COMPARING PUBLIC AND PRIVATE REAL ESTATE THROUGH REPEAT-SALES INDEXES AND UNLEVERED REIT RETURNS

By

Griffin W. Amdur

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Faculty Advisor:

Dr. Todd Sinai

Professor of Real Estate and Business Economics and Public Policy

THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA

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ABSTRACT

This paper constructs repeat-sales indexes using Real Capital Analytics (RCA) transaction data from central business districts (CBD) in Chicago, New York City (Manhattan), Philadelphia, Washington D.C., Los Angeles, San Francisco, and Boston. The indexes can be used to measure the historical returns of offices in these markets. This paper brings insight on whether public and private real estate should be treated as the same asset class. It was found that exposure to private real estate has a positive liquidity premium compared to public REITs. This was found by comparing RCA's Manhattan Office Repeat-Sales Index to SL Green's unlevered returns.

Keywords:
Real Estate Indexes, Repeat-Sales, Private Real Estate, REITs

Discipline:
Real Estate

INTRODUCTION

This paper examines the performance of public and private real estate. It is important to study this topic to determine if public and private real estate should be treated as the same or a separate asset class. If the performance of public and private real estate differs, institutional investors would benefit from diversification. Theoretically, in aggregate, REITs and private funds have the same underlying assets so should perform similarly. However, there has been conflicting empirical evidence regarding if this occurs.

With the growth of real estate transactional databases, the topic is becoming increasingly researched. The previous studies have compared REITs to the NCREIF Property Index (NPI), an appraisal-based index. However, there has been substantial evidence showing appraisal-based indexes do not accurately track private real estate's performance. It has also been shown that transaction-based (repeat-sales) indexes is a more accurate method compared to appraisal-based indexes.

There has not been a study comparing the performance of REITs to a repeat-sales index for commercial real estate. Furthermore, there has not been a study comparing a singular REIT's returns with a specific repeat-sales index, which is the focus of this paper. The reason being that almost all REITs have significant portfolio exposure to different asset classes or geographies. However, SL Green is unique, as it has a portfolio almost entirely comprised of office buildings in Manhattan. Also, indexes normally cover large regions to include many transactions, but Manhattan's defined borders and large number of transactions makes it possible to collect enough observations to create an accurate index that represents the office market. Comparing the Manhattan Repeat-Sale Index with SL Green's historical unlevered returns provides valuable insights regarding how public and private real estate has historically performed.

There are two existing repeat-sales indexes for offices that are published by CoStar and RCA. CoStar's releases indexes on asset class and region (Office, Northeast), but does not refine indexes to smaller submarkets. RCA creates granular indexes for focused submarkets (Office, CBD), but uses a unique technique for constructing their indexes. The indexes in this paper use RCA's transaction data, but uses an alternative methodology for construction compared to the existing repeat-sales indexes.

LITERATURE REVIEW

Portfolio Diversification with Real Estate

According to modern portfolio theory, diversification across asset classes creates an optimal risk adjusted portfolio. Real estate has intrinsic value and is classified as a real asset. Its value is comprised of two components: the building and land. Inflation, changes in currency values and other macroeconomic factors tend to affect real estate less than other financial instruments. According to Preqin, institutional investors in 2014 allocated 7.5% of their portfolio in real estate and had targeted portfolio allocation rates around 9.5%. It has been found that the optimal real estate allocation rate should be 10%-15% of a portfolio (Pagliari, 2017).

Commercial real estate is often thought of as a hybrid asset and can be hypothetically considered a bond with an equity kicker. Total return of a real estate investment is comprised of the net operating cash flows and capital gains / losses from sale. A general rule in long-term real estate investing is approximately 80% of the total return should come from operating cash flows and 20% from capital gains. This generalization is meant to show that it is easier to project operating cash flows than future cap rates.

Dividends issued by corporations allow shareholders to realize a portion of their investment. The historical dividend yield of the S&P 500 over the last 50 years is 2.95%, with the median being 2.88%, the minimum average 1.17% and the maximum average 5.37% (Schiller 2000). The average historical cumulative return of the S&P 500 during the same period is 8.29%, with the median being 11.09%, the minimum -38.49% and the maximum 34.11% (Schiller 2000). This illustrates that the main component of total returns in the equity market comes from capital gains and not dividends (similar to operating cash flows). On the other hand, the total return of a bond comes from coupon payments when assuming the note is not traded over the loan period.

Consistent net rental income from tenants serves as stable cash in-flows that are similar to fixed-income coupon payments. This predictability allows investors to lever their investment to reasonably align cash out-flows from interest payments and other operating expenditure. However, net operating cash flows are substantially less predictable than a bond's coupon payments. With expectations of future inflation and higher interest rates, there tends to be downward pressure on bond and real estate prices. However, future expectations regarding cash flow growth can help offset effects of valuations, resulting in lower volatility in prices. These offsetting factors makes real estate a hybrid-asset and allow investors to safely add leverage to an asset.

There are multiple investment vehicles that gain exposure to real estate. Publically traded REITs are constantly marked-to-market. A REIT's implied cap rate allows investors to know the current market value of the firm's assets. NAREIT reports the REIT market capitalization has grown exponentially over the past two decades. In 2017 the market cap of 222 publically traded REITs was $1.13 trillion compared to only 189 REITs with a market capitalization of $32 billion in 1993. This explosion in market capitalization as well as the creation of the UPREIT structure in 1993 marks the beginning of the Modern REIT Era (Gyourko, 2004). The vast majority of REITs

own equity in commercial real estate, as companies are able to use their scale and expertise in acquisitions / asset management to create value. REITs tend to own larger commercial assets to have cost effective professional management. In this paper real estate that is owned by private companies is consider private real estate. There are different modes to invest in private real estate such as private equity funds or direct investment through the purchasing of property. Funds are the normal outlet for institutional investors to gain exposure to private real estate as they can increase diversification among multiple properties. The only way to determine the actual value of a privately held real estate is via sale. Private-market investments tend to have long holding periods as illiquidity and transactions costs make portfolio rebalancing impractical (Pagliari, 2017).

Real Estate Indexes

An index is a hypothetical portfolio of securities intended to replicate a market. Indexes are used to give investors a benchmark to compare their investment's performance to a synthetic market's average return. In real estate there are two commonly used indexes among institutional investors to benchmark returns: FTSE NAREIT PureProperty Index and NCREIF Property Index (NPI). The NAREIT index tracks the real-time total performance of all public equity REITs, making it the benchmark for public real estate. The index is weighted by the REITs market capitalization, and the index's value is determined by daily stock market price of the equity and REIT dividend payments. The NPI is the benchmark for core private real estate and is an appraisal-based index. This index tracks property-level returns, is weighted by the assets' appraised market value, and is reported on a quarterly basis. The NPI uses the quarter-over-quarter property cash flows to determine if the asset's value has changed if a new appraisal had not been done in that quarter.

There are two well-known alternative methods for creating private real estate indexes: hedonic analysis and the repeat-sales method. In hedonic analysis, independent variables are determined by categorizing common features among properties, which are then regressed against the dependent variable, price. For example, independent variables in a hedonic regression of single-family homes are number of bedrooms, number of bathrooms, square footage, etc. A regression would then be run on a dataset of sold properties containing these independent variables to show the coefficients of each feature. The regression's output could then be used to predict the market value of properties that have not transacted. This method has been found to be not effective in valuing commercial real estate as there are increased idiosyncrasies between properties such as tenants, capital expenditures, etc., making it difficult to find common independent variables that explain that price.

Repeat-sales is another method to create a real estate index. This approach uses properties that have been both bought and sold to determine the compounded return of the capital gain / loss. Each properties return is matched with other properties that shared overlapping transaction ranges to find an average monthly return for the market. There are two methods to weight a repeat-sales index: arithmetic and geometric. A geometric repeat-sales indexes weights properties equally regardless of value. An arithmetic repeat-sales index weights properties by the market value. The Case–Schiller Index is a famous repeat-sales index that tracks the single family home market with arithmetic weights. Value-weighted indexes tend to have increased volatility as large transaction may distort the index value. Equal-weighted indexes skew the index values towards the return of lower-valued transactions while value-weighted indexes skew market averages towards higher value-transactions. It is important to note that index values for a specific period change over time.

Once a property has been bought-and-sold a new data point is added that changes the average return for a market for the period between the two transactions.

As mentioned, CoStar constructs an equal-weighted, repeat-sales indexes for offices in each US region, and RCA constructs repeat-sales indexes on small markets such as a city's CBD. Both indexes exclude some transactions with some common filters being: properties with missing transaction prices, "flipped" properties that are bought and resold in less than 12 months, and extreme price movements (CoStar 50% / -40% per year and RCA 50% / -50% per year). RCA's repeat-sales methodology was redeveloped in September 2017 by Francke, Geltner, and Van de Minne to now include econometric techniques that allows for the construction of accurate indexes even with few transactions. The indexes are commonly referred to as transaction-based indexes (TBI), and are updated by the MIT Real Estate Center every month. RCA's indexes use a structural time series approach that allows a self-learning model to pull information from data points in surrounding periods to determine if a transaction was a signal or noise (Francke, Geltner, et al. 2017). A signal is a systematic price movement and noise is random dispersion of price movement. This technique makes the index less susceptible to skew and outliers as it doesn't infer price movement from just a single period. RCA's indexes also include an autoregressive component to factor how past transactions affect future transactions. Lastly, RCA's redeveloped methodology uses a stochastic volatility model to better determine what transactions are signals versus noise (Francke, Geltner, et al. 2017). This feature allows the index to apply different weights to each transactions, which is an alternative to geometric and arithmetic approaches.

Limitations and Issues with Real Estate Indexes

There are limited issues with the construction of the NAREIT Index because it is continually repriced and reweighted from the public markets. On the other hand, the NPI has substantial biases that result from the index being appraisal-based. The NPI data comes from comes from a portfolio of properties, were the owners an asset's operating cash flows and updated appraisal value. Although NCREIF provides quarterly updates to its NPI, most of the properties have "stale" valuations as a property is generally only reappraised only once per year (Geltner and Goetzmann 2000). A "stale" valuation occurs in any quarter where the property does not undergo a new appraisal. Additionally, appraisals are expensive and frequently only occur in the fourth quarter when firms begin compiling financials for their shareholder's annual report. This creates a large seasonality effect in the NPI, leading to substantial fourth quarter volatility within the index (Geltner and Goetzmann 2000). From 1978-2002 the average variance in the fourth quarter of the NPI was six times higher than the first three quarters (Gyourko 2004). The seasonality effect leads to the NPI only really tracking changes in rental income in the first three quarters. The change in a property's appreciation is only being realized in the fourth quarter.

There are further concerns regarding the validity of appraisals in NPI due to appraisal smoothing. Appraisal smoothing is the idea that appraisers are biased to anchor new appraisals to historical valuations, which leads to a high level of autocorrelation in valuations (Geltner and Goetzmann 2000). Although appraisers are hired from an outside third-party, there may be moral hazard in the valuation process as the appraisers want to be rehired by the firm in the future. It is unlikely that a firm will rehire an appraiser who gives a valuation that is lower than what the company expected. Fisher, Miles and Webb (1999) found empirical evidence of appraisal smoothing by documenting a difference in appraised valuations compared to recently sold

properties. Approaches to mitigate the effect of appraisal smoothing add volatility to the index through econometric techniques to try and adjust for the autocorrelation (Pagliari 2017). It has been found that these de-smoothing methods increase the index's standard deviation by 80%-100% (Newell and MacFarlane 1995). Many academics have questioned appraisal smoothing's validity as it often adds volatility with little explanation regarding why certain parameters were set.

Two substantial differences between the NPI and the NAREIT indexes are time horizons and leverage. With all publically traded companies, investors attempt to value the firm's future cash flows, while an appraisers' goal is to determine the current market value. Appraisals tend to use a backwards looking approach when determining the market value of a property by using historical market conditions and comparable transactions as references. This fundamental difference creates a significant lag in returns between the two indexes. Another difference is that the NPI reports unlevered returns while the NAREIT index reports levered returns (around 40%-50%) (Pagliari 2017). It has been noted that some institutional investors use the NAREIT index as the benchmark for value-add and opportunistic funds because the returns are levered (Pagliari 2017).

Private and Public Real Estate Returns

Before examining the difference in public and private real estate returns, it is important to note that REITs are not a perfect substitute for private real estate as REITs often generate cash flows from developments and third-party management services. Historically, publically traded REITs have traded similarly to other non-real estate equities. From 1978-2002 the correlation in share price movement between REITs and the S&P 500 was .55, was .64 with small-cap stocks, and -.03 with NPI (Gyourko 2004). This strong positive correlation with equities and negative

correlation with NPI at first seems intuitively incorrect. However, as mentioned there is a significant lag in the NPI due to the backward looking appraisal process and high level of autocorrelation in valuations that does not occur with REITs (Pagliari 2017). When there was a four quarter lag in the NAREIT index, the correlation with the NPI index increased to .58 (Gyourko 2004). Although the two indexes become more correlated when a lag is added, it still surprises academics that the indexes correlations are not higher as they are both meant to track the same asset.

The lagged correlation of NARIET and NPI is approximately the same from 1978-1991 and 1991-2002 (Gyourko 2004). This can be explained by little to no change in the appraisal process during this period. Interestingly, REIT correlations with the small cap stocks were significantly higher from 1978-1991 (.82) when compared to 1992-2002 (.39). As mentioned, the REIT industry market cap exploded from 1992-2002, which changed investors' opinions that REITs properly represent the commercial real estate market instead of the broader equity market (Gyourko 2004).

Zisler (1991) was the first to highlight the low volatility and severe autocorrelation in the NPI. The historical volatility of the NPI is 5% and for the NAREIT Index was 21% (Ang, Chen, et al 2016). The substantial difference in the two indexes standard deviation can be attributed to the frequency of assets' valuations, appraisal smoothing and leverage. Interestingly, after making adjustments for the above differences, Ang *et al.* (2016) found that the volatility for private real estate was 21%, the same as the NAREITs Index.

Gyourko (2004) found the standard deviation of quarterly net rental income for the NPI was .16% with the quarterly return being 1.95%. Although the standard deviation seems extremely small, the results are not surprising as the NPI is comprised of a massive portfolio of properties so

rental income should be relatively stable. Gyourko also found capital appreciation component's average return was .052% in the fourth quarter versus .3% and .28% in the third and first quarters with the standard deviation in the fourth quarter being 2.36% versus 1.1-1.2% in the other three quarters. This shows an increase of appraisals in the fourth quarter and proves that the seasonality effect exists in the NPI.

Liquidity Premium

Efficient market hypothesis states: when many rational investors are actively trying to make the most money, then competition will cause the full effects of news to be instantaneously reflected in the intrinsic value of the asset. REITs are liquid, cost effective and relatively efficient. Interestingly, Bond and Chang (2012) found that REITs have lower liquidity compared to similar companies of equal size. Gopalan *et al.* (2010) found that asset liquidity significantly impacts stock liquidity and that the firms that have assets that can be liquidated quickly receive larger equity valuation and more trading volume. Private commercial real estate is inefficient because it is illiquid, has unpredictable pricing, large transaction cost, and asymmetric information between transacting parties. Hypothetically, illiquid assets should trade at a discount to liquid assets and private real estate returns should outperform REITs, but it is unclear if this exists in the market.

Williams (1995) found private markets have a positive liquidity premium to compensate transacting parties for the time spent and transaction costs for matching a willing buyer and seller. Duffie *et al* (2007) found that the size of this liquidity premium is based on the quantity of possible buyers and size of search costs, with all other conditions being the same. An approach to account for the liquidity premium of private real estate was developed by Fisher *et al.* in 2003. They proposed a method to control time-varying liquidity and applied the results to a commercial real

estate repeat-sales index. They constructed a "constant-liquidity value" to determine prices if the ease of selling had been the same throughout time, and then hedonically adjusted transaction prices using this variable-liquidity index (Fisher, Gatzlaff, et al. 2003). This liquidity index is based on the spread between sellers' and buyers' reservation prices. In 2010 Bond and Slezak used MIT/RCA's transaction-based indexes and Fisher *et al.* methodology to determine the cost of immediate liquidation for private real estate. Bond and Slezak found the average cost for immediate liquidation was 15.9% (See Appendix 1). Similarly, Benveniste, Capozza, and Seguin (2001) found that creating liquidity for a portfolio increases the assets' value by 12%-22%. Their findings also showed that liquidity of an individual property adds 16% to the notional value.

As mentioned, there has been competing views among academics whether private and public real estate should be treated as the same asset class and have similar returns in the long-run. (Pagliari, Scherer, and Monopoli 2005) found that returns from NPI and de-levered NAREIT indexes were similar in the long-run. This was consistent with Horrigan *et al.* (2009) long-run findings, and they claim that it is possible to replicate private real estate portfolio with REITs. An opposing study from Riddioygh, Moriarty and Yeatman (2005), that also examined long horizon returns, found public real estate returns were 3.08% higher than private real estate returns from 1980-1998. They attribute this gap to differences in liquidity and geography. However, it is important to note that the majority of the data was gathered before the modern REIT era, when the market perceived REITs similarly to broader securities market.

Seeing that investment horizons for private real estate tends to be longer than for REITs, studies have shown that portfolio's benefit from diversification with REITs and private real estate in the short-term and medium-term. This is due to differing short term idiosyncratic components between public and private markets, with autocorrelation of returns being unique to private

markets and capital market shocks for REITs (Ang, Naber and Wald, 2013). Hoesli and Oikarinen (2013) found that in the short-run, private real estate and REIT returns can diverge due to data complications, market frictions and slow adjustments to fundamentals in private markets, confirming diversification benefits of REITs and private real estate in the short term. A study by Pagliari (2017) attempted to determine the optimal portfolio allocation for public and private real estate using *ex post* portfolio optimization. Using data from 1978-2013 and after adjusting the NPI for autocorrelation and low volatility, Pagliari found that optimal portfolio over this period was 5.7% private real estate and 8.4% public real estate.

SIGNIFICANCE

There are two goals in this paper. The first goal is to test whether repeat-sales indexes constructed on a granular level (CBDs) can accurately track the real estate market. It is important for there to be accurate real estate indexes to allow institutional investors to compare their investments performance to the market. The second goal of this study is to compare the performance of REITs and private real estate to bring insight on whether public and private real estate should be considered the same asset class. The answer to this question is important because it tells investors if portfolios could benefit from diversification in both public and private real estate.

DATA

Repeat Sales Indexes

The data was collected from Real Capital Analytics (RCA), which aggregates information on commercial real estate transactions. The sampled data includes all office transaction in RCA's database from January 1, 2000 to October 31, 2017 in the central business districts (CBD) of

Chicago, New York City, Philadelphia, Washington D.C., Los Angeles, San Francisco, and Boston. RCA collected transactions data from properties with prices above $5 million until 2005, but then extended their coverage to all properties above $2.5 million. These cutoffs potentially eliminated observations that would have been included in the index. However, this price cutoff affects offices less than other asset classes as offices tend to transact for larger values. RCA's database has select information regarding the cap rates of the properties making it impossible find the net operating income of the property. Therefore, the constructed indexes only track the capital gain or loss of a property.

There are possible concerns regarding the accuracy of the data. The real estate industry has historically been "tight-lipped" when it comes revealing proprietary transaction information. RCA acknowledges this issue by stating whether a transactions data is *confirmed* or *approximated* and only publishes transactions that the company believes are accurate. With all real estate, there is asymmetric information between the buyer and seller. This could lead to properties with issues to transact more frequently, possibly skewing the index. However, office building transactions generally occur between real estate professionals who have expertise in identifying potential issues, minimizing the effect of this possible bias.

SL GREEN

SL Green Realty Corp (SLG) is a REIT that has been publically traded on the NYSE since 1997 and has approximately $14 billion in assets. SLG is the only publically traded REIT whose portfolio is mainly composed of offices in one geographic market and has been publically traded for over ten years. In 2017 SL Green's rental income from Manhattan office and retail tenants was 91.1% of total revenue. An assumption is that the percentage of revenue from Manhattan office

and retail tenants has remained consistent throughout the company's history. Seeing that generally office buildings in Manhattan have retail space on their lower levels, it is assumed that rental income from retail tenants in SL Green's properties is proportional to rest of Manhattan's office market. SL Green has no standalone retail assets in Manhattan. It is important to note that SL Green has historically had a small development/redevelopment pipeline. They segment these completed projects cash flows into a development / redevelopment category that contributed 5.2% of SLG's total revenue in 2017. Empire State Realty Trust is another public REIT whose portfolio is largely composed of Manhattan office buildings. However, it only became public in 2014, making the sampling to small to compare to the Manhattan Repeat-Sales Index.

Unlevered REIT Total Returns

CRSP/Compustat's merged databases were used to gather necessary metrics from SL Green's balance sheet, income statement, and other financial information regarding the equity value. It is assumed that the company's return on assets is equivalent to their unlevered return. The following information was pulled on a quarterly basis: current liabilities (DLCQ), long term debt (DLTTQ), preferred dividends (DVPQ), interest and related expenses (XINTQ) and total assets (ATQ). Preferred stock-liquidation values (PSTKL) was obtained from Compustat on an annual basis. SL Green's historical equal-weighted monthly return that included dividends and quarterly market capitalization was found on CRSP.

METHODOLOGY

Office Repeat-Sales Methodology

RCA's database was used to aggregate all office transactions in the subject markets. The dataset was then sorted to include properties that have been sold at least twice. The capital gain / loss of the property was found by subtracting the two transaction prices. The duration between transactions was used to determine the compounded annual growth rate. Each property's CAGR was broken into monthly returns and then matched with other properties that shared overlapping transaction ranges. This made it possible to find the average monthly return for each market. Finally, to construct the index, a time-series graph charted the average monthly return.

The dataset was subject to additional filters to enhance the indexes accuracy. Below are the criteria for exclusion in the indexes construction.

- Sales where no price was stated
- Development sites
- Portfolios of properties
- Partial sale of buildings (floors)
- Properties with square footage differences by <10% between transactions
- Properties that transacted twice within twelve months ("flipped")
- Outliers with CAGR's of less than -40% and greater than 50%

Unlevered REIT Returns Methodology

The methodology for finding unlevered REIT returns was taken from Ling and Naranjo's paper *Returns and Information Transmission Dynamics in Public and Private Real Estate Markets*. The authors assume that a REITs unlevered return is equal to its return on assets. The formulas below were used to calculate the return on assets.

$$r_{i,t}^{TA} = \left(r_{i,t}^{e}\emptyset_{i,}^{e}\right) + \left(r_{i,t}^{d}\emptyset_{i,t}^{d}\right) + \left(r_{i,t}^{p}\emptyset_{i,t}^{p}\right)$$

$$r_{i,t}^{d} = int_{i,t}^{d}/bval_{i,t-1}^{d}$$

$$r_{i,t}^{p} = pdiv_{i,t}^{p}/lval_{i,t-1}^{p}$$

$$TA_{i,t} = mcap_{i,t}^{e} + bval_{i,t}^{d} + lval_{i,t}^{p}$$

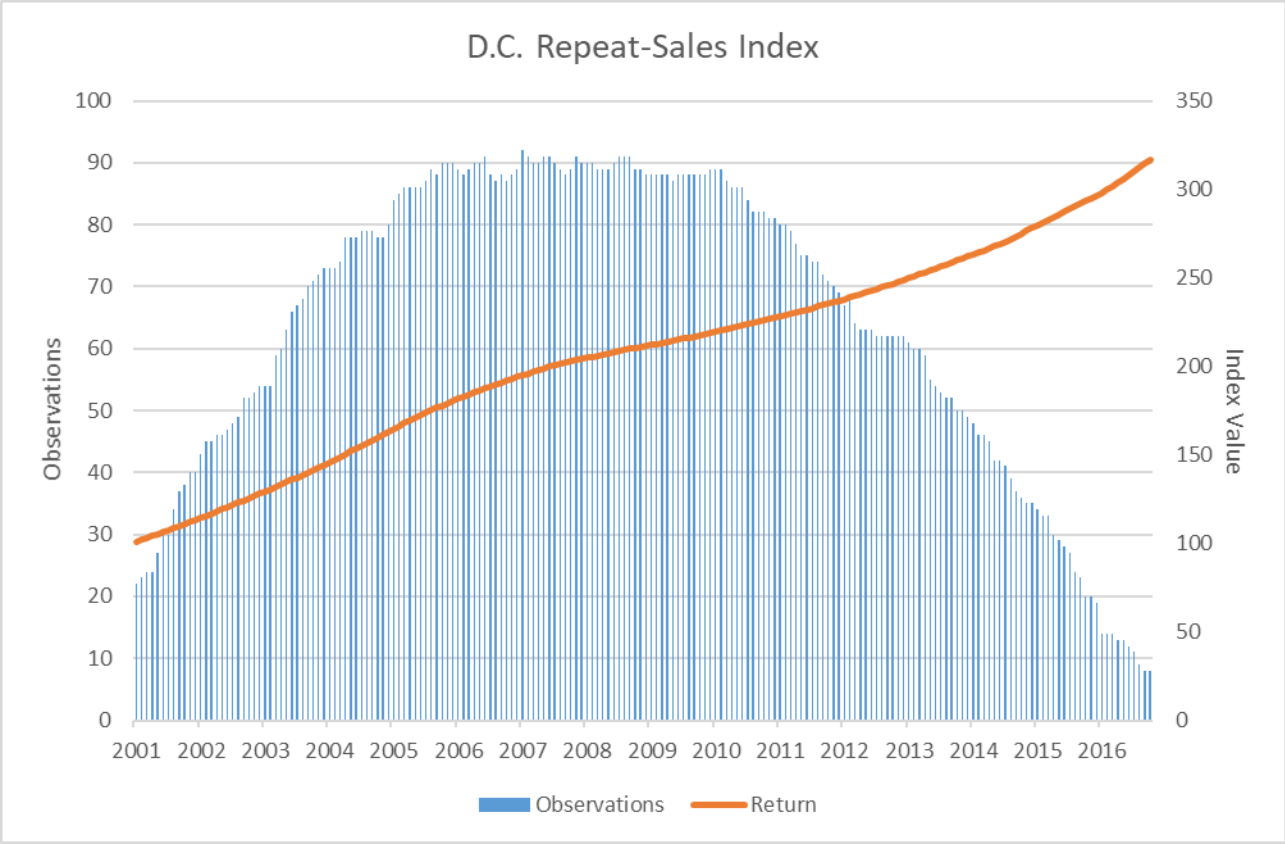
$$\emptyset_{i,t}^{e} = (mcap_{i,t-1}^{e})/TA_{i,t-1}$$

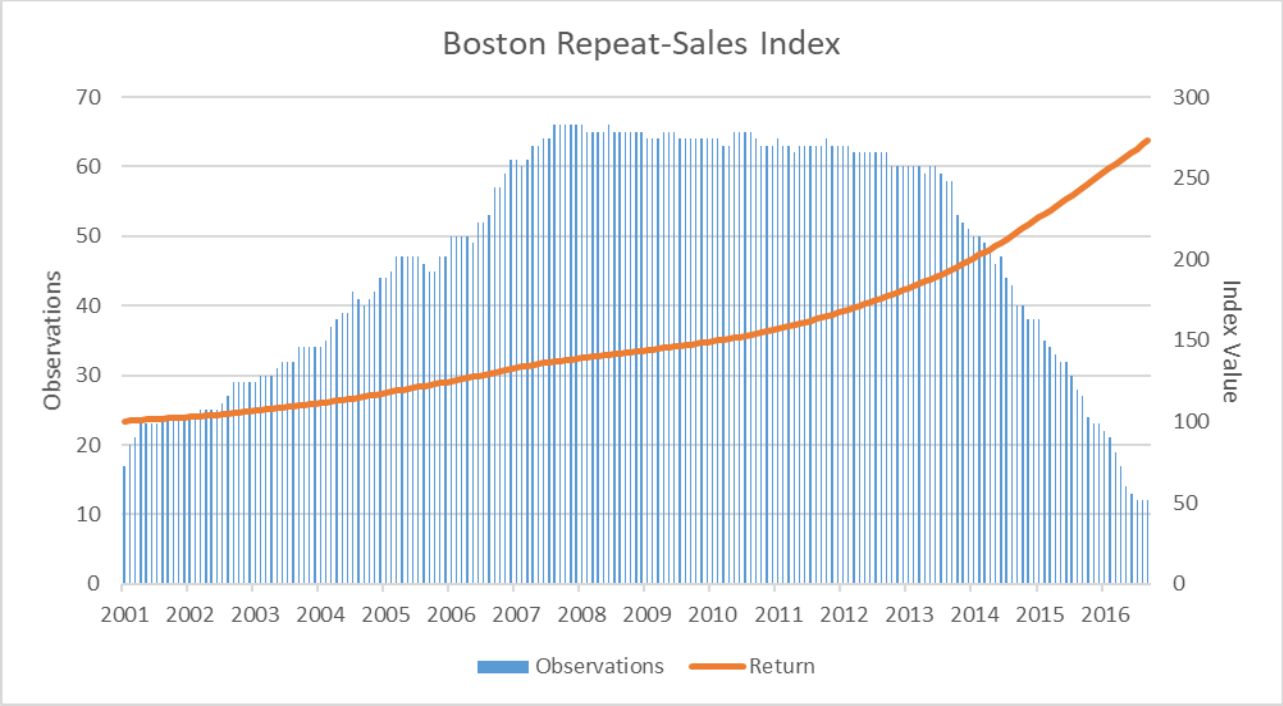
$$\emptyset_{i,t}^{d} = (bval_{i,t-1}^{d})/TA_{i,t-1}$$

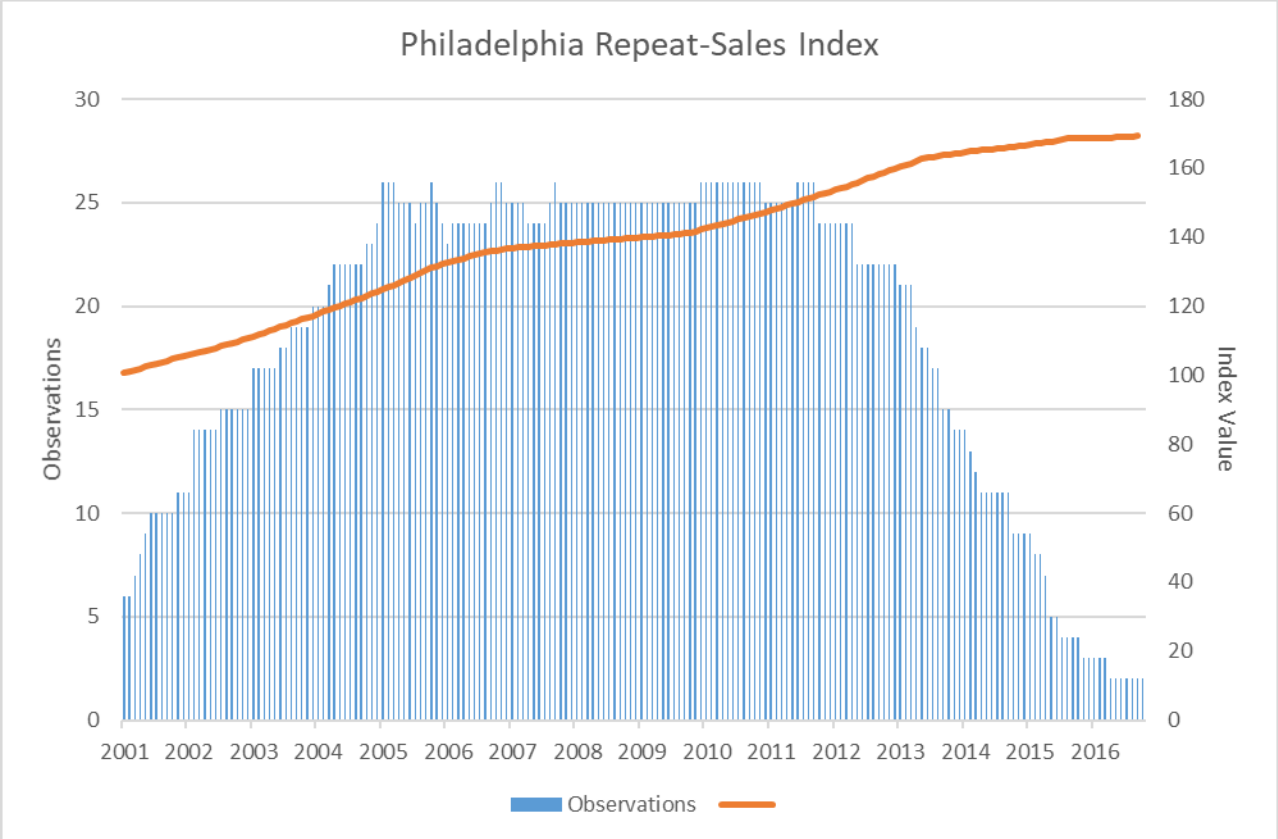
$$\emptyset_{i,t}^{p} = (lval_{i,t-1}^{p})/TA_{i,t-1}$$

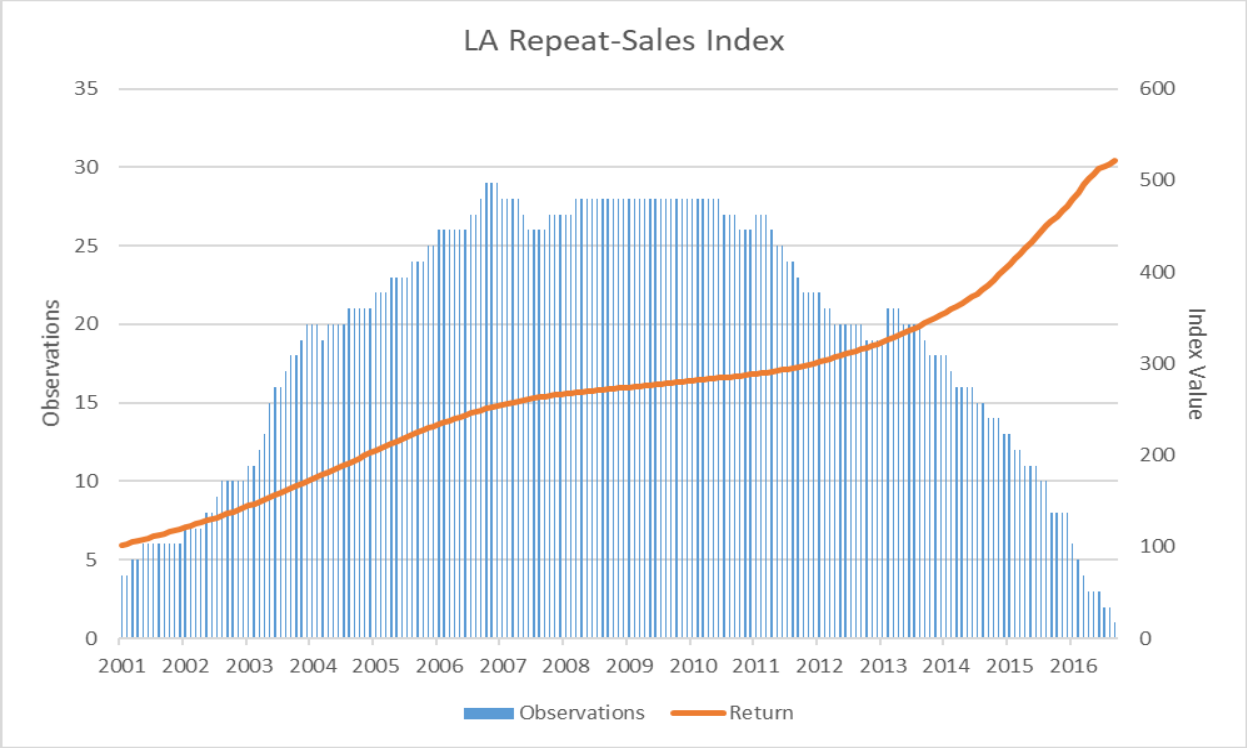
RESULTS

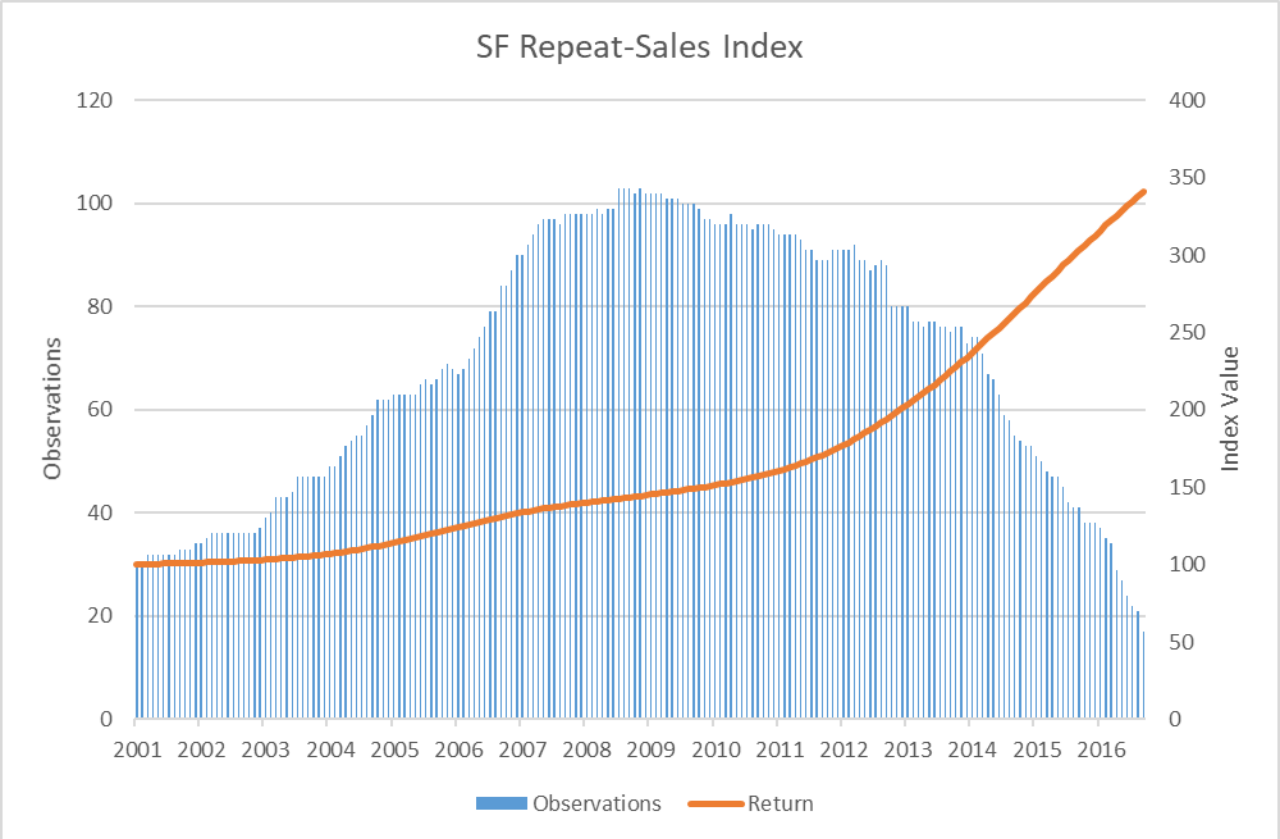
Repeat-Sales Indexes Results

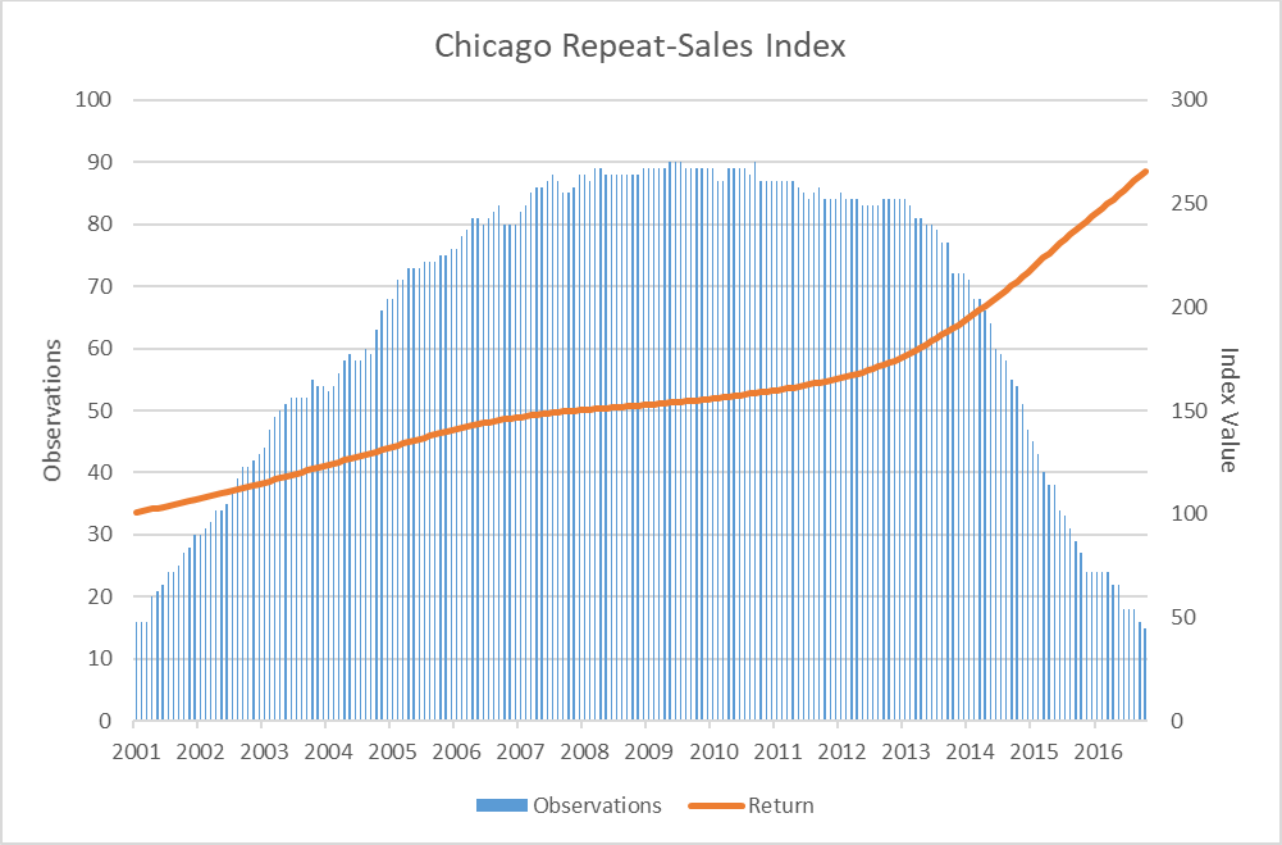



Boston Repeat-Sales Index
Observations
Index Value
70
60
50
40
30
20
10
0
300
250
200
150
100
50
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations
Return


Philadelphia Repeat-Sales Index
Observations
Index Value
30
25
20
15
10
5
0
180
160
140
120
100
80
60
40
20
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations


LA Repeat-Sales Index
Observations
Index Value
35
30
25
20
15
10
5
0
600
500
400
300
200
100
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations
Return


SF Repeat-Sales Index
Observations
Index Value
120
100
80
60
40
20
0
400
350
300
250
200
150
100
50
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations
Return


Chicago Repeat-Sales Index
Observations
Index Value
100
90
80
70
60
50
40
30
20
10
0
300
250
200
150
100
50
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations
Return

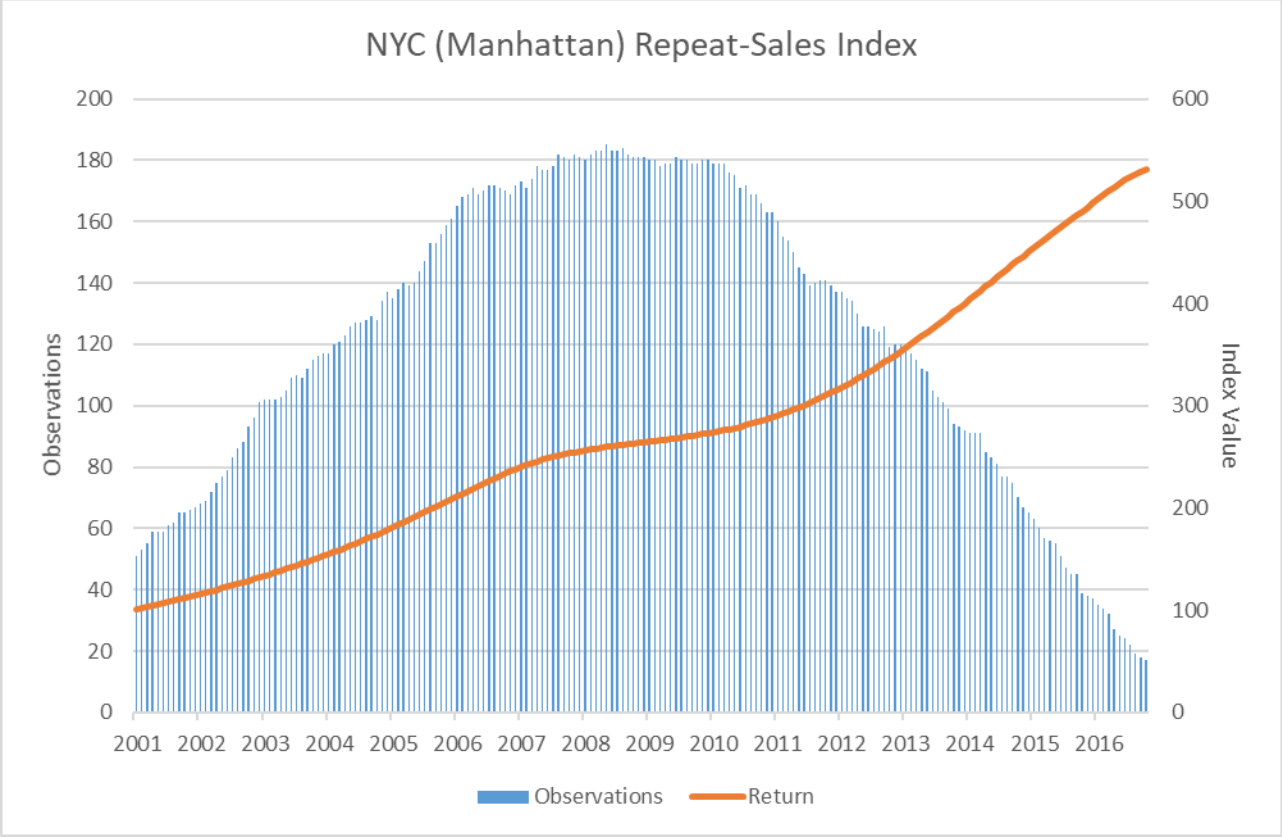

NYC (Manhattan) Repeat-Sales Index
Observations
Index Value
200
180
160
140
120
100
80
60
40
20
0
600
500
400
300
200
100
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Observations
Return

Table 1: Repeat-Sales Index's Summary Statistics

Quarterly statistic except for CAGR

	NYC	DC	Philly	SF	LA	Chicago	Boston
Transactions	471	204	43	229	61	193	147
CAGR	11.19%	7.59%	3.40%	8.10%	11.06%	6.39%	6.59%
STD	1.04%	0.86%	0.48%	1.20%	1.54%	0.83%	0.76%
Mean	2.68%	1.84%	0.84%	1.97%	2.67%	1.55%	1.61%
Median	2.96%	1.60%	0.92%	1.78%	2.59%	1.63%	1.45%
Max	4.24%	3.20%	1.71%	4.10%	4.93%	3.31%	3.11%
Min	0.70%	0.77%	0.00%	0.22%	0.59%	0.39%	0.53%

The indexes above show how the office asset class performed in each market. All indexes began with $100 notional value starting 3/1/2001 and ended 12/31/2016. This parameter allowed for more observations to be included at the start and end date. A general problem with the repeat-sales methodology is there are limited data points and indexes become less accurate with fewer observations. A data point is added when a property is both bought and sold. It is impossible to know how many data points are needed to make an accurate index that can be used as a benchmark in a market. The constructed indexes are especially "thin" due to the specification of the asset class and market. The effect of thin markets can be seen on the Los Angeles graph. In 2015, the index began to grow quickly and there were fewer than 15 observations. It is very likely that the LA office market did not grow at this rate and a few transactions with high returns inflated the index in these periods. The effect of few transactions occurring in down markets can be seen in the indexes as no index ever had a quarter with a negative return.

Table 2: Outliers

	NYC	DC	Philly	SF	LA	Chicago	Boston	Total
CAGR greater than 50%	36	6	1	11	2	7	5	**68**
CAGR less than -40%	1	0	0	0	0	0	0	**1**
Total transactions	471	204	43	229	61	193	147	**1348**
Total transactions net outliers	434	198	42	218	59	186	142	**1279**
% of transactions that are outliers	5.1%							

Issues with Filters

The most difficult aspect in creating repeat-sales indexes is identifying like-kind transactions. A major assumption in the creation of the indexes is that all capital expenditures and tenant improvements keep the property in the same condition between transactions. Large capital expenditures would inflate the capital gain and returns of an index. RCA's transaction data notes the year the property was last renovated, but unfortunately this information was only listed on roughly half of the properties so it was ignored in this study.

The percent of transactions that were outliers seems too high for these transactions to be anomalies. However, the majority of the outliers occurred from properties that transacted twice within a two-year period, possibly indicating that the filter for "flipped" properties should be extended for a longer period of time. Also, around half of the outliers occurred in Manhattan, which only comprised a third of the transactions. It is likely Manhattan office buildings receive more capital expenditures than office buildings in other markets because Manhattan is a high-end market with significant appreciation during the sample period .

Public and Private Office Returns

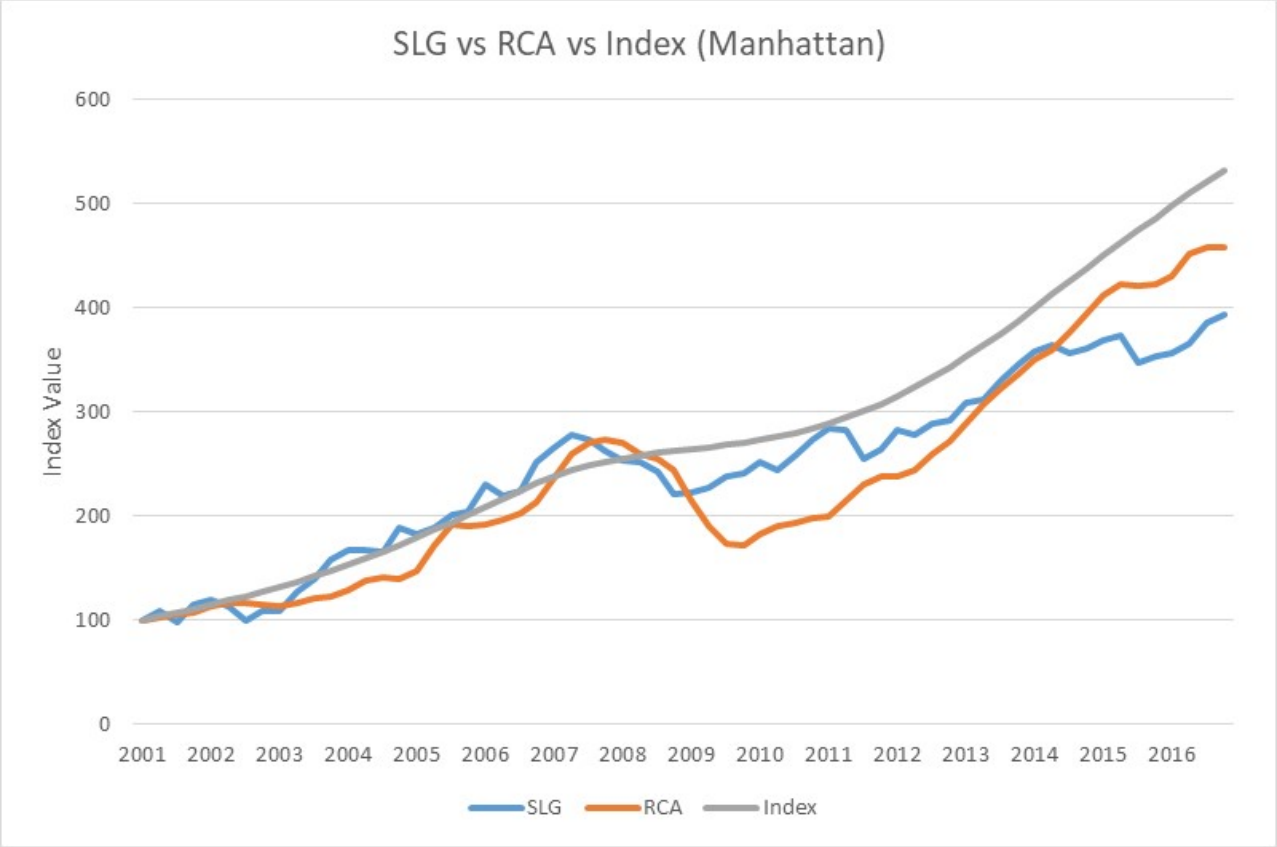


Table 3: Correlations

Correlation	SLG	RCA
SLG	1	
RCA	0.94	1
Index	0.96	0.97

Table 4: Manhattan Summary Statistics

Quarterly statistic except for CAGR

	SLG	RCA	Index
CAGR	9.09%	10.14%	11.19%
STD	5.97%	4.68%	1.04%
Mean	2.37%	2.52%	2.68%
Median	2.19%	2.88%	2.96%
Max	17.30%	16.79%	4.24%
Min	-12.20%	-11.91%	0.70%

As mentioned, REITs normally have portfolios that are comprised of diverse properties in many regions. SL Green is unique because the vast majority of their properties are offices in Manhattan. Manhattan has distinct borders making it easy to define the market. There are also strict floor area ratio laws in Manhattan, so it is difficult for existing office building to add square footage through renovations. There does not seem to be another REIT that has portfolio exposure as specialized as SLG and has been publically listed for over ten years. This allows for the unique opportunity to compare a singular REIT to a specific market. As mentioned, there is substantial evidence public and private real estate performance is the same in the long-run. This study assumes that SLG returns are a proxy for the entire Manhattan office market and that a 16 year period with quarterly updates is sufficient to be considered the long-run.

As mentioned, RCA's repeat-sales indexes are constructed by the MIT Real Estate Center and a new methodology for these indexes was constructed in September 2017. RCA does not publically release the datasets with the underlying transactions that are used in their repeat-sales indexes. Therefore, the RCA Repeat-Sales Manhattan Office Index quarterly returns graphed above was manually gathered from their online platform in order to compare SLG's unlevered returns and this paper's Manhattan Index. RCA's new methodology is different than this paper's approach, as RCA incorporates advanced econometric techniques such as a structural time series, an autoregressive component and a stochastic volatility model (Francke, Geltner, et al. 2017). Comparing RCA to this paper's index and SLG shows the relationship of the three different methodologies.

The correlations between the three indexes are extremely high. This is a significant finding as it shows that repeat-sales indexes accurately track SL Green's unlevered returns, confirming

that the repeat-sales indexes can be used as a benchmark for real estate markets. Gyourko in 2004 found that the correlation the NAREIT Index and the NPI with a four quarter lag was .64. The results of this study show that repeat-sales indexes more accurately represent real estate markets than appraisal-based indexes. However, it is important to note that in Gyrkos study the REIT returns were levered, and it is likely a lagged unlevered NAREIT Index would have higher correlation with the NPI.

RCA's updated methodology for constructing repeat-sales is more accurate than this study's approach as SLG's summary statistics are more similar to RCA. This shows promise that the newly remodeled RCA repeat-sales indexes accurately tracks the broader real estate market, when assuming SL Green accurately represents the Manhattan office market. Further statistical analysis would have to be conducted to test the significance in the similarity in RCA's and SLG's summary statistics. The Sharpe ratio for the RCA Index is 2.17 and for SLG is 1.52. These results show that privately owned offices receive a liquidity premium that is shown by a larger risk-adjusted return. If this is true private real estate will out-perform REITs in the long-run.

CONCLUSION

It will be interesting to see the predictive ability of the new RCA indexes. Using repeat-sales indexes to estimate a market returns when there are limited data points is extremely difficult. However, RCA / MIT have included new econometric techniques to hopefully make their indexes accurate on granular markets with few transactions. Seeing a repeat-sales index's value for a time period is adjusted every time a new overlapping data point is added, the approach is less accurate in more recent quarters as there are few observations. By measuring how much index values change (spread of index values) we can see how accurate RCA's approach is with few data points.

If new RCA indexes can accurately track real estate markets with few data points it would be a major breakthrough for the real estate industry. From this study it appears that RCA has accurately tracked SLG's unlevered returns. However, the predictability of this approach cannot be determined until we see the spread in index values, and seeing that the new methodology was only developed in September, we need more time to see how the model reacts to the addition of more data points. A study to test the predictability of the RCA Indexes can occur in a few years, once the models adjustments to additional data points being added occurs.

If an accurate repeat-sales index can be created with relatively few data points than the real estate industry would undergo a major transformation. Not only would institutional real estate investors be more easily able to measure funds' performance, but real estate derivatives could be created. Derivatives are important financial tools for price discovery and risk management through increasing market efficiency and reducing transaction costs. Private real estate is one of the only asset classes that does not have developed derivative markets. This market would exponentially reduce cost of gaining private real estate exposure and create substantial value (Case and Schiller, 1993). The creation of liquid real estate derivative market would reduce volatility as it would lead to increased price discovery for the whole asset class. IF RCA's indexes are shown to accurately represent a market than real estate derivatives could be made and tremendous value would be generated.

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APPENDIX

Appendix A: Cost of Immediate Liquidation (Bond and Slezak 2010)

Figure 1

Real Estate Liquidity Cost
(Percentage Reduction in Value to Obtain Sale in the Quarter)