York City sample in Table 11 consists of 809 repeat sale observations, while the Los Angeles sample in Table 12 consists of 1709 repeat sales.

The results in Tables 11 and 12 are quite consistent with the results for the both the national and property type samples. A location specific index adds incremental explanatory power over the national index, but in economic terms the effect is not large. NOI Growth is significant as in the previous regressions, once again indicating that property specific time varying factors are an important determinant of property APA.

Consistent with the notion that local macroeconomic conditions drive local price appreciation, we observe an interesting interaction between the orthoganlized MSA indices and Employment Growth. The inclusion of the MSA index makes Employment Growth insignificant in the estimations. In this sense both contain similar information about local market level fundamentals. In each case it appears that local economic conditions are being captured in the local repeat sales indices.

3.4 Los Angeles Apartment Sample

The analysis thus far indicates that national, type and location factors play a role in pricing. To examine the relationship between all these variables, we use a location and property type specific sample. Given data limitations, we were able to estimate only one such index: Los Angeles Apartments. This sample consists of 924 repeat sales between 1998 and 2010.

We once again orthoganalize the repeat sale indices. Using National as a base, we construct a Los Angeles specific factor, an Apartment specific factor and a Los Angeles Apartment specific factor that are all orthogonal to each other. By adding each to the regression we can observe the incremental explanatory power of that factor over the others.

Examining Columns 1 through 4 in Table 13, we observe that each index provides additional explanatory power. In fact the combined adjusted R^2 of all the indices is 40%. This is a significant increase over the previous results. Once again, time invariant property characteristics have some explanatory power, although it tends to be low. NOI Growth is once again significant, although its explanatory power appears to be lower than in previous regressions.

Based on the full regression model in Column 9, we obtain an adjusted R^2 of 54%. This once again indicates that even matching a property type / location sample to a property type / location index, and controlling for property level cash flows and property characteristics, we are still only able to explain approximately half of the variation in property price appreciation. The obvious conclusion from this result is that even property type and location specific indices are going to do a poor job of measuring individual property price appreciation experiences. Thus using these indices as anything more than as an approximation for what is happening to an unobservable "average" asset in the market is likely to be fraught with danger. A second interpretation of this result is that properties are very heterogeneous assets. While two properties may be of the same type and in the same market, they are likely to experience very different price appreciation based on factors that are specific to each property. This suggests that even benchmarking at this fine granulation, if an investor is able to understand these idiosyncratic attributes they may be able to significantly outperform the market as a whole.

4 Conclusions

The development of commercial real estate indices has been an important step in the analysis of the returns on real estate investment. This study tries to examine how well these indices capture the performance of individual properties. In one sense this is similar to asking, how does a benchmark index like the S&P500 capture the performance of an individual security? The results we find using a large sample of holding period returns on 8864 properties suggest that aggregate indices capture a small portion of the total price appreciation; the adjusted R^2s from matching property level to index price appreciation is typically in the 15-20% range. The one exception to this is a property type and location index for the Los Angeles apartment market, where the adjusted R^2 is 40%. This suggests that indices need to be quite focused to have any real explanatory power. Obviously this is problematic because such indices are difficult to estimate due to the large quantity of repeat sales observations required.

We also find in our estimation that property level cash flows play a significant role in explaining price appreciation. However, even after controlling for property level cash flows and market level price changes using repeat sales indices, we are only able to explain approximately 50% of the variation in property price appreciation. This suggests that the highly heterogeneous nature of real estate assets has a major impact on the pricing of real estate in the cross-section. A potential benefit of this finding is that it indicates that real estate investors may be able to exploit investment skill to invest in properties that outperform even in a closely defined investment universe.

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Table 1: Repeat Sales Indices

Table reports descriptive statistics of quarterly price appreciation estimated using a repeat sales methodology. Underlying data for the indices were 11261 repeat sales occurring between 1998 and 2010 in the CoStar database. Office, Industrial, Multifamily and Retail property types were included and properties had to be larger than 2500 sq.ft. or have more than 10 units for multifamily and have a price greater than $2m. All properties must have been held for longer than one year and properties with annual appreciation of less than -40% or greater than 50% were excluded as were the top and bottom 1% of observations based on total price appreciation. Transactions include only true arm's length non-distressed sales. National includes all property types, while Apartment, Office, Industrial and Retail are property type specific indices. Los Angeles and New York include only properties in those respective MSAs and Los Angeles Apartments includes only apartment building in the Los Angeles MSA.

Index	Obs	Underlying Repeat Sales	Mean	Std	Min	Max
National	55	11261	0.012	0.045	-0.132	0.153
Apartment	55	4695	0.015	0.050	-0.121	0.179
Office	55	2849	0.011	0.068	-0.236	0.196
Retail	55	1468	0.010	0.085	-0.188	0.314
Industrial	55	2249	0.008	0.051	-0.203	0.103
Los Angeles	55	2001	0.016	0.055	-0.219	0.160
New York	55	995	0.020	0.100	-0.268	0.230
Los Angeles Apartments	55	1034	0.021	0.061	-0.258	0.202

Table 2: Property Annualized Price Appreciation

Table reports annualized price appreciation (APA) for 8864 repeat sales transactions between 1999 and 2010 from the CoStar database. Annualized price appreciation is calculated as $\left(\frac{P_t}{P_{t-i}}\right)^{\left(\frac{1}{i}\right)} - 1$, where i is the number of years between sales. Office, Industrial, Multifamily and Retail property types were included and properties had to be larger than 2500 sq.ft. or have more than 10 units for multifamily and have a price greater than $2m. All properties must have been held for longer than one year and properties with annual appreciation of less than -40% or greater than 50% were excluded as were the top and bottom 1% of observations based on total price appreciation. Transactions include only arm's length non-distressed sales.

Year	Number of Transactions	Mean	Std.Dev	Min	Max	P25	P75
1999	36	0.157	0.132	-0.225	0.408	0.083	0.227
2000	136	0.170	0.121	-0.281	0.497	0.094	0.233
2001	239	0.127	0.129	-0.355	0.475	0.052	0.198
2002	383	0.106	0.114	-0.326	0.432	0.041	0.160
2003	701	0.118	0.107	-0.332	0.496	0.047	0.177
2004	1012	0.118	0.114	-0.267	0.494	0.046	0.182
2005	1401	0.129	0.107	-0.369	0.498	0.057	0.188
2006	1399	0.123	0.109	-0.348	0.498	0.054	0.181
2007	1526	0.116	0.107	-0.364	0.498	0.050	0.167
2008	897	0.076	0.103	-0.357	0.497	0.025	0.124
2009	465	0.004	0.093	-0.391	0.424	-0.043	0.054
2010	669	-0.004	0.087	-0.319	0.426	-0.054	0.042

Table 3: Index Annualized Price Appreciation

Table reports index annualized price appreciation matched to 8864 repeat sales transactions between 1999 and 2010 from the CoStar database. Office, Industrial, Multifamily and Retail property types were included and properties had to be larger than 2500 sq.ft. or have more than 10 units for multifamily and have a price greater than $2m. All properties must have been held for longer than one year and properties with annual appreciation of less than -40% or greater than 50% were excluded as were the top and bottom 1% of observations based on total price appreciation. Transactions include only arm's length non-distressed sales.

Year	Number of Transactions	Mean	Std.Dev	Min	Max	P25	P75
1999	36	0.075	0.013	0.049	0.116	0.066	0.083
2000	136	0.084	0.010	0.063	0.115	0.077	0.089
2001	239	0.070	0.012	0.022	0.096	0.064	0.078
2002	383	0.049	0.013	0.015	0.072	0.040	0.059
2003	701	0.062	0.012	0.040	0.098	0.054	0.066
2004	1012	0.076	0.014	0.051	0.108	0.066	0.086
2005	1401	0.099	0.020	0.065	0.152	0.080	0.113
2006	1399	0.102	0.016	0.061	0.146	0.084	0.113
2007	1526	0.095	0.012	0.055	0.116	0.085	0.104
2008	897	0.063	0.025	-0.081	0.099	0.053	0.079
2009	465	-0.007	0.054	-0.232	0.062	-0.040	0.033
2010	669	-0.021	0.046	-0.232	0.042	-0.052	0.021

Table 4: Annualized Price Appreciation

Table reports property annualized price appreciation and index matched annualized price appreciation for repeat sales transactions between 1999 and 2010 from the CoStar database. National is a national index including apartment, office, retail and industrial property types, while Apartment, Office, Retail and Industrial are property type indices. Los Angeles and New York are indices for all property types in Los Angeles and New York respectively and LA Apartment is an index for apartment buildings in Los Angeles. To be included in the sample, properties had to be larger than 2500 sq.ft. or have more than 10 units for multifamily and have a price greater than $2m. All properties must have been held for longer than one year and properties with annual appreciation of less than -40% or greater than 50% were excluded as were the top and bottom 1% of observations based on total price appreciation. Transactions include only arm's length non-distressed sales.

		Property						Index					
Index	Obs	Mean	Std	Min	Max	P25	P75	Mean	Std	Min	Max	P25	P75
National	8864	0.101	0.115	-0.391	0.498	0.034	0.164	0.072	0.044	-0.232	0.152	0.060	0.100
Apartment	3880	0.104	0.111	-0.369	0.496	0.035	0.168	0.076	0.045	-0.169	0.156	0.070	0.100
Office	2268	0.097	0.116	-0.329	0.498	0.029	0.154	0.062	0.050	-0.330	0.178	0.041	0.094
Retail	1068	0.114	0.117	-0.391	0.498	0.051	0.174	0.086	0.049	-0.185	0.181	0.061	0.119
Industrial	1648	0.092	0.120	-0.355	0.497	0.024	0.160	0.061	0.051	-0.199	0.153	0.036	0.100
Los Angeles	1709	0.125	0.108	-0.319	0.497	0.058	0.182	0.100	0.057	-0.177	0.204	0.083	0.136
LA Apartments	924	0.134	0.105	-0.319	0.481	0.067	0.190	0.111	0.066	-0.136	0.205	0.075	0.158
New York	809	0.119	0.129	-0.364	0.492	0.044	0.189	0.088	0.061	-0.131	0.244	0.071	0.127

Table 5: Descriptive Statistics

Table reports descriptive statistics for property characteristics of 8864 repeat sales transactions from the CoStar database between 1998 and 2010. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Footprint is the typical floor plate of the building (in millions of square feet.) Floors, is the number of floors in the building. Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS.

	Obs	Mean	Std	Min	Max
Age	8864	38.27	22.82	5.00	170.00
Size	8864	0.10	0.13	0.00	2.65
Corner Lot	8864	0.25	0.43	0.00	1.00
Land Leverage	8864	0.31	0.18	0.00	1.00
Land	8864	5.25	8.80	0.02	245.30
Floors	8864	3.22	4.41	1.00	100.00
Footprint	8864	0.05	0.07	0.00	1.34
Buy Price	8864	10.36	22.50	2.00	745.50
Employment Growth	8864	-0.01	0.02	-0.11	0.06
Holding Period	8864	3.75	2.13	1.00	12.80
NOI Growth	3223	0.06	0.11	-0.37	1.11

Table 6: National Sample

Table reports regression results for a pooled sample of repeat sales transactions between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Apartment, Office and Industrial are property type dummy variables. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
National	0.99			0.67	0.817	0.679	
	(38.25)**			(16.80)**	(16.76)**	(10.57)**	
Age		0.000	0.000	0.000	0.000	0.000	
		(1.48)	(0.29)	(-1.84)	(0.49)	(1.29)	
Size		0.071	0.089	0.075	0.124	0.123	
		(3.08)**	(4.28)**	(3.70)**	(6.03)**	(4.43)**	
Corner Lot		0.006	0.004	0.003	0.002	0.002	
		(1.95)	(1.53)	(1.30)	(0.97)	(0.56)	
Land Leverage		0.038	0.038	0.039	0.015	0.009	
		(5.13)**	(5.70)**	(5.89)**	(2.18)*	(1.00)	
Land		-0.001	-0.001	-0.001	-0.001	0.000	
		(4.41)**	(4.24)**	(4.12)**	(2.89)**	-1.76	
Floors		0.002	0.002	0.002	0.002	0.000	
		(4.19)**	(3.74)**	(4.28)**	(3.75)**	(0.07)	
Footprint		0.086	0.068	0.069	0.04	-0.03	
		(2.58)**	(2.27)*	(2.35)*	(1.38)	(0.80)	
Buy Price		-0.001	-0.001	-0.001	-0.001	-0.001	
		(5.85)**	(7.16)**	(6.50)**	(8.76)**	(4.35)**	
Apartment		-0.007	-0.004	-0.004	-0.011	-0.011	
		(1.73)	(0.99)	(0.94)	(2.81)**	(2.24)*	
Office		-0.017	-0.007	-0.006	-0.01	-0.017	
		(3.68)**	(1.61)	(1.57)	(2.35)*	(3.07)**	
Industrial		-0.024	-0.012	-0.01	-0.011	-0.012	
		(5.10)**	(2.81)**	(2.34)*	(2.67)**	(1.56)	
Employment Growth			1.525	0.506	0.733	0.889	
			(30.75)**	(6.50)**	(7.77)**	(7.77)**	
Holding Period			-0.012	-0.013	-0.012	-0.006	
			(21.29)**	(24.32)**	(20.55)**	(7.57)**	
NOI Growth						0.384	0.441
						(32.45)**	(34.49)**
Constant	0.03	0.089	0.141	0.088	0.187	-0.012	0.085
	(14.02)**	(17.09)**	(27.75)**	(14.96)**	(1.86)	(0.16)	(53.24)**
Obs.	8,864	8,864	8,864	8,864	8,864	3,223	3,223
Adj. R-squared	0.14	0.02	0.21	0.23	0.26	0.47	0.27
State FE	No	No	No	No	Yes	Yes	No
Sale Year FE	No	No	No	No	Yes	Yes	No

Table 7: Apartment Sample

Table reports regression results for a pooled sample of apartment repeat sales transactions between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Apartment is the annualized price appreciation on a holding period matched apartment repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	0.952	0.952			0.572	0.744	0.754	0.672	
	(25.50)**	(26.04)**			(9.89)**	(10.18)**	(9.39)**	(8.59)**	
Apartment		1.144			1.165	0.631	0.735		
		(12.87)**			(13.61)**	(3.74)**	(4.21)**		
Age			-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	
			(2.01)*	(3.11)**	(0.84)	(2.41)*	(2.11)*	(2.08)*	
Size			0.125	0.141	0.100	0.163	0.169	0.164	
			(3.76)**	(4.74)**	(3.47)**	(5.53)**	(4.15)**	(4.01)**	
Corner Lot			0.011	0.009	0.007	0.003	0.000	0.001	
			(2.34)*	(2.14)*	(1.68)	(0.68)	(0.12)	(0.16)	
Land Leverage			0.051	0.056	0.052	0.018	0.019	0.021	
			(4.25)**	(5.19)**	(5.03)**	(1.72)	(1.65)	(1.76)	
Land			-0.001	-0.001	-0.001	0.000	0.000	0.000	
			(3.49)**	(3.34)**	(3.16)**	(1.57)	(1.35)	(1.30)	
Floors			0.004	0.004	0.004	0.004	0.002	0.002	
			(3.18)**	(3.91)**	(3.81)**	(3.37)**	-1.05	-1.06	
Footprint			0.093	0.101	0.062	0.032	-0.016	-0.008	
			(1.50)	(1.83)	(1.16)	(0.61)	(0.24)	(0.12)	
Buy Price			-0.002	-0.002	-0.001	-0.002	-0.001	-0.001	
			(7.51)**	(8.44)**	(5.41)**	(6.85)**	(3.56)**	(3.54)**	
Emp. Grow				1.458	0.602	0.974	0.874	0.937	
				(20.67)**	(5.43)**	(7.24)**	(6.09)**	(6.54)**	
Holding Period				-0.012	-0.013	-0.011	-0.006	-0.004	
				(14.14)**	(16.48)**	(10.22)**	(5.83)**	(4.23)**	
NOI Grow							0.355	0.352	0.411
							(24.97)**	(24.71)**	(26.55)**
Constant	0.036	0.036	0.092	0.142	0.094	0.135	0.081	0.089	0.087
	(11.36)**	(11.60)**	(15.73)**	(24.43)**	(12.74)**	(1.46)	(1.11)	(1.21)	(43.29)**
Obs.	3,880	3,880	3,880	3,880	3,880	3,880	2,162	2,162	2,162
Adj. R-squared	0.14	0.18	0.02	0.22	0.27	0.31	0.48	0.47	0.25
State FE	No	No	No	No	No	Yes	Yes	Yes	No
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 8: Office Sample

Table reports regression results for a pooled sample of office repeat sales transactions between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Office is the annualized price appreciation on a holding period matched office repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	1.143	1.143			0.844	1.087	0.657	0.657	
	(20.06)**	(20.38)**			(10.41)**	(10.75)**	(4.34)**	(4.34)**	
Office		0.887			0.636	0.587	0.014		
		(8.52)**			(6.47)**	(4.43)**	-0.08		
Age			0.000	0.000	0.000	0.000	0.000	0.000	
			(1.69)	(1.72)	(2.06)*	(0.08)	(1.44)	(1.44)	
Size			0.075	0.07	0.053	0.134	0.075	0.075	
			(1.86)	(1.98)*	(1.55)	(3.79)**	(1.38)	(1.38)	
Corner Lot			0.005	0.003	0.003	0.007	0.007	0.007	
			(0.87)	(0.57)	(0.61)	(1.47)	(1.19)	(1.19)	
Land Leverage			0.04	0.036	0.042	0.009	0.034	0.034	
			(2.84)**	(2.89)**	(3.47)**	(0.68)	(1.78)	(1.79)	
Land			-0.001	-0.001	-0.001	-0.001	0.000	0.000	
			(1.80)	(1.72)	(1.78)	(1.54)	(0.38)	(0.39)	
Floors			0.001	0.001	0.001	0.001	0.001	0.001	
			(1.96)	(1.86)	(2.41)*	(1.56)	(0.89)	(0.89)	
Footprint			0.159	0.211	0.265	0.277	0.162	0.162	
			(1.00)	(1.51)	(1.95)	(2.06)*	(0.71)	(0.71)	
Buy Price			-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	
			(3.19)**	(3.84)**	(3.42)**	(6.50)**	(2.80)**	(2.81)**	
Emp. Grow				1.626	0.415	0.467	0.878	0.876	
				(15.56)**	(2.68)**	(2.53)*	(3.63)**	(3.64)**	
Holding Period				-0.015	-0.016	-0.016	-0.011	-0.011	
				(14.24)**	(15.08)**	(13.41)**	(6.58)**	(6.78)**	
NOI Grow							0.401	0.401	0.49
							(12.99)**	(13.02)**	(15.12)**
Constant	0.014	0.014	0.067	0.14	0.07	0.266	-0.007	-0.007	0.075
	(2.90)**	(2.95)**	(9.89)**	(19.49)**	(7.35)**	(2.70)**	(0.09)	(0.09)	(22.53)**
Obs.	2,268	2,268	2,268	2,268	2,268	2,268	602	602	602
Adj. R-squared	0.15	0.18	0.02	0.24	0.29	0.32	0.46	0.46	0.27
State FE	No	No	No	No	No	Yes	Yes	Yes	No
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 9: Retail Sample

Table reports regression results for a pooled sample of retail repeat sales transactions between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Retail is the annualized price appreciation on a holding period matched retail repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	0.912	0.912			0.637	0.747	0.687	0.68	
	(11.18)**	(11.33)**			(5.14)**	(4.93)**	(2.92)**	(2.83)**	
Retail		0.863			0.788	0.925	0.774		
		(5.55)**			(5.13)**	(4.79)**	(3.60)**		
Age			0.000	0.000	0.000	0.000	0.000	0.000	
			(0.33)	(0.36)	(0.13)	(0.09)	(0.77)	(0.85)	
Size			0.037	0.226	0.24	0.286	0.197	0.2	
			(0.19)	(1.22)	(1.32)	(1.57)	(1.03)	(1.02)	
Corner Lot			0.002	0.003	0.004	0.005	-0.006	-0.008	
			(0.21)	(0.46)	(0.62)	(0.69)	(0.83)	(0.96)	
Land Leverage			0.045	0.05	0.05	0.037	-0.012	-0.017	
			(2.22)*	(2.63)**	(2.67)**	(1.91)	(0.51)	(0.71)	
Land			0.001	0.000	0.001	0.001	0.000	0.000	
			(1.03)	(0.70)	(0.84)	(0.78)	(0.15)	(0.05)	
Floors			0.013	0.01	0.011	0.01	-0.006	-0.005	
			(2.47)*	(2.08)*	(2.43)*	(2.02)*	(0.98)	(0.83)	
Footprint			0.084	0.027	0.012	0.024	-0.147	-0.15	
			(0.40)	(0.14)	(0.06)	(0.13)	(0.70)	(0.69)	
Buy Price			-0.001	-0.002	-0.002	-0.003	-0.001	-0.001	
			(2.17)*	(3.94)**	(4.18)**	(4.78)**	(0.91)	(0.86)	
Emp. Grow				1.581	0.57	0.695	0.228	0.507	
				(9.83)**	(2.32)*	(2.24)*	(0.58)	(1.30)	
Holding Period				-0.009	-0.01	-0.008	-0.007	-0.009	
				(5.29)**	(5.46)**	(4.22)**	(2.66)**	(3.32)**	
NOI Grow							0.555	0.54	0.543
							(14.92)**	(14.32)**	(13.52)**
Constant	0.045	0.045	0.075	0.117	0.06	-0.015	0.198	0.141	0.091
	(6.41)**	(6.49)**	(6.60)**	(9.78)**	(3.82)**	(0.13)	(2.60)**	(1.86)	(18.64)**
Obs.	1,068	1,068	1,068	1,068	1,068	1,068	331	331	331
Adj. R-squared	0.1	0.13	0.01	0.15	0.18	0.2	0.53	0.51	0.36
State FE	No	No	No	No	No	Yes	Yes	Yes	No
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 10: Industrial Sample

Table reports regression results for a pooled sample of industrial repeat sales transactions between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Industrial is the annualized price appreciation on a holding period matched industrial repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	0.946	0.946			0.718	0.756	0.861	1.013	
	(16.90)**	(17.19)**			(8.23)**	(6.77)**	(2.11)*	(2.60)*	
Industrial		1.011			0.853	0.878	0.627		
		(7.60)**			(6.50)**	(4.42)**	(1.23)		
Age			0.000	0.000	0.000	0.000	0.000	0.000	
			(0.17)	(1.06)	(0.32)	(0.26)	(0.64)	(0.68)	
Size			0.361	0.286	0.319	0.411	0.486	0.44	
			(2.30)*	(2.01)*	(2.31)*	(2.93)**	(0.74)	(0.67)	
Corner Lot			0.000	-0.003	-0.004	-0.005	0.004	0.005	
			(0.02)	(0.42)	(0.69)	(0.73)	(0.24)	(0.29)	
Land Leverage			0.033	0.028	0.028	0.008	0.011	0.014	
			(1.89)	(1.74)	(1.80)	(0.52)	(0.20)	(0.27)	
Land			-0.001	-0.001	-0.001	-0.001	0.001	0.001	
			(1.56)	(2.28)*	(2.13)*	(1.34)	(0.31)	(0.35)	
Floors			0.008	0.008	0.008	0.008	0.02	0.024	
			(1.26)	(1.24)	(1.33)	(1.30)	(0.53)	(0.66)	
Footprint			-0.077	-0.012	-0.053	-0.079	-0.183	-0.114	
			(0.50)	(0.09)	(0.39)	(0.58)	(0.30)	(0.19)	
Buy Price			-0.004	-0.004	-0.004	-0.005	-0.006	-0.006	
			(3.53)**	(3.80)**	(3.84)**	(5.24)**	(3.01)**	(3.32)**	
Emp. Grow				1.458	0.326	0.442	-0.053	-0.137	
				(12.86)**	(1.83)	(1.95)	(0.09)	(0.24)	
Holding Period				-0.011	-0.012	-0.012	-0.012	-0.014	
				(8.09)**	(8.87)**	(7.58)**	(2.57)*	(3.38)**	
NOI Grow							0.468	0.463	0.517
							(8.92)**	(8.84)**	(9.72)**
Constant	0.029	0.029	0.067	0.135	0.075	0.063	0.013	0.018	0.081
	(6.33)**	(6.44)**	(6.17)**	(12.05)**	(5.97)**	(0.54)	(0.13)	(0.19)	(10.90)**
Obs.	1,648	1,648	1,648	1,648	1,648	1,648	128	128	128
Adj. R-squared	0.15	0.18	0.02	0.19	0.24	0.26	0.62	0.61	0.42
State FE	No	No	No	No	No	Yes	Yes	Yes	No
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 11: New York MSA Sample

Table reports regression results for a pooled sample of repeat sales transactions in the New York MSA between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. NYC is the annualized price appreciation on a holding period matched New York MSA repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	0.969	0.969			0.69	0.737	0.663	0.51	
	(12.28)**	(12.47)**			(4.95)**	(4.22)**	-1.85	-1.39	
NYC		0.83			0.656	0.667	0.909		
		(5.17)**			(4.12)**	(3.86)**	(2.80)**		
Age			0.000	0.000	0.000	0.000	0.000	0.000	
			(1.24)	(0.13)	(0.73)	(0.43)	(0.07)	(0.67)	
Size			0.155	0.173	0.12	0.128	-0.251	-0.2	
			(1.99)*	(2.43)*	(1.71)	(1.79)	(0.79)	(0.61)	
Corner Lot			0.004	-0.002	0.001	0.001	-0.006	-0.008	
			(0.41)	(0.18)	(0.06)	(0.11)	(0.33)	(0.40)	
Land Leverage			0.084	0.074	0.063	0.068	-0.003	-0.024	
			(3.81)**	(3.62)**	(3.13)**	(3.21)**	(0.06)	(0.46)	
Land			0.000	0.000	0.000	0.000	0.000	0.001	
			(0.55)	(0.42)	(0.57)	(0.46)	(0.03)	(0.43)	
Floors			0.002	0.001	0.001	0.002	0.003	0.001	
			(1.72)	(1.38)	(1.32)	(1.59)	(0.74)	(0.17)	
Footprint			-0.044	-0.041	-0.048	-0.045	-0.121	-0.695	
			(0.36)	(0.36)	(0.44)	(0.41)	(0.13)	(0.74)	
Buy Price			-0.001	-0.001	-0.001	-0.001	0.000	0.000	
			(2.67)**	(3.36)**	(2.36)*	(2.61)**	(0.36)	(0.50)	
Emp. Grow				1.753	0.458	0.677	-0.174	0.319	
				(9.97)**	(1.49)	(1.81)	(0.22)	(0.40)	
Holding Period				-0.012	-0.012	-0.012	-0.004	-0.002	
				(5.71)**	(5.42)**	(5.04)**	(0.75)	(0.40)	
NOI Grow							0.375	0.386	0.398
							(3.44)**	(3.41)**	(3.33)**
Constant	0.058	0.058	0.055	0.124	0.075	0.046	-0.057	0.069	0.09
	(8.91)**	(9.05)**	(3.64)**	(7.67)**	(3.99)**	(0.85)	(0.53)	(0.68)	(7.60)**
Obs.	809	809	809	809	809	809	108	108	108
Adj. R-squared	0.16	0.18	0.04	0.19	0.23	0.23	0.49	0.44	0.09
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 12: Los Angeles MSA Sample

Table reports regression results for a pooled sample of repeat sales transactions in the Los Angeles MSA between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. LA is the annualized price appreciation on a holding period matched Los Angeles MSA repeat sale index orthogonalized to National. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
National	1.106	1.106			0.896	0.971	0.823	0.617	
	(22.97)**	(23.57)**			(9.56)**	(9.89)**	(6.10)**	(4.48)**	
LA		1.045			1.013	1.183	1.445		
		(9.59)**			(9.53)**	(8.06)**	(7.99)**		
Age			0.000	0.000	0.000	0.000	0.000	0.000	
			(1.30)	(0.08)	(0.06)	(0.16)	(0.86)	(0.50)	
Size			0.561	0.426	0.394	0.353	0.205	0.214	
			(5.06)**	(4.43)**	(4.28)**	(3.78)**	(2.20)*	(2.20)*	
Corner Lot			0.014	0.008	0.007	0.007	0.001	-0.001	
			(2.46)*	(1.72)	(1.58)	(1.50)	(0.10)	(0.11)	
Land Leverage			-0.016	-0.012	-0.008	-0.008	-0.019	-0.017	
			(1.07)	(0.92)	(0.63)	(0.65)	(1.25)	(1.06)	
Land			-0.001	-0.001	-0.002	-0.002	0.001	0.001	
			(0.78)	(1.31)	(1.81)	(1.83)	(0.38)	(0.34)	
Floors			0.002	0.001	0.001	0.001	0.004	0.004	
			(0.94)	(0.45)	(0.55)	(0.43)	(1.83)	(1.76)	
Footprint			-0.321	-0.204	-0.179	-0.158	-0.056	-0.058	
			(2.42)*	(1.78)	(1.63)	(1.44)	(0.46)	(0.46)	
Buy Price			-0.003	-0.002	-0.002	-0.002	-0.002	-0.002	
			(6.27)**	(5.43)**	(5.34)**	(4.68)**	(3.73)**	(3.57)**	
Emp. Grow				1.672	0.152	0.453	0.735	0.998	
				(18.32)**	(0.86)	(1.54)	(1.90)	(2.49)*	
Holding Period				-0.009	-0.013	-0.012	-0.007	-0.005	
				(7.56)**	(10.25)**	(9.49)**	(4.25)**	(3.03)**	
NOI Grow							0.282	0.291	0.312
							(13.50)**	(13.44)**	(12.54)**
Constant	0.046	0.046	0.114	0.168	0.103	0.142	0.08	0.069	0.11
	(11.20)**	(11.50)**	(12.47)**	(18.66)**	(9.44)**	(4.35)**	(3.53)**	(2.94)**	(28.79)**
Obs.	1,709	1,709	1,709	1,709	1,709	1,709	780	780	780
Adj. R-squared	0.24	0.27	0.03	0.28	0.34	0.35	0.48	0.44	0.17
Sale Year FE	No	No	No	No	No	Yes	Yes	Yes	No

Table 13: Los Angeles Apartment Sample

Table reports regression results for a pooled sample of apartment repeat sales transactions in the Los Angeles MSA between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Apartment is the annualized price appreciation on a holding period matched apartment repeat sale index orthogonalized to National, LA and LA/Apt. LA is the annualized price appreciation on a holding period matched Los Angeles MSA repeat sale index orthogonalized to National, Apartment and LA/Apt. LA/Apt is the annualized price appreciation on a holding period matched Los Angeles MSA apartment repeat sale index orthogonalized to National, LA and Apartment. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
National	1.021	1.021	1.021	1.021		
	(16.20)**	(16.36)**	(17.88)**	(18.52)**		
LA		0.769	0.769	0.769		
		(4.38)**	(4.79)**	(4.96)**		
Apartment			1.943	1.943		
			(13.40)**	(13.88)**		
LA/Apt				1.26		
				(8.27)**		
Age					0.000	0.000
					(1.14)	(0.28)
Size					0.343	0.174
					(2.41)*	(1.42)
Corner Lot					0.006	0.004
					(0.79)	(0.58)
Land Leverage					-0.042	-0.046
					(1.94)	(2.46)*
Land					-0.001	0.002
					(0.48)	(0.77)
Floors					0.016	0.015
					(3.43)**	(3.76)**
Footprint					0.819	0.553
					(2.49)*	(1.95)
Buy Price					-0.005	-0.003
					(6.26)**	(5.03)**
Emp. Grow						1.589
						(13.05)**
Holding Period						-0.011
						(6.42)**
NOI Grow						
Constant	0.061	0.061	0.061	0.061	0.094	0.152
	(11.13)**	(11.24)**	(12.28)**	(12.72)**	(5.67)**	(10.08)**
Obs.	924	924	924	924	924	924
Adj. R-squared	0.22	0.24	0.36	0.4	0.06	0.3
Sale Year FE	No	No	No	No	No	No

Table 13: Los Angeles Apartment Sample ctd..

Table reports regression results for a pooled sample of apartment repeat sales transactions in the Los Angeles MSA between 1998 and 2010 from the CoStar database. The dependent variable is the property's annualized price appreciation. National is the annualized price appreciation on a holding period matched national repeat sale index. Apartment is the annualized price appreciation on a holding period matched apartment repeat sale index orthogonalized to National, LA and LA/Apt. LA is the annualized price appreciation on a holding period matched Los Angeles MSA repeat sale index orthogonalized to National, Apartment and LA/Apt. LA/Apt is the annualized price appreciation on a holding period matched Los Angeles MSA apartment repeat sale index orthogonalized to National, LA and Apartment. Age is the age of the property at the time of sale, Size is the building's square feet (in millions.) Corner Lot is a dummy variable equal to one if the property is a corner lot. Land Leverage is assessed land value divided by total assessed value. Land is the property's land area in acres. Floors, is the number of floors in the building. Footprint is the typical floor plate of the building (in millions of square feet.) Buy Price is purchase price of the building. Employment Growth is the percentage change in county employment rate between the time of purchase and sale. Holding Period, is the number of years between purchase and sale. NOI Growth is the annualized growth rate in the property's NOI. All data were obtained from CoStar except the employment data which are obtained from the BLS. *, ** denote 5 and 1% levels of significance respectively.

	(7)	(8)	(9)	(10)	(11)	(12)
National	0.976	1.063	0.947	0.675	0.534	
	(8.71)**	(7.92)**	(6.20)**	(4.70)**	(3.62)**	
LA	0.808	1.02	1.456	1.363		
	(5.45)**	(5.68)**	(7.31)**	(6.76)**		
Apartment	1.807	2.138	2.278	1.256	0.967	
	(12.32)**	(5.97)**	(6.12)**	(4.10)**	(3.07)**	
LA/Apt	1.219	1.352	1.016			
	(8.24)**	(6.30)**	(4.66)**			
Age	0.000	0.000	0.000	0.000	0.000	
	(1.29)	(1.16)	(0.92)	(0.86)	(0.61)	
Size	0.042	0.05	0.101	0.09	0.066	
	(0.38)	(0.45)	(0.97)	(0.85)	(0.60)	
Corner Lot	0.002	0.003	0.000	0.001	0.000	
	(0.40)	(0.44)	(0.03)	(0.12)	(0.08)	
Land Leverage	-0.037	-0.04	-0.04	-0.038	-0.042	
	(2.23)*	(2.42)*	(2.30)*	(2.11)*	(2.25)*	
Land	0.000	0.000	0.001	0.001	0.001	
	(0.07)	(0.21)	(0.36)	(0.37)	(0.35)	
Floors	0.009	0.01	0.01	0.01	0.009	
	(2.54)*	(2.71)**	(2.55)*	(2.63)**	(2.19)*	
Footprint	0.225	0.241	0.111	0.152	0.125	
	(0.90)	(0.95)	(0.45)	(0.60)	(0.48)	
Buy Price	-0.002	-0.002	-0.002	-0.002	-0.002	
	(2.59)**	(2.83)**	(2.78)**	(2.83)**	(2.24)*	
Emp. Grow	-0.201	-0.154	0.194	0.82	1.014	
	(0.91)	(0.40)	(0.43)	(1.87)	(2.23)*	
Holding Period	-0.014	-0.016	-0.01	-0.005	-0.005	
	(8.66)**	(6.86)**	(4.16)**	(2.30)*	(2.09)*	
NOI Grow			0.229	0.235	0.243	0.266
			(10.16)**	(10.22)**	(10.19)**	(9.26)**
Constant	0.088	0.083	0.036	0.072	0.059	0.116
	(5.62)**	(3.11)**	(1.30)	(2.64)**	(2.08)*	(25.13)**
Obs.	924	924	587	587	587	587
Adj. R-squared	0.46	0.46	0.54	0.52	0.49	0.13
Sale Year FE	No	Yes	Yes	Yes	Yes	No