A Successive Effort on Performance Comparison
Between Public and Private Real Estate Equity Investment

by

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Submitted to the Department of Urban Studies and Planning
in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

The research has a two-fold objective. Initially, the author compares the performance between public and private real estate equity investment represented by NAREIT Equity REIT Index and NCREIF Property Index from 1987 to 2005. Before comparison, the two return series are restated to eliminate their discrepancies in leverage, property-sector mix, and asset management fees. In addition to the 2.66% difference in mean returns between public and private markets over the 19-year research timeframe, the results indicate that the return restatement is able to reconcile the performance of the indices both by property sector (i.e. retail, apartment, office, and industrial) and at the aggregate level.

Subsequently, the author compares MIT CRE's Transactions-Based Index (TBI) with NCREIF Property Index in order to confirm the advantage of transaction- over appraisal-based indices under some circumstances. After TBI goes through a similar restatement process, TBI and NCREIF Property Index are respectively benchmarked with NAREIT Equity REIT Index from 1995 to 2005. Although some conflicting results are found in the retail and apartment sectors, the research basically identifies TBI's relative proximity to the public market benchmark, which further supports the argument that transaction-based indices are better data sources for the analyses in which responsive reflections on private market conditions are necessary.

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ACKNOWLEDGEMENTS

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1. INTRODUCTION

1.1 Public versus Private Real Estate Equity Investment

Real estate market researchers and analysts are always interested in how investment vehicles influence investment performance. In a public market, investors purchase shares of exchange-traded real estate investment trusts (REITs) and are indirectly exposed to the risks and returns embedded in the properties held by the firms. In a private market, market participants search for lucrative properties to invest in and conclude the deals through negotiated trades. To analyze the difference between REIT and direct property investment, aggregate information on the risks and returns of both markets are necessary. Fortunately, the real estate industry has a popular performance indicator for each market, namely National Association of Real Estate Investment Trusts (NAREIT) Equity REIT Index (the "REIT Index") and National Council of Real Estate Fiduciaries (NCREIF) Property Index ("NPI"). Both indices represent sizable pools of commercial real estate in their respective markets (Table 1) and are widely adopted by researchers for various analytical purposes.

Table 1: Market Capitalizations of the REIT Index and NPI

Year Ended	Market Capitalization ($millions)[1]	
	NAREIT Equity REIT Index	NCREIF Property Index
1987	4,759	22,185
1988	6,142	28,471
1989	6,770	32,656
1990	5,552	37,971
1991	8,786	37,010
1992	11,171	39,499
1993	26,082	40,950
1994	38,812	41,031
1995	49,913	48,279
1996	78,302	54,424
1997	127,825	66,135
1998	126,905	67,353
1999	118,233	81,989
2000	134,431	97,635
2001	147,092	113,709
2002	151,272	122,621
2003	204,800	133,291
2004	275,291	146,604
2005	301,491	189,800
2006	400,741	247,102

Source: NAREIT, NCREIF

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[1] The market capitalization of NCREIF Property Index reflects "property (asset)" value while that of NAREIT Equity REIT Index is based on "equity" value.

If public and private real estate equities are both traded in perfectly efficient markets with flawless capital flows, holding-period returns on the assets of similar kinds should eventually converge across markets and eliminate any arbitrage opportunity. In reality, however, historical returns on publicly-traded REITs exceeded those on private real estate equity over the long run as indicated by the REIT Index and NPI. For example, the REIT Index returns averaged 15.35% over the 29-year period ended in 2006 while the NPI returns only averaged 10.13%. This performance difference can be further identified in Figure 1 which plots cumulative returns on both indices from 1978 to 2006.

Figure 1: Cumulative Return Comparison between the REIT Index and NPI 1978 - 2006

Base Value (1977) = 100

Source: NAREIT, NCREIF
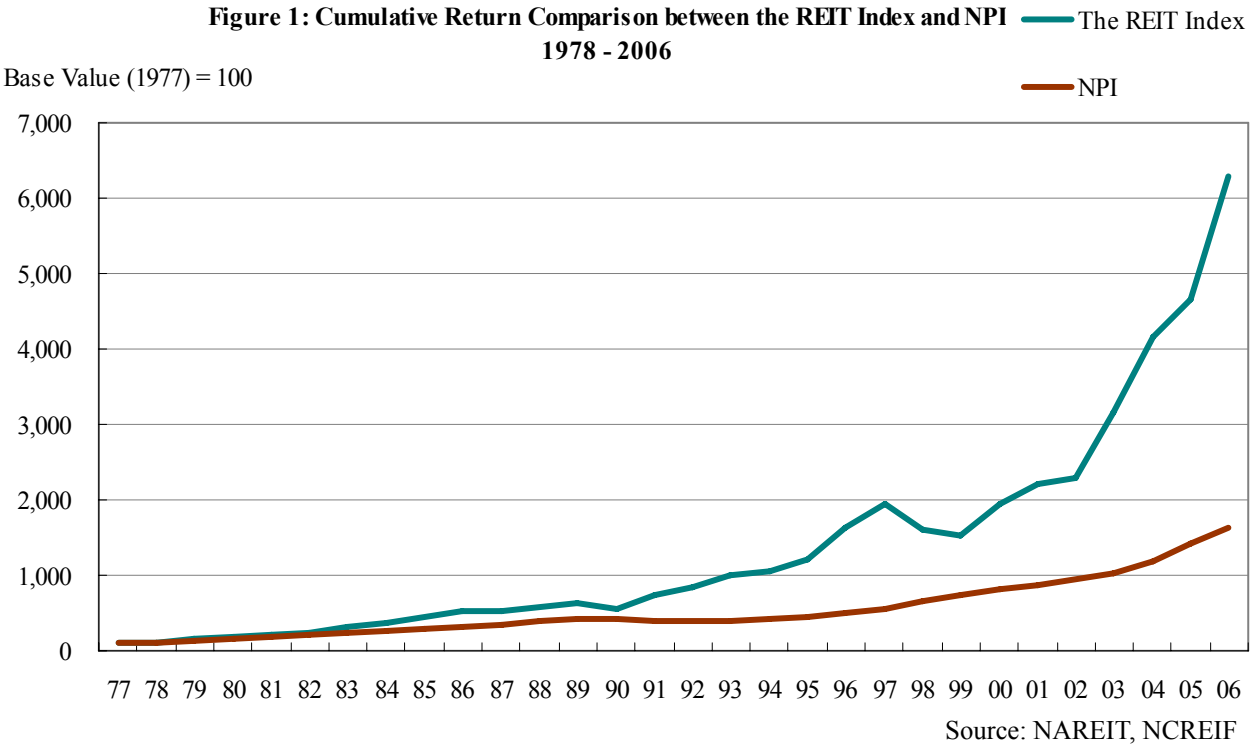
It is widely recognized that there are discrepancies existing between public and private real estate markets in asset liquidity, investor clientele, market microstructure, and so forth. Although they are all possible explanations for the different market performance in the history, whether these discrepancies are the ultimate and full causes is doubtful. Specifically, returns on REITs reflect the benefit received by their equity holders and are levered. NPI returns published by NCREIF, however, are calculated at the property level and unlevered. As leverage increases the volatility (i.e. risk) as well as expected return of investment, a direct comparison between the REIT Index and NPI returns does not satisfy researchers and analysts' demand for identifying the pure influence of the investment vehicles in the real estate market.

In addition to leverage, discrepancy between the public and private market indices exists in property-sector mix. NPI is an index mainly composed of core properties (i.e. retail, apartment, office, and industrial sectors) plus a minimal portion represented by the hotel sector. On the other hand, although the REITs focusing on core-property investment are included in the REIT Index, those specializing in non-core property sectors such as hotel (lodging/resorts), health care, self-storage, manufactured homes, and specialty are also its major constituents. Since REIT returns have been historically inconsistent across property sectors (Table 2), the performance difference between the REIT Index and NPI might be just a result of their different sector focuses.

Table 2: NAREIT Equity REIT Index Returns by Property Sector

	Core Property Sector					
Year	Office	Industrial	Mixed[2]	Retail	Apartments	Diversified[3]
1994	2.86%	18.67%	-	2.98%	2.19%	-6.04%
1995	38.80%	16.21%	-	5.10%	12.26%	21.15%
1996	51.80%	37.22%	40.79%	34.60%	28.93%	33.97%
1997	29.01%	19.02%	27.90%	16.95%	16.04%	21.67%
1998	-17.35%	-11.74%	-8.85%	-4.94%	-8.77%	-22.11%
1999	4.25%	3.90%	-0.72%	-11.77%	10.73%	-14.41%
2000	35.46%	28.62%	31.96%	17.97%	35.53%	24.11%
2001	6.65%	7.42%	8.15%	30.42%	8.66%	12.51%
2002	-6.82%	17.32%	8.56%	21.07%	-6.15%	4.24%
2003	34.01%	33.14%	31.30%	46.77%	25.49%	40.25%
2004	23.28%	34.09%	19.59%	40.23%	34.71%	32.42%
2005	13.11%	15.42%	7.40%	11.80%	14.65%	9.87%
2006	45.22%	28.92%	28.27%	29.01%	39.95%	38.03%
Geometric Mean	18.21%	18.31%	16.69%	17.23%	15.49%	13.30%

	Non-core Property Sector				
Year	Manufactured Homes	Lodging/ Resorts	Health Care	Self Storage	Specialty
1994	3.31%	-8.89%	4.12%	8.90%	-5.22%
1995	10.67%	30.79%	24.87%	34.40%	27.64%
1996	34.93%	49.19%	20.39%	42.84%	46.12%
1997	18.65%	30.09%	15.77%	3.41%	27.33%
1998	-0.87%	-52.83%	-17.45%	-7.20%	-24.33%
1999	-2.80%	-16.15%	-24.83%	-8.04%	-25.70%
2000	20.94%	45.77%	25.84%	14.69%	-31.60%
2001	13.72%	-8.63%	51.85%	43.24%	7.60%
2002	-4.06%	-1.49%	4.82%	0.56%	-5.35%
2003	29.99%	31.69%	53.59%	38.14%	38.55%
2004	6.40%	32.70%	20.96%	29.70%	26.85%
2005	-2.58%	9.76%	1.79%	26.55%	10.44%
2006	15.34%	28.17%	44.55%	40.95%	23.56%
Geometric Mean	10.39%	8.68%	15.01%	19.14%	5.93%

Source: NAREIT

Finally, NPI returns by nature are gross-of-fee, which means that the fees charged by asset managers to construct and maintain the diversified portfolios for investors have not been considered. REIT investment returns, however, are theoretically net-of-fee at the individual REIT level because compensations for the REIT management team have already been taken out of the equity cashflows available for shareholders. Obviously, NPI and the REIT Index returns will not be comparable without an appropriate net-of-fee adjustment on NPI. Furthermore, when REIT investment is considered at the aggregate or index level, the asset management fees for investment through REIT index funds or other instruments will be incurred. This investment cost must be reflected in the REIT Index returns or an apple-to-apple comparison between the indices is not possible.

The first question the author would like to answer in the research, therefore, is "How different are the historical returns on NAREIT Equity REIT Index and NPI after they are restated to be comparable in leverage, property-sector mix, and asset management fees?" The author believes that the return restatement will enable a more meaningful performance comparison between public and private real estate equity investment and lead to a clearer picture on the influence of the investment vehicles in the real estate market.

1.2 Transaction- versus Appraisal-Based Indices

In addition to the relative performance of public and private real estate markets, the effectiveness of specific indices in measurement of market performance is also discussed by researchers and analysts often. As stated earlier, NPI is the most widely used indicator for the U.S. commercial property market. The index, however, is not totally satisfactory. The major problem comes from its appraisal base. Appraisals are subjective and backward-looking, which induce "lags" in appraisal-based indices. Moreover, since not all the properties included in NPI are reappraised every quarter, the "stale appraisal" effect further adds the lags.

Another feature of appraisal-based indices often criticized with "lagging" is "smoothing". Due to lack of continuous and transparent information on real estate prices, appraisers have to derive property values based on fundamental variables and general market information. During their appraisal process, the latest transaction prices may only be noises and appraisers have to extract signals from the noises to determine the correct property values. An optimal combination of past and current information is thus involved in appraisals and leads to "smoothing" in

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[2] Mixed REITs have portfolios composed of both office and industrial properties.

[3] Most diversified REITs focus on core-property investment though some may have non-core property holdings.

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appraisal-based indices.

NPI's lagging and smoothing issues sometimes make it ineffective in application to some circumstances such as portfolio optimization and studies on market turning points. One way to eliminate the unpleasant effects embedded in appraisal-based indices is through the techniques of reverse-engineering. The techniques, nevertheless, are mathematically complicated and uneasy for the broad real estate investors to understand.[4] Another way to address the appraisal issues is developing indices based on property transaction prices rather than appraisal values. In this regard, Massachusetts Institute of Technology (MIT) Center for Real Estate (CRE) launched a transaction-based index in 2006, "Transactions-Based Index of Institutional Commercial Property Investment Performance (TBI)", based on the transaction prices of the properties sold from the NCREIF database. Although not aiming to replace but to complement NPI, TBI does manifest some functional superiority. Besides exhibiting greater volatility and less autocorrelation, MIT's study shows that TBI leads NPI in the timing of the historical market turning points. During the times when temporary downturns are expected in the U.S. property market such as Gulf War of 1991, financial crisis of 1998, and 911 terrorist attack of 2001, TBI indicates quarterly down ticks while NPI does not register losses.

To provide further evidences on TBI's advantage at timely reflecting the performance of the private real estate market, a public market index (e.g. the REIT Index) may serve as a benchmark to evaluate both TBI and NPI. In the author's opinion, if TBI is found to move more closely and consistently with the REIT Index than NPI is, its aforementioned advantage can be further supported.

The rationale behind this benchmarking evaluation is obvious. As REIT values are determined in stock exchanges and the assets of (equity) REITs are mostly properties, liquidity and information efficiency should lead the share prices to responsively reflect the underlying property values. This linkage between share prices and underlying property values enables the REIT Index to serve as a leading indicator for the cyclical movements of the private real estate market. Therefore, after the indices are all restated for comparability enhancement, TBI's and NPI's respective proximity to the REIT Index could be used to examine TBI's advantage over NPI. Accordingly, the second question the author would like to answer in the research is "Does TBI move more closely and consistently with NAREIT Equity REIT Index than NPI does?"

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[4] For more information on reverse-engineering, see "De-lagging the NCREIF index: Transaction prices and reverse-engineering" (J. Fisher and D. Geltner 2000).

1.3 Research Objective

To sum up, the author's objective is two-fold. The research is first devoted to comparing historical performance between public and private real estate equity investment. Both the property-sector (i.e. retail, apartment, office, and industrial) and all-sector returns on the REIT Index and NPI are presented for comparisons between the indices after they are restated for leverage, property-sector mix, and asset management fees (including REIT index investment costs). The restatement leaves the differences between the indices purely on other discrepancies between public and private markets (e.g. asset liquidity or investor clientele) and provides a clearer picture on the influence of the investment vehicles.

The other objective of the research is examining the advantage of transaction- over appraisal-based indices through their respective comparisons with a public market benchmark. Specifically, TBI and NPI are analyzed in terms of their proximity and consistency with NAREIT Equity REIT Index after all the indices are restated for comparability enhancement. The analysis is conducted at both the property-sector (i.e. retail, apartment, office, and industrial) and all-sector levels. It is assumed that if TBI is found to move more closely and consistently with the public market benchmark than NPI is, its functional superiority for some analytical purposes (e.g. portfolio optimization and studies on market turning points) can be further supported.

2. LITERATURE REVIEW

2.1 Performance Comparison between Public and Private Real Estate Markets

The performance comparison between public and private real estate equity investment in the research is conducted on the basis established by two previous studies. "Privately versus Publicly Held Asset Investment Performance" (2005) was written by T. Riddiough, M. Moriarty, and P. Yeatman. It was developed and updated from Moriarty and Yeatman's "A Risk-Adjusted Performance History of Public and Private Market Real Estate Investment 1978 – 1997" (1999) and extended its focus to exemplify an alternative performance evaluation approach of constituting an index to match the asset characteristics of a reference index. The other study is "Public versus Private Real Estate Equities: A More Refined, Long-Term Comparison" (2005). Its authors are J. Pagliari, K. Scherer, and R. Monopoli. Both Riddiough et al. and Pagliari et al. quantified the difference between historical REIT index and NPI returns after restating them for comparability enhancement. The two articles are similar in terms of their return restatement for leverage and property-sector mix despite a number of methodological differences in their processes. On the other hand, Riddiough et al. made additional restatement for NPI's asset management fees while Pagliari et al. removed the effect of appraisal smoothing embedded in NPI. Their findings are anyway consistent. Riddiough et al. found the difference between the restated REIT index and NPI returns over 1980 to 1998 to be 3.08%. Pagliari et al.'s research for 1981 to 2001 reported a 3.00% difference between the restated index returns.

Other studies dedicated to analyzing the relative performance of public and private real estate markets include "Price Discovery in American and British Property Markets" (R. Barkham and D. Geltner 1995), "REITs and Real Estate: Two Markets Reexamined" (M. Giliberto and A. Mengden 1996), "REIT-Based Pure-Play Portfolios: The Case of Property Types" (D. Geltner and B. Kluger 1998), and "Are EREITs Real Estate?" (M. Seiler, J. Webb, and N. Myer 1999).

Barkham and Geltner's return restatement involved unsmoothing private market returns and de-levering public market returns. They confirmed that price discovery occurred in the public market though the price information did not fully transmit to the private market for a year or more. Giliberto and Mengden analyzed historical cashflows and total returns of NAREIT Equity REIT Index and NPI without return restatement. Their study indicated a strong positive correlation between private and public market cashflows. Geltner and Kluger constructed pure-play and unlevered REIT portfolios by property sector. The portfolio returns were then compared with the unsmoothed NCREIF returns. They found that REIT returns were generally higher in mean value and volatility. Seiler et al. also examined the characteristics of public and

private markets by property sector. They concluded that the two markets behaved differently and should be treated as separate asset classes from a real estate portfolio manager's perspective. No return restatement was made in their study, however.

2.2   Performance Comparison between Transaction- and Appraisal-Based Indices

The comparisons between transaction- and appraisal-based indices have been made in several studies over past years. In their writing of "A Transaction-Based Index of Commercial Property and Its Comparison to the NCREIF Index" (1998), D. Gatzlaff and D. Geltner developed the first repeat-sales transaction-based index of commercial properties in the U.S. based on the data of the Florida Department of Revenue from 1975 to 1997. The index was then compared with NCREIF Florida Index. In addition to discussion on the characteristics of transaction- and appraisal-based indices, analysis for the difference between institutional and broader commercial property performance was also conducted in the research.

Two articles pertaining to transaction-based indices were published in 1999, "Characteristics of a Full-Disclosure, Transaction-Based Index of Commercial Real Estate" by D. Downs and B. Slade and "Temporal and Distribution Biases in Real Estate Transaction Based Price Indices" by S.E. Ong. The former used the dataset of commercial property transactions obtained for Phoenix MSA (a full-disclosure market) to construct a Phoenix transaction-based index and compared it with NCREIF Phoenix Index. In their research, Downs et al. identified some public policy issues emerging on the state-mandated disclosure rules which impacted the reliability of appraisals. The latter focused on a very different topic (i.e. temporal and distribution biases on transaction-based indices) and contended that transaction-based index returns provided biased estimates of the true underlying real estate returns. The transaction data from thirty-four condominium developments in Singapore were used to test and verify the existence of these biases.

The presentation and discussion on the methodology of MIT CRE's TBI is included in "A Quarterly Transactions-Based Index of Institutional Real Estate Investment Performance and Movements in Supply and Demand" by J. Fisher, D. Geltner, and H. Pollakowski (2007). In the writing, TBI was presented for both investment periodic total returns and capital appreciation for major property types in the NCREIF database. Fisher et al. pointed out that TBI avoided appraisal-based sources of index "lagging" and "smoothing" biases. Besides, they elaborated that TBI methodology allowed production of the indices tracking movements on the demand and supply sides of the market separately based on the methodology developed by J. Fisher, D. Gatzlaff, D. Geltner, and D. Haurin in "Controlling for the Impact of Variable Liquidity in Commercial Real Estate Price Indices" (2003). The concept of constant-liquidity value defined

and tested in Fisher el al.'s work addressed the issue that standard transaction-based indices systematically reflected inter-temporal differences in the ease of selling a property (i.e. variable liquidity). Also, its application to the NCREIF database revealed that constant-liquidity values tended to lead standard transaction-based indices in time and display greater volatility and cycle amplitude.

Finally, the paper written by D. Geltner and D. Ling, "Considerations in the Design and Construction of Investment Real Estate Research Indices" (2006), discussed several technical issues in constructing real estate indices such as property sampling, the trade-off between random measurement error and temporal lag bias, optimal reporting and property revaluation frequencies, and so forth. While their conclusion favored transaction-based indices, the authors did not rule out the usefulness of appraisal-based indices for some research purposes.

2.3   Addition to Current Body of Knowledge

The research is intended to add to the current body of knowledge in two ways: First, the performance comparison between public and private real estate equity investment employs several techniques and resources for return restatement which are different from those utilized previously. Through these differences, the author aims to fill the gaps in the methodologies of previous studies. The research timeframe is also expanded to 2005. Second, the evaluation for TBI and NPI is conducted through benchmarking them with a REIT index. This approach should further support the advantage of transaction- over appraisal-based indices beyond the scope of previous works.

3. DATA AND METHODOLOGY

3.1 Collect Research Data

The author's effort on data collection started from contacting NAREIT and obtaining the constituent lists of the REIT Index, along with each constituent's ticker symbol, market capitalization, and property sector[5] for every month from 1991 to 2006. NAREIT also provided a separate file containing the REITs' names and individual portfolio summaries (i.e. value or percentage of gross invested book assets allocated to various property sectors) for every year from 1978 to 1993.[6] Supplementary information on individual REITs' major investment methods and property-sector focuses over 1986 to 1990, moreover, was extracted from the early NAREIT publications[7] in MIT Rotch Library.

In preparation for the performance comparison between the REIT Index and NPI, the next step was screening out the REITs having similar portfolios as NPI property pools. As previously stated, NPI is basically a core-property index. The REITs to screen out, therefore, should be those mainly investing in real properties in either the retail, apartment, office, or industrial sector (i.e. core-play equity REITs).[8] The core-play equity REITs from 1991 to 2006 were easily identified in the constituent lists of the REIT Index with the relevant information. The only adjustment made by the author was removing the firms not completely existing for a specific year (i.e. either entering or leaving the REIT Index in the middle of the year) considering that the subsequent restatement on index returns would be conducted on an annual basis and partial-year data would cause much complication in its process.[9] The file of individual REITs' portfolio summaries, along with the early NAREIT publications, were reviewed and a test of 75% gross invested book assets was principally utilized to identify the core-play equity REITs prior to 1991.[10] As the work proceeded, it was found that early REITs tended to be more diversified and the number of core-play equity REITs was limited over the 80s. This had a large impact on how far the research timeframe could reach back. Eventually 1987 was decided to be the starting point of the research when there were at least two firms representing each property sector.

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[5] NAREIT's investment-type (i.e. equity, mortgage, or hybrid) and property-sector assignments on member firms are both based on a 75% benchmark of gross invested book assets.

[6] The file was originally used by Professor David Geltner for constructing pure-play REIT portfolios and provided by NAREIT several years ago.

[7] These publications included *1987 REIT Fact Book*, *1989 REIT Facts*, and *1990 Member Directory*.

[8] Mixed and diversified REITs were not included in the research due to the difficulty in attributing their property holdings and returns to the respective sectors.

The second data source for the research was CRSP[11]/Compustat Merged Database accessed through Wharton Research Data Services. Since the database has not been updated with the annual data of 2006 by mid-July of 2007, the research timeframe had to stop at 2005. The following market and accounting data items for the individual core-play equity REITs were obtained from 1987 to 2005 (including the year-end data of 1986).

- Common stock closing price (year-end)
- Common dividend per share (annual)
- Number of common stocks outstanding (year-end)
- Long-term debt – total (year-end)
- Debt in current liabilities (year-end)
- Dividends – preferred (annual)
- Preferred stock – redemption value (year-end)
- Minority interest (balance sheet) (year-end)

How these data items facilitated the restatement on index returns would be described subsequently. An important point to address here is that the data contained in CRSP/Compustat Merged Database indeed failed to cover all the core-play equity REITs for every year. Its coverage, however, was sufficient enough. Out of the total 1,255 firm-year counts on the lists of the core-play equity REITs from 1987 to 2005, only 28 (or approximately 2%) were missing.

The core-play equity REITs to be included in the research were finalized after removal of those missing in CRSP/Compustat Merged Database. Their numbers are presented in Table 3 by year and property sector.

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[9] The only exception was 1994. It was found that excluding the six firms entering the office and industrial sectors in the middle of the year would result in very different performance of both sectors due to the newly listed firms' dominant market capitalizations and the small number (and size) of other office/industrial REITs in 1994. For better represented sector returns, the six firms were included in the 1994 list of core-play equity REITs and annualization techniques were employed to make correct restatement on the annual sector returns.

[10] Due to the limited number of core-play equity REITs and the need for including sufficient samples to derive the REIT property-sector returns prior to 1991, the 75% principle was broken in some cases. Specifically, as a REIT was classified core-play in certain year(s) and had a continuous focus on a specific property sector, it would still be included in the research during the years when its specific core-property holding only represented 55% to 75% of the gross invested book assets.

[11] Center for Research in Security Prices

Table 3: Number of Core-Play Equity REITs included in the Research

Year	Property Sector				Total
	Retail	Apartment	Office	Industrial	
1987	11	2	5	2	20
1988	12	2	5	4	23
1989	12	2	8	6	28
1990	11	2	8	6	27
1991	11	2	8	7	28
1992	12	6	7	8	33
1993	15	8	6	8	37
1994	33	18	11	12	74
1995	42	29	10	9	90
1996	44	30	10	8	92
1997	43	26	10	9	88
1998	45	24	19	11	99
1999	49	21	19	10	99
2000	45	19	19	10	93
2001	41	18	19	7	85
2002	33	18	19	7	77
2003	33	19	20	8	80
2004	31	19	20	8	78
2005	31	17	21	7	76
Total	554	282	244	147	1,227

Other data sources for the research were CRSP Mutual Fund Database (MFDB), NCREIF, MIT CRE, and Mr. Michael Giliberto. CRSP MFDB provided the historical expense ratios of Vanguard REIT Index Fund from 1996 to 2005. In addition to various NPI return series, information on the asset management fees of NCREIF Fund Index – Open-end Diversified Core Equity (NFI-ODCE) from 1987 to 2005 was obtained through NCREIF's online database. MIT CRE provided TBI returns by property sector (only available from 1995)[12] and Mr. Giliberto kindly shared the returns on Giliberto-Levy Commercial Mortgage Performance Index over the research timeframe with the author. More about the use of these data will follow in the successive sections.

3.2 Calculate Common Equity Returns on Core-Play Equity REITs by Property Sector

Before any return restatement could be conducted, it was necessary to have the returns. Although NPI returns over the whole research timeframe were available at both the property-sector and aggregate levels, the returns on NAREIT Equity REIT Index are not separated by property sector prior to 1994. To derive the REIT property-sector returns on common equity from 1987 to

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[12] As TBI does not have separate returns by property sector until the 2nd quarter of 1994, the subsequent comparison between TBI and NPI could only begin from 1995 when the full-year TBI property-sector returns are observable.

2005[13], the author used a simple method to calculate firm-by-firm returns and their weighted average values by property sector as follows. The common equity returns utilized in the research are on an annual basis and contain two components, dividend yield and price appreciation. Accordingly, the firm-by-firm return is expressed as

$$r_{i,t}^{CE} = (p_{i,t} - p_{i,t-1} + d_{i,t})/p_{i,t-1}$$

where for every REIT i:

$r_{i,t}^{CE}$ = common equity return in year t

$p_{i,t}$ = common stock price at the end of year t

$p_{i,t-1}$ = common stock price at the end of year t-1

$d_{i,t}$ = common dividend (per share) in year t

The property-sector return on common equity is the weighted average return of the REITs in the sector, which is weighted upon each REIT's average common equity market capitalization for the year. For any sector j, its common equity return is defined as

$$R_{j,t}^{CE} = \sum_{i=1}^{n} (r_{i,t}^{CE} w_{i,t}^{CE}), \ i = 1, 2, \ldots n \ \text{(totally n REITs in sector j)}$$

where:

$R_{j,t}^{CE}$ = common equity return in year t, sector j

$r_{i,t}^{CE}$ = common equity return in year t, REIT i

$w_{i,t}^{CE}$ = REIT i's common equity weight in the sector in year t

$$= \frac{(CE_{i,t-1} + CE_{i,t})/2}{\sum_{i=1}^{n} [(CE_{i,t-1} + CE_{i,t})/2]}$$

where:

$CE_{i,t-1}$ = common equity market capitalization at the end of year t-1, REIT i

$CE_{i,t}$ = common equity market capitalization at the end of year t, REIT i

The calculation was applied to the four property sectors respectively and their common equity returns were generated for the research timeframe of 1987 to 2005.[14]

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[13] For a consistent basis of the return series, NAREIT's original property-sector returns from 1994 to 2005 were not used for analysis in the research. The common equity returns on the REIT Index over the whole research timeframe were calculated by the author.

3.3 Restate REIT Returns for Leverage

The initial restatement to enhance comparability between the REIT Index and NPI returns was de-levering REIT returns. To remove the leverage effect on public market performance, REIT returns on common equity have to be transformed to returns on assets. The de-leverage is enabled through calculating a weighted average cost of capital (WACC) based on the returns on various capital claims including common equity, preferred equity, and debt as well as their corresponding weights in capital structure. This work needs to be done on a firm-by-firm basis and the WACC (or return on assets) for REIT i is calculated as

$$r_{i,t}^A = (r_{i,t}^{CE} \hat{w}_{i,t}^{CE}) + (r_{i,t}^{PE} \hat{w}_{i,t}^{PE}) + (r_{i,t}^D \hat{w}_{i,t}^D)$$

where for every REIT i:

$r_{i,t}^A$ = return on assets in year t

$r_{i,t}^{CE}$ = common equity return in year t (as previously defined)

$r_{i,t}^{PE}$ = preferred equity return in year t

$r_{i,t}^D$ = return on debt in year t

$\hat{w}_{i,t}^{CE}$, $\hat{w}_{i,t}^{PE}$, and $\hat{w}_{i,t}^D$ = weights corresponding to common equity, preferred equity, and debt within REIT i's capital structure during year t

Preferred equity return is derived from the REIT's annual total preferred dividends and average redemption value of preferred stocks[15] for the year as follows.

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[14] These returns are close to NAREIT's original property-sector returns over 1994 to 2005 though not exactly the same. The difference mainly results from two factors (i.e. index constituency and re-weighting scheme). The author only included the REITs existing for the whole year in his return calculation and annually re-weighted individual REITs' returns within the sector. NAREIT's property-sector indices, on the other hand, adjusted their constituents monthly. Plus, as NAREIT's indices were based on monthly returns for 1994 to 1998 and daily returns for 1999 to 2006, they were supposedly re-weighted monthly in early years and daily recently. A comparison between NAREIT's original property-sector returns and the returns calculated by the author from 1994 to 2005 is placed in Appendix One.

[15] According to Compustat User's Guide, this item represents the total dollar value of "the net number of preferred shares outstanding multiplied by the voluntary liquidation or redemption value per share (whichever is greater)". When a specific voluntary liquidation or redemption value is not reported, the involuntary liquidation value is used. When an involuntary liquidation figure is not reported, the carrying value for liquidating is used.

$$r_{i,t}^{PE} = \frac{pd_{i,t}}{(PE_{i,t-1} + PE_{i,t})/2}$$

where for every REIT i:

$r_{i,t}^{PE}$ = preferred equity return in year t

$pd_{i,t}$ = total preferred dividends in year t

$PE_{i,t-1}$ = redemption value of preferred stocks at the end of year t-1

$PE_{i,t}$ = redemption value of preferred stocks at the end of year t

Return on debt is not based on any accounting data item. Since both interest income and capital appreciation are important components in total returns, it is inappropriate to use only annual interest expenses over average "book value" of debts to approximate the return for debt holders. Instead, the author utilized the total return on Giliberto-Levy Commercial Mortgage Performance Index to represent the return on REIT debt at the aggregate level. Giliberto-Levy Index calculates quarterly returns on a pool of traditional fixed-rate loans of nearly $200 billion collateralized by commercial real estate. The Index returns are on a marked-to-market basis, available by property sector, and after adjustment for credit losses. Through the use of Giliberto-Levy Index returns, the return on debt plugged in the WACC formula is able to reflect not only the interest income but also the change on debt market value caused by interest rate volatility. Accordingly, return on debt is expressed as

$r_{i,t}^{D}$ = total return on Giliberto-Levy Index (by property sector) in year t[16]

where for every REIT i:

$r_{i,t}^{D}$ = return on debt in year t

The weights corresponding to common equity, preferred equity, and debt for calculation of return on assets are determined by their proportional values in total assets. Here the author incorporates the book value of minority interest in common equity value (and in turn, total asset value) to correctly reflect the REIT's capital structure at the property level. Behind this adjustment is the fact that minority interest on a consolidated balance sheet generally includes either operating

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[16] Although the total return on Giliberto-Levy Index was used to approximate return on debt in the firm-by-firm de-leverage process, it was not assumed to be an accurate estimate for the return received by debt holders at the "individual REIT level" but at the "aggregate level". The method was only employed to facilitate the de-leverage process. However, it should produce the same result as applying the Giliberto-Levy Index returns at the property-sector level (i.e. after all the other components in the WACC formula have been calculated and aggregated for all the REITs in the sector).

partnership units in the UPREIT structure or joint-venture partners' interests in the REIT's properties. When the REIT's portfolio is viewed at the property level (or when return on assets is calculated), therefore, total asset value will be underestimated and leverage ratio will be overestimated if minority interest is excluded from common equity value whereas a full amount of debt on the property is considered. Accordingly, total asset value for REIT i should be defined as

$$A_{i,t} = (CE_{i,t} + MI_{i,t}) + PE_{i,t} + D_{i,t}$$

where for every REIT i:

$A_{i,t}$ = total asset value at the end of year t

$CE_{i,t}$ = common equity market capitalization at the end of year t

$MI_{i,t}$ = book value of minority interests at the end of year t

$PE_{i,t}$ = redemption value of preferred stocks at the end of year t

$D_{i,t}$ = book value of short-term and long-term debts at the end of year t

And the weights of these capital claims are calculated based on their average values and the average value of total assets for the year as

$$\hat{w}_{i,t}^{CE} = \frac{[(CE_{i,t-1} + CE_{i,t})/2] + [(MI_{i,t-1} + MI_{i,t})/2]}{(A_{i,t-1} + A_{i,t})/2}$$

$$\hat{w}_{i,t}^{PE} = \frac{(PE_{i,t-1} + PE_{i,t})/2}{(A_{i,t-1} + A_{i,t})/2} \qquad \hat{w}_{i,t}^{D} = \frac{(D_{i,t-1} + D_{i,t})/2}{(A_{i,t-1} + A_{i,t})/2}$$

where for every REIT i:

$A_{i,t}$, $CE_{i,t}$, $MI_{i,t}$, $PE_{i,t}$, and $D_{i,t}$ are as defined in the formula of total asset value.

$A_{i,t-1}$ = total asset value at the end of year t-1

$CE_{i,t-1}$ = common equity market capitalization at the end of year t-1

$MI_{i,t-1}$ = book value of minority interests at the end of year t-1

$PE_{i,t-1}$ = redemption value of preferred stocks at the end of year t-1

$D_{i,t-1}$ = book value of short-term and long-term debts at the end of year t-1

Finally, the property-sector return on assets is determined as the weighted average return of the REITs in the sector. The weights utilized here are according to each REIT's average total asset value for the year. For any sector j, its return on asset is defined as

$$R_{j,t}^A = \sum_{i=1}^{n} (r_{i,t}^A \ddot{w}_{i,t}^A), \; i = 1, 2,\ldots n \; (\text{totally n REITs in sector j})$$

where:

$R_{j,t}^A$ = return on assets in year t, sector j

$r_{i,t}^A$ = return on assets in year t, REIT i

$\ddot{w}_{i,t}^A$ = REIT i's asset weight in the sector in year t

$$= \frac{(A_{i,t-1} + A_{i,t})/2}{\sum_{i=1}^{n} [(A_{i,t-1} + A_{i,t})/2]}$$

where:

$A_{i,t-1}$ = total asset value at the end of year t-1, REIT i

$A_{i,t}$ = total asset value at the end of year t, REIT i

Finishing calculating the REIT returns on assets from 1987 to 2005 by property sector concluded the return restatement for leverage.

3.4 Restate REIT, TBI, and NPI Returns for Asset Management Fees

As previously stated, asset management fees ought to be removed from the gross-of-fee NPI returns to enhance their comparability with the REIT returns. In order to logically estimate the fees paid by the investors of NPI property pools over the research timeframe, the author used NCREIF's NFI-ODCE, which reported both gross- and net-of-fee returns, as a tool for fee estimation. The differences between annual NFI-ODCE gross- and net-of-fee returns from 1987 to 2005 (Table 4) were assumed as the appropriate fee ratios to be deducted from the NPI returns over the same period across property sectors.[17] In addition to NPI, the TBI returns also went through this restatement process considering their gross-of-fee nature and NCREIF-based data source.

A fee-related restatement has to be made on the REIT Index too. Although REIT returns are

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[17] Although the property pools of NPI and NFI-ODCE should be close enough to allow the fee approximation, an issue which might rise in the restatement method is "size bias". In a tiered fee structure, larger investors pay lower fees and smaller contributors pay marginally higher fees. As some non-ODCE properties within NPI pools may be owned by very large investors with directly-held separate accounts instead of a group of investors with smaller dollar commitments to co-mingled funds, NPI's overall fee ratio might be lower than NFI-ODCE's. This size bias, however, should be minimal.

considered net-of-fee at the individual REIT level, the index returns are the ones representing the public market in the subsequent performance comparisons. The costs of REIT index investment, therefore, must be considered in the research. As the most popular and cost-efficient way to invest in a REIT index is probably through index funds, their historical expense ratios should serve as a good approximation of the costs related to the aggregate investment in public real estate equity.

The historical expense ratios of the most prominent and sizable REIT index mutual fund, Vanguard REIT Index Fund, are presented in Table 5 and utilized in the fee adjustment over the research timeframe across property sectors. One thing to note is that because the Fund initially entered the market in 1996, the fees deducted from the REIT Index returns prior to its existence (i.e. from 1987 to 1995) are all based on the Fund's expense ratio in 1996.

Table 4: NFI-ODCE Management Fees

Year	Fee Ratio
1987	1.15%
1988	1.15%
1989	1.12%
1990	1.01%
1991	0.91%
1992	0.94%
1993	1.02%
1994	1.07%
1995	1.10%
1996	1.18%
1997	1.18%
1998	1.13%
1999	1.12%
2000	1.09%
2001	1.01%
2002	0.97%
2003	0.99%
2004	1.05%
2005	1.24%
Average	1.07%

Table 5: Vanguard REIT Index Fund[18] Expenses

Year	Expense Ratio
1996	0.35%
1997	0.24%
1998	0.24%
1999	0.26%
2000	0.33%
2001	0.32%
2002	0.27%
2003	0.26%
2004	0.23%
2005	0.19%
Average	0.27%

3.5   Restate REIT and TBI Returns for Property-Sector Mix

The final return restatement was restating the all-sector REIT Index and TBI returns. The REIT property-sector returns, after de-leverage and fee deduction, were aggregated to generate a

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[18] Including Investor Shares, Admiral Shares, and Institutional Shares.

weighted average return in accordance with the NPI sector weights. (Figure 2 presents the NPI sector weights[19] from 1987 to 2005 with the numerical data tabulated below.[20]) In addition to the REIT Index, the all-sector returns of TBI were also calculated based on its property-sector returns and the NPI sector weights.[21] Having the all-sector REIT Index returns from 1987 to 2005 and TBI returns from 1995 to 2005 comparable to NPI in terms of sector weights completed all the effort on return restatement in the research and the three return series were ready for subsequent comparisons.

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[19] As the research focuses on core-property sectors and the hotel sector historically has had a minimal representation on the NPI property pools, the NPI used throughout the research is of core-property sectors only (i.e. retail, apartment, office, and industrial). The difference between the NPI returns with and without the hotel sector over the research timeframe is anyway minor, only 1.4 basis points averagely over the 19-year period.

[20] The annual weights were produced from averaging the quarterly weights provided by NCREIF's online database.

[21] The original all-sector TBI is an equally-weighted index, not based on the NPI property-sector weights.

Figure 2: NPI Property-Sector Weights
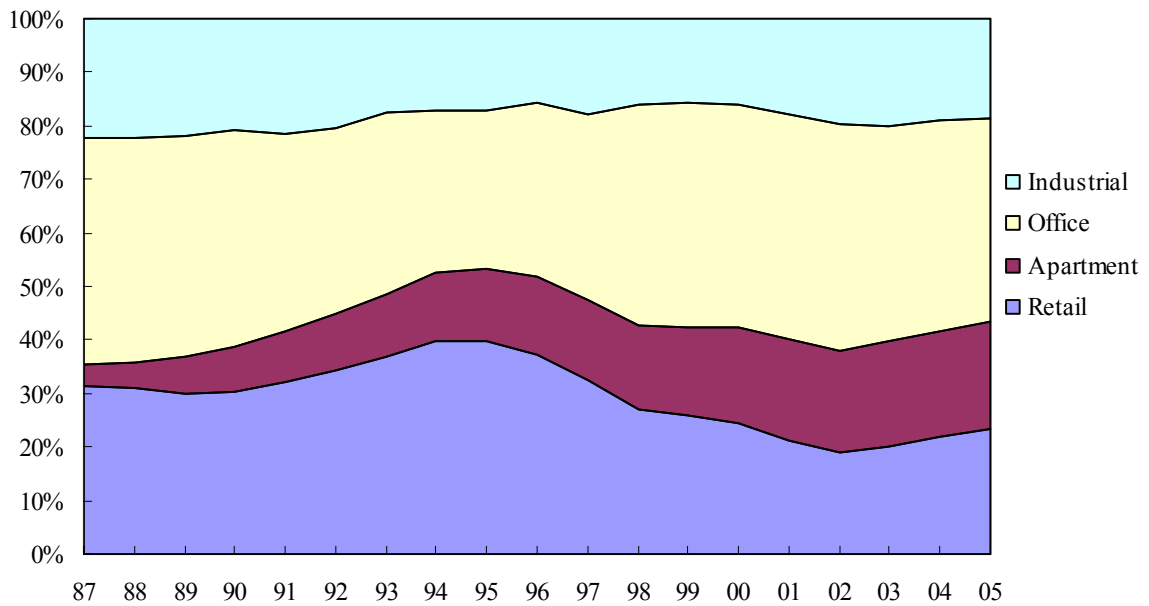
Year	Retail	Apartment	Office	Industrial
1987	31.53%	3.80%	42.28%	22.39%
1988	31.10%	4.83%	41.83%	22.24%
1989	30.00%	6.85%	41.42%	21.72%
1990	30.33%	8.31%	40.66%	20.70%
1991	32.10%	9.59%	36.89%	21.42%
1992	34.18%	10.86%	34.42%	20.54%
1993	36.89%	11.75%	33.96%	17.40%
1994	39.93%	12.66%	30.25%	17.16%
1995	39.69%	13.75%	29.50%	17.06%
1996	37.22%	14.70%	32.22%	15.86%
1997	32.34%	15.17%	34.54%	17.95%
1998	26.91%	15.96%	41.01%	16.11%
1999	25.88%	16.52%	41.74%	15.85%
2000	24.37%	17.87%	41.81%	15.96%
2001	21.33%	18.75%	42.15%	17.77%
2002	19.03%	18.90%	42.32%	19.75%
2003	20.10%	19.70%	40.23%	19.97%
2004	22.05%	19.53%	39.32%	19.11%
2005	23.24%	20.24%	37.77%	18.76%

4.   RESULTS – THE REIT INDEX VERSUS NPI RETURNS AFTER RESTATEMENT

Table 6 to 15 and Figure 3 to 12 contain the property-sector as well as all-sector returns on the REIT Index and NPI from 1987 to 2005, both before and after restatement. Sub-period statistics from 1995 to 2005 are also provided in the tables. The review is first conducted at the individual property sectors, followed by an all-sector comparison.

4.1   Retail and Apartment

The restating effects are generally as expected in the retail and apartment sectors. In both sectors, the restated mean returns on the REIT Index are higher than those on NPI. The restatement increases the consistency between public and private markets as indicated by their reducing differences in mean returns and standard deviations. In the overall restatement process, de-leverage is the major factor for the closer mean returns. (Table 7 and 9) After restatement, the Sharpe ratio[22] increases in REIT investment due to a lower return volatility though decreases in the private market mainly because of the deductions of asset management fees from the returns. Which investment vehicle offers more risk-adjusted benefit, however, is inconclusive by directly comparing their restated Sharpe ratios. The REIT Index's Sharpe ratio is higher in the retail sector whereas this is not found in the apartment sector. Lastly, it is worth to note that the aforementioned results are consistently demonstrated in both the full research timeframe (i.e. 1987 to 2005) and the sub-period of 1995 to 2005.

The cumulative returns presented on Figure 3 to 6 further confirm the REIT Index and NPI's closer performance after restatement. Also, the figures indicate that public and private markets did not really move apart until the early 90s in the retail and apartment sectors.

4.2   Office and Industrial

Although the restated mean returns on the REIT Index are still higher than those on NPI in the office and industrial sectors, some unexpected results arise when the restating effects are reviewed over the 19-year research timeframe. First, in the office sector, the discrepancy in mean returns between the indices actually widens after restatement. Second, de-leverage somehow increases, rather than decreases, the mean returns on the REIT Index in both the office and industrial sectors. (Table 11 and 13) A deep look into the raw data implies that the issues may result from the small sample size of the REITs included in the research during the late 80s and early 90s. At the time, several office and industrial REITs with dominant market capitalizations

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[22] The risk-free rate utilized in the calculation of Sharpe ratios is the average total return of U.S. 30-day T-bills, 4.51% from 1987 to 2005 and 3.82% from 1995 to 2005.

performed poorly in the capital market (e.g. Koger Equity, Inc. and American Industrial Properties REIT) and provided highly negative common equity returns in several years. When there were only a few REITs representing the sector, the sector returns unavoidably tilted over these large though poorly-performing firms. The very low sector returns in several early years eventually decreased the sector mean return on the REIT Index over the research timeframe (before restatement).

Subsequently, when the poor returns were transformed unlevered, they increased very much. (Some of them indeed turned from negative to positive.) The mean return on the REIT Index is thus raised by de-leverage. In turn, the increased mean return on the REIT Index enlarges its discrepancy from that on NPI in the office sector. In the industrial sector, however, the story is somewhat different. Since the original mean return on the REIT Index is low enough to be below that on NPI, they become closer after the former is restated to be higher and over the latter.

When only the data of the sub-period of 1995 to 2005 are utilized, the restating effects are back to normal. After restatement, the mean returns on the indices become closer in both sectors. Also, de-leverage exerts a major effect on reducing the REIT Index returns as well as their differences from the NPI returns.

After restatement, the REIT Index's standard deviation decreases and becomes closer to NPI's, which happens across the property sectors and timeframes. Furthermore, as previously observed in the other two sectors, the restatement in the office and industrial sectors makes the REIT Index's Sharpe ratios increase while NPI's Sharpe ratios decrease. Despite of the increased Sharpe ratios, however, the public market is not able to outperform the private market in this regard. The REIT Index's restated Sharpe ratio only exceeds NPI's in the office sector over 1987 to 2005, not in the other sector or timeframe.

In addition to reflecting the aforementioned results in a graphic form, Figure 7 to 10 indicate that public and private markets began moving apart during the early 90s in the office sector and that the REIT Index and NPI, after restatement, have the closest co-movement in the industrial sector. The former statement is consistent with the finding in the retail and apartment sectors and should be reliable. The latter statement, however, may be just caused by the previously described sample size issue and the understated REIT returns during the late 80s and early 90s. Therefore, it may not be concluded that the REIT Index and NPI have a uniquely close co-movement in the industrial sector.

4.3 All Sectors

The REIT Index's all-sector returns were restated in accordance with the NPI sector weights. After this additional restatement, the all-sector mean returns on the REIT Index are 9.57% over 1987 to 2005 and 13.12% over 1995 to 2005, both higher than those on NPI. The result also indicates that after restatement, the difference in mean returns between the indices decreases from 4.04% to 2.66% over 1987 to 2005. The difference in standard deviations, moreover, reduces from 9.75% to 3.84%. When only the sub-period of 1995 to 2005 is considered, the restating effect on mean returns is not as obvious. Their differences between the indices are 2.86% before restatement and 2.51% after restatement. On the other hand, the difference in standard deviations largely decreases from 12.84% to 4.86%, mainly resulting from a reduction of the REIT Index's volatility.

With regard to the restating effects generated by different restating tools, the restatement for property-sector mix lowers the mean return on the REIT Index by 1.53% over the research timeframe and serves as the largest contributor in reducing its difference from that on NPI. (Table 15) During the sub-period of 1995 to 2005, however, the restatement for property-sector mix increases, rather than decreases, the mean return on the REIT Index by 1.95%. This is actually a reasonable result as in realty, core-property REITs outperformed non-core property REITs over this period. In turn, the author's all-sector REIT returns must increase after restatement for property-sector mix, in which non-core property REITs were all removed. As a result, the restating effect from de-leverage, instead of property-sector mix, becomes the largest contributor in reducing the difference between the indices.

The changes on Sharpe ratios here are not much different from those found in the individual property sectors. Regardless of research periods, the REIT Index's Sharpe ratios increase and NPI's Sharpe ratios decrease. Also, a direct comparison on Shape ratios between the indices still generates an inconclusive result. Although the REIT Index has a higher restated Sharpe ratio from 1987 to 2005, NPI's Sharpe ratio is higher over the sub-period of 1995 to 2005. Therefore, the research is not able to provide a definite view on the advantage of either the public or private market in generating higher risk-adjusted returns.

The trend lines on Figure 11 and 12 basically address the points already presented at previous property-sector reviews. First, the REIT Index is less volatile and move more closely with NPI after restatement. Second, apartness of the two indices started from the early 90s.

4.4 The Author, Riddiough et al., and Pagliari et al.

Since there have been two groups of researchers devoted to relevant researches with different methodologies[23], it is worthwhile to bring up their results and compare with the author's. In contrast to the author's 2.66% difference in mean returns between public and private markets from 1987 to 2005, Riddiough et al. reported a 3.08% difference over 1980 to 1998 and Pagliari et al. found a 3.00% difference during 1981 to 2001. Although the results of the three groups seem consistent, it may not be appropriate to compare them directly as the researchers all defined their research timeframes differently. Instead, it is more meaningful to extract their results over the overlapping period (i.e. from 1987 to 1998) for a closer look.[24] As Figure 13 indicates, the author's cumulative returns on the restated REIT index are the lowest among the three groups, probably because of the large deductions of asset management fees from the returns. On the other hand, except for the ending positions on the figure, the three trend lines move very consistently. From Figure 14, it can be easily told that Pagliari et al.'s cumulative returns on the restated NPI follow a more volatile trend than the other two do and reach a much higher holding period return. This should be attributed to their restatement for smoothing on NPI, which was not conducted by the other groups. Lastly, Figure 15 presents the three groups' annual differences (not cumulative) between the restated REIT index and NPI returns. The author is closer to Riddiough et al. in this regard as the two groups have more coordinative movements of both the restated REIT index and NPI returns.

In terms of the difference in mean returns between the restated REIT index and NPI during the overlapping period, more inconsistency exists among the three groups than over their respective research timeframes. The author's 3.00% is closer to Riddiough et al.'s 3.82% while Pagliari et al. has a very different 1.03%. Pagliari et al.'s much higher restated NPI returns during the period should be the main reason for their large difference from the other two groups. As previously stated, however, the three groups actually have more consistent results over a longer though individually defined research timeframe.

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[23] These methodological differences are summarized in Appendix Two.

[24] As Riddiough et al. did not disclose their overall restated REIT index and NPI returns year by year, the author used their annual property-sector returns available in the article and the historical NPI sector weights in Moriarty and Yeatman's 1999 paper to generate Riddiough et al.'s return series. A check on the mean returns confirms the accuracy of the author's calculation.

Table 6: The REIT Index versus NPI Returns - Retail (Before and After Restatement)

Year	Before Restatement			After Restatement		
	REIT	NPI	Diff.	REIT	NPI	Diff.
1987	5.22%	12.38%	-7.16%	4.16%	11.23%	-7.07%
1988	16.67%	14.94%	1.73%	14.08%	13.79%	0.28%
1989	15.86%	12.53%	3.32%	15.05%	11.41%	3.63%
1990	-16.46%	5.96%	-22.42%	-8.94%	4.95%	-13.88%
1991	36.20%	-1.86%	38.06%	28.27%	-2.77%	31.03%
1992	21.90%	-2.25%	24.15%	17.81%	-3.19%	21.01%
1993	7.86%	4.83%	3.03%	8.45%	3.81%	4.64%
1994	3.16%	6.01%	-2.85%	2.32%	4.94%	-2.62%
1995	8.58%	3.99%	4.59%	12.21%	2.89%	9.32%
1996	32.14%	4.86%	27.29%	18.40%	3.68%	14.72%
1997	19.30%	8.53%	10.77%	15.13%	7.35%	7.78%
1998	-4.63%	12.90%	-17.53%	0.89%	11.77%	-10.88%
1999	-11.05%	9.54%	-20.59%	-3.80%	8.43%	-12.22%
2000	17.16%	7.82%	9.34%	14.99%	6.72%	8.26%
2001	31.27%	6.85%	24.43%	18.01%	5.84%	12.17%
2002	21.63%	13.66%	7.97%	18.07%	12.69%	5.38%
2003	46.52%	17.63%	28.89%	26.25%	16.63%	9.61%
2004	38.20%	23.07%	15.13%	22.19%	22.02%	0.17%
2005	14.49%	19.96%	-5.47%	9.23%	18.72%	-9.49%
Geometric Mean (87-05)	14.82%	9.35%	5.47%	11.83%	8.28%	3.55%
Standard Deviation (87-05)	16.70%	6.72%	9.99%	9.82%	6.68%	3.15%
Sharpe Ratio (87-05)	0.617	0.720	-0.103	0.745	0.564	0.181
Geometric Mean (95-05)	18.21%	11.55%	6.66%	13.45%	10.45%	3.00%
Standard Deviation (95-05)	17.46%	6.30%	11.15%	8.86%	6.31%	2.55%
Sharpe Ratio (95-05)	0.824	1.226	-0.402	1.087	1.051	0.036

Note: Diff. = REIT - NPI

Table 7: Summary on Return Restating Effects - Retail

Restating Item	From 1987 to 2005				From 1995 to 2005			
	Geometric Mean		Difference on GM		Geometric Mean		Difference on GM	
	REIT	NPI	Value	Chg	REIT	NPI	Value	Chg
Original	14.82%	9.35%	5.47%	-	18.21%	11.55%	6.66%	-
De-leverage	12.14%	9.35%	2.79%	-2.69%	13.73%	11.55%	2.18%	-4.48%
Private Market Asset Mgmt Fees	12.14%	8.28%	3.86%	1.07%	13.73%	10.45%	3.28%	1.10%
REIT Index Investment Costs	11.83%	8.28%	3.55%	-0.31%	13.45%	10.45%	3.00%	-0.28%

Note: GM = Geometric Mean
      Chg = Change on Value

Figure 3: Cumulative Return Comparison (Before Restatement)
Retail 1987 - 2005

——— REIT Retail

——— NPI Retail
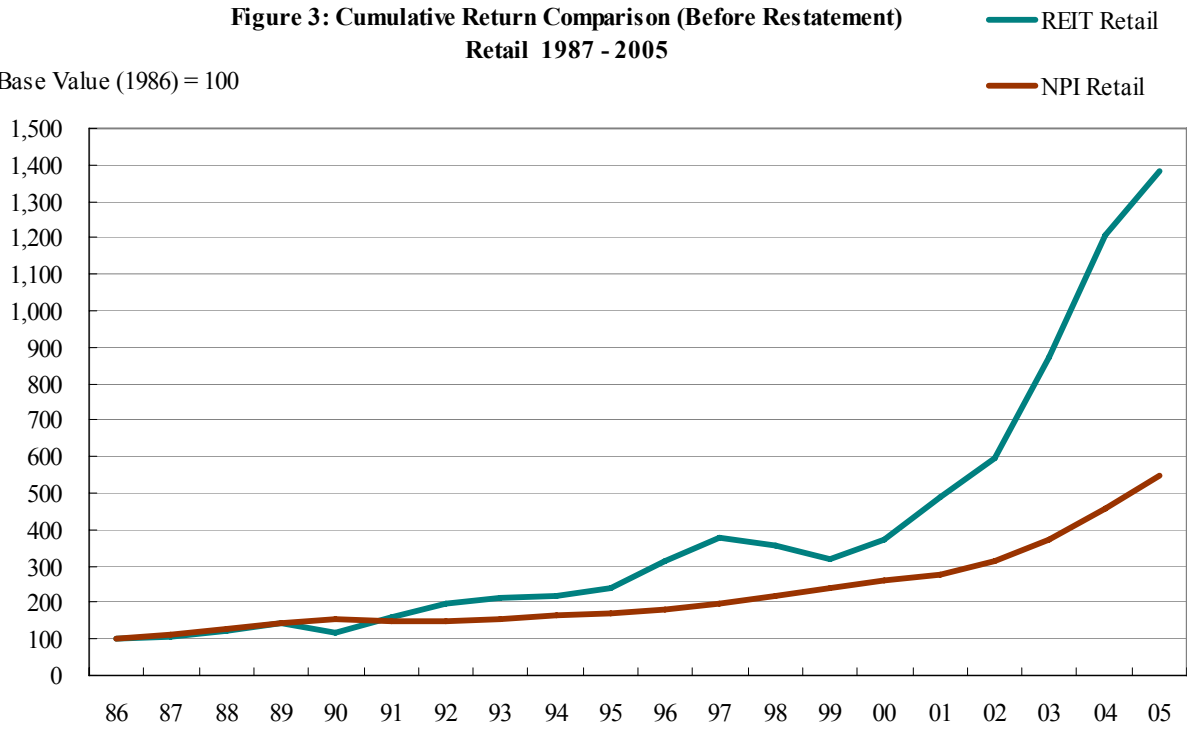
Base Value (1986) = 100

Figure 4: Cumulative Return Comparison (After Restatement)
Retail 1987 - 2005

——— REIT Retail

——— NPI Retail

Base Value (1986) = 100

30
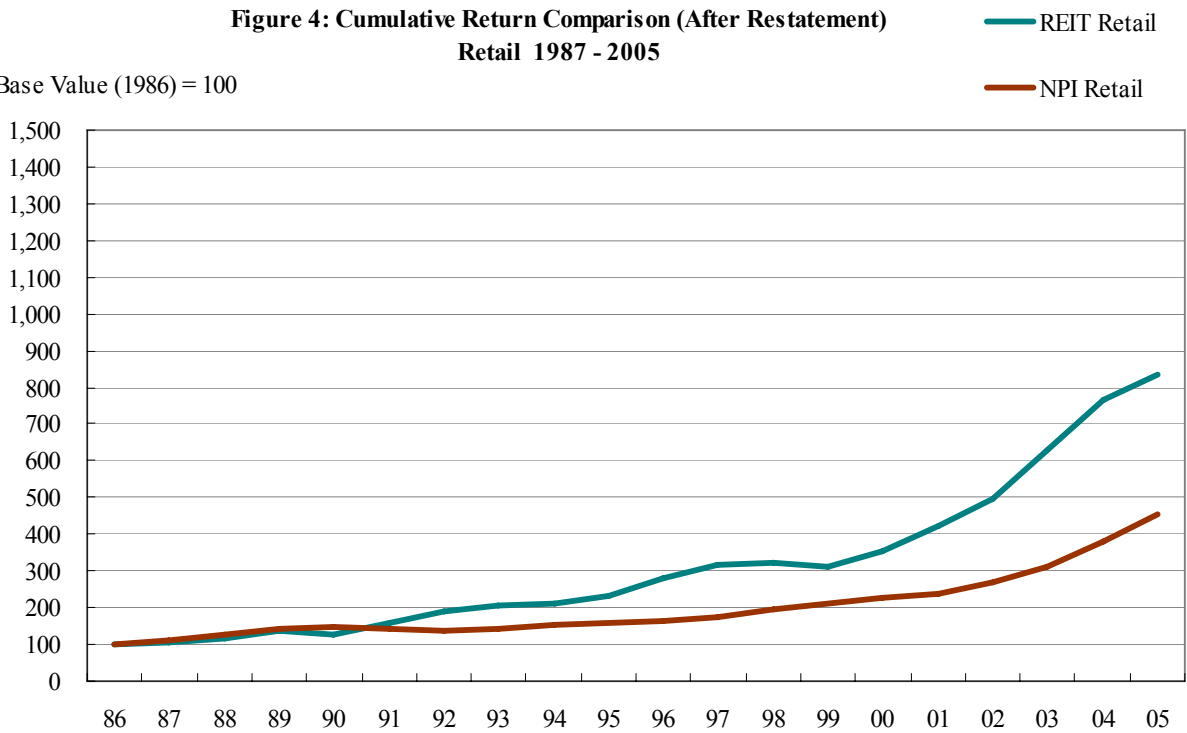
Table 8: The REIT Index versus NPI Returns - Apartment (Before and After Restatement)

Year	Before Restatement			After Restatement		
	REIT	NPI	Diff.	REIT	NPI	Diff.
1987	3.07%	6.94%	-3.87%	2.13%	5.80%	-3.67%
1988	10.43%	10.34%	0.09%	9.56%	9.19%	0.38%
1989	6.53%	8.82%	-2.29%	9.90%	7.70%	2.21%
1990	-10.26%	5.80%	-16.06%	-2.07%	4.79%	-6.86%
1991	46.06%	-1.35%	47.41%	29.04%	-2.26%	31.29%
1992	39.77%	1.72%	38.05%	29.50%	0.78%	28.72%
1993	34.04%	8.72%	25.32%	26.39%	7.70%	18.69%
1994	3.03%	12.08%	-9.05%	2.18%	11.02%	-8.84%
1995	11.66%	11.67%	-0.01%	13.63%	10.56%	3.06%
1996	27.92%	11.54%	16.39%	17.15%	10.36%	6.79%
1997	15.47%	12.89%	2.57%	13.37%	11.72%	1.65%
1998	-8.44%	14.09%	-22.53%	-0.64%	12.96%	-13.60%
1999	10.14%	11.71%	-1.57%	6.16%	10.59%	-4.43%
2000	34.63%	12.94%	21.69%	23.35%	11.84%	11.50%
2001	8.53%	9.33%	-0.80%	8.26%	8.32%	-0.06%
2002	-4.96%	8.73%	-13.69%	5.05%	7.76%	-2.72%
2003	25.31%	8.93%	16.38%	15.08%	7.94%	7.14%
2004	32.33%	13.08%	19.25%	19.37%	12.03%	7.34%
2005	13.71%	21.30%	-7.59%	9.20%	20.06%	-10.86%
Geometric Mean (87-05)	14.62%	9.86%	4.76%	12.06%	8.79%	3.27%
Standard Deviation (87-05)	16.55%	4.80%	11.76%	9.69%	4.73%	4.96%
Sharpe Ratio (87-05)	0.611	1.116	-0.505	0.780	0.905	-0.125
Geometric Mean (95-05)	14.31%	12.34%	1.98%	11.62%	11.24%	0.38%
Standard Deviation (95-05)	14.09%	3.46%	10.63%	6.98%	3.39%	3.59%
Sharpe Ratio (95-05)	0.745	2.461	-1.716	1.117	2.187	-1.070

Note: Diff. = REIT - NPI

**Table 9: Summary on Return Restating Effects - Apartment**

Restating Item	From 1987 to 2005				From 1995 to 2005			
	Geometric Mean		Difference on GM		Geometric Mean		Difference on GM	
	REIT	NPI	Value	Chg	REIT	NPI	Value	Chg
Original	14.62%	9.86%	4.76%	-	14.31%	12.34%	1.98%	-
De-leverage	12.37%	9.86%	2.51%	-2.25%	11.89%	12.34%	-0.44%	-2.42%
Private Market Asset Mgmt Fees	12.37%	8.79%	3.58%	1.07%	11.89%	11.24%	0.65%	1.09%
REIT Index Investment Costs	12.06%	8.79%	3.27%	-0.31%	11.62%	11.24%	0.38%	-0.28%

* GM = Geometric Mean
** Chg = Change on Value

**Figure 5: Cumulative Return Comparison (Before Restatement)
Apartment 1987 - 2005**

REIT Apart.

NPI Apart.
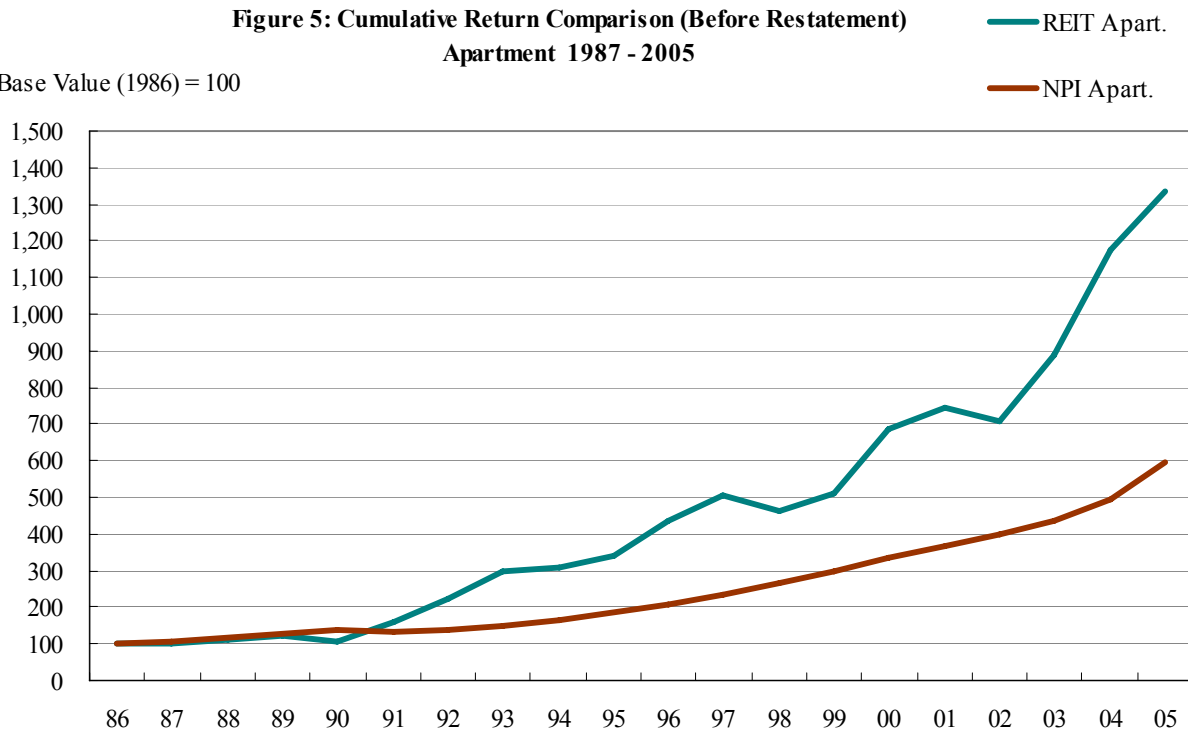
Base Value (1986) = 100

**Figure 6: Cumulative Return Comparison (After Restatement)
Apartment 1987 - 2005**

REIT Apart.
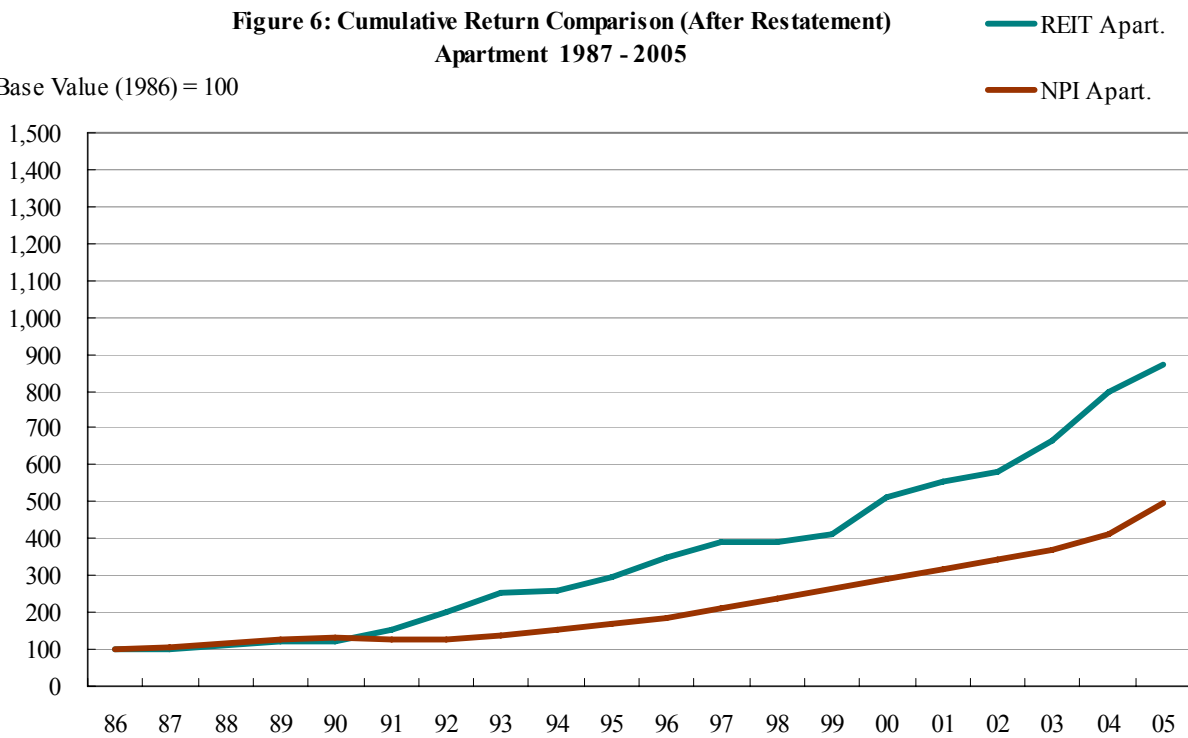
NPI Apart.

Base Value (1986) = 100

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Table 10: The REIT Index versus NPI Returns - Office (Before and After Restatement)

Year	Before Restatement			After Restatement		
	REIT	NPI	Diff.	REIT	NPI	Diff.
1987	-14.67%	3.97%	-18.63%	-10.76%	2.82%	-13.58%
1988	19.33%	5.98%	13.35%	15.65%	4.83%	10.82%
1989	-6.06%	4.15%	-10.21%	-1.29%	3.03%	-4.31%
1990	-44.91%	-1.06%	-43.85%	-22.67%	-2.07%	-20.59%
1991	-29.04%	-11.44%	-17.60%	-8.56%	-12.35%	3.79%
1992	12.20%	-8.05%	20.25%	0.24%	-8.99%	9.23%
1993	78.50%	-3.95%	82.45%	29.32%	-4.97%	34.29%
1994	-0.51%	3.92%	-4.43%	4.09%	2.86%	1.23%
1995	37.22%	7.19%	30.02%	28.14%	6.09%	22.05%
1996	51.09%	13.57%	37.52%	37.90%	12.39%	25.50%
1997	32.74%	17.87%	14.87%	26.80%	16.69%	10.11%
1998	-19.76%	19.61%	-39.37%	-8.75%	18.48%	-27.23%
1999	4.23%	12.21%	-7.98%	3.19%	11.09%	-7.91%
2000	34.84%	14.16%	20.68%	24.47%	13.07%	11.40%
2001	4.20%	6.22%	-2.03%	6.12%	5.22%	0.91%
2002	-2.84%	2.84%	-5.68%	6.07%	1.87%	4.20%
2003	33.03%	5.83%	27.20%	18.25%	4.84%	13.41%
2004	23.51%	12.07%	11.44%	14.78%	11.02%	3.76%
2005	13.66%	19.66%	-6.00%	8.86%	18.42%	-9.56%
Geometric Mean (87-05)	8.07%	6.22%	1.86%	7.91%	5.15%	2.76%
Standard Deviation (87-05)	29.47%	8.75%	20.72%	16.00%	8.68%	7.32%
Sharpe Ratio (87-05)	0.121	0.195	-0.074	0.212	0.073	0.139
Geometric Mean (95-05)	17.45%	11.79%	5.66%	14.34%	10.70%	3.64%
Standard Deviation (95-05)	21.13%	5.80%	15.32%	13.55%	5.73%	7.82%
Sharpe Ratio (95-05)	0.645	1.375	-0.729	0.777	1.201	-0.425

Note: Diff. = REIT - NPI

Table 11: Summary on Return Restating Effects - Office

Restating Item	From 1987 to 2005				From 1995 to 2005			
	Geometric Mean		Difference on GM		Geometric Mean		Difference on GM	
	REIT	NPI	Value	Chg	REIT	NPI	Value	Chg
Original	8.07%	6.22%	1.86%	-	17.45%	11.79%	5.66%	-
De-leverage	8.22%	6.22%	2.00%	0.15%	14.62%	11.79%	2.82%	-2.83%
Private Market Asset Mgmt Fees	8.22%	5.15%	3.07%	1.07%	14.62%	10.70%	3.92%	1.09%
REIT Index Investment Costs	7.91%	5.15%	2.76%	-0.31%	14.34%	10.70%	3.64%	-0.28%

Note: GM = Geometric Mean
      Chg = Change on Value

Figure 7: Cumulative Return Comparison (Before Restatement)
Office 1987 - 2005

Base Value (1986) = 100

— REIT Office
— NPI Office
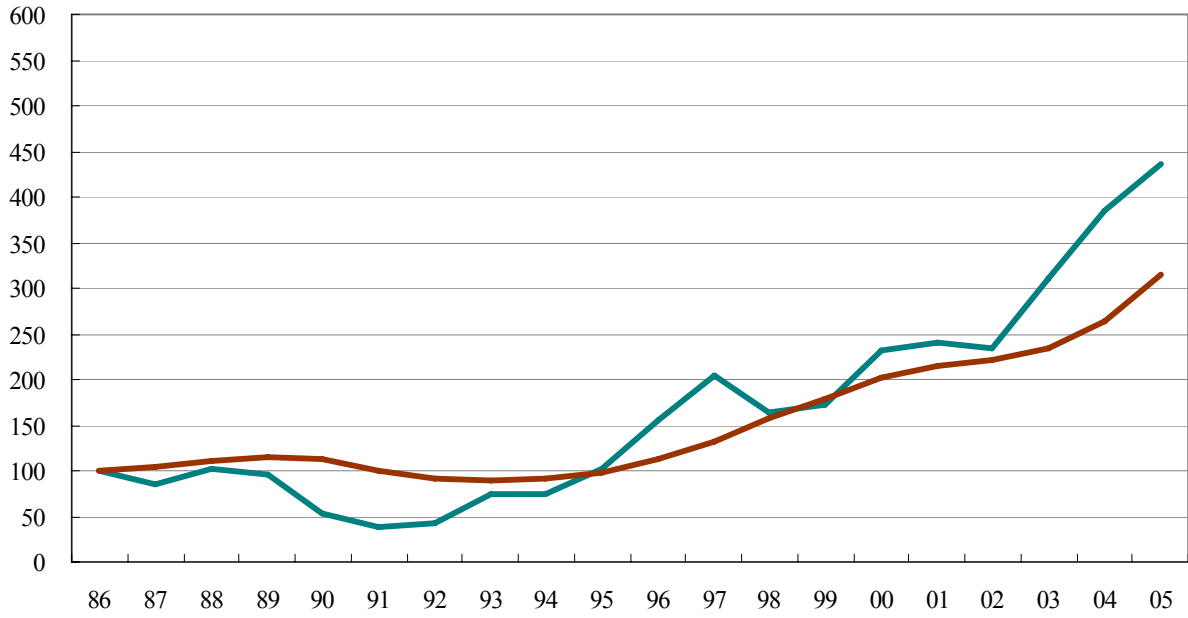
Figure 8: Cumulative Return Comparison (After Restatement)
Office 1987 - 2005

Base Value (1986) = 100
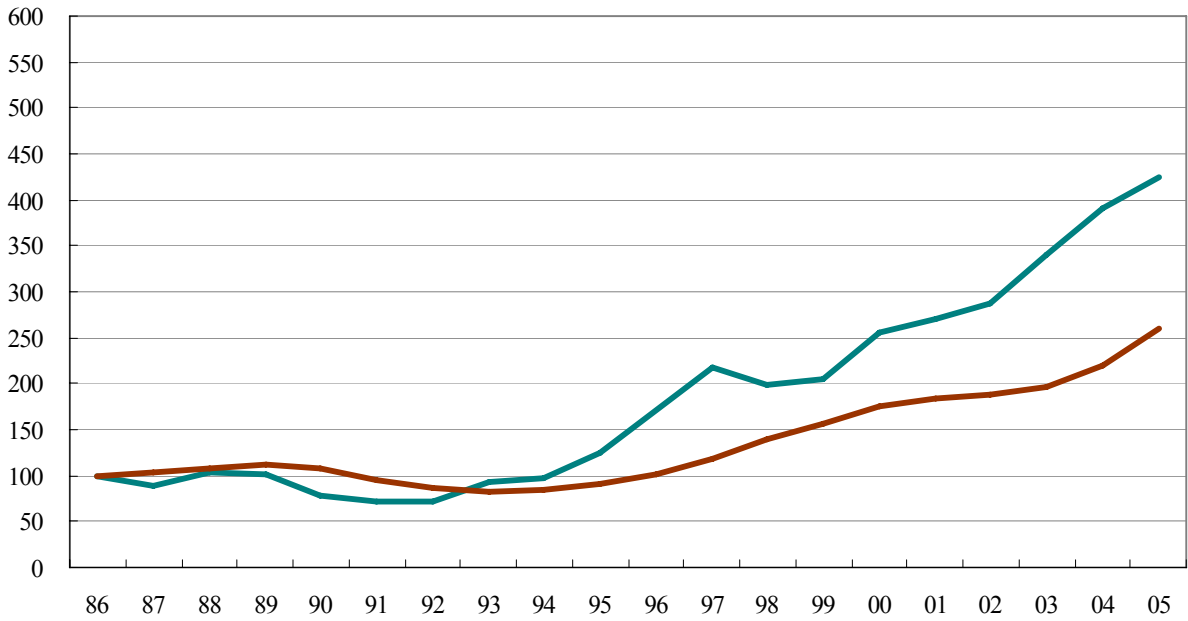
— REIT Office
— NPI Office

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Table 12: The REIT Index versus NPI Returns - Industrial (Before and After Restatement)

Year	Before Restatement			After Restatement		
	REIT	NPI	Diff.	REIT	NPI	Diff.
1987	-35.68%	9.88%	-45.56%	-20.49%	8.74%	-29.22%
1988	9.36%	9.89%	-0.52%	10.00%	8.74%	1.26%
1989	-14.02%	8.75%	-22.76%	3.96%	7.63%	-3.67%
1990	-24.80%	1.95%	-26.75%	-1.35%	0.94%	-2.29%
1991	-19.39%	-3.87%	-15.52%	7.65%	-4.78%	12.43%
1992	6.60%	-4.47%	11.07%	8.24%	-5.41%	13.64%
1993	38.34%	-0.75%	39.09%	11.93%	-1.77%	13.70%
1994	13.81%	7.65%	6.16%	9.89%	6.58%	3.31%
1995	15.48%	12.30%	3.18%	15.35%	11.20%	4.16%
1996	35.00%	13.56%	21.44%	23.86%	12.38%	11.48%
1997	20.13%	15.89%	4.23%	16.30%	14.72%	1.59%
1998	-11.37%	15.88%	-27.24%	-3.21%	14.75%	-17.96%
1999	2.77%	11.67%	-8.90%	2.23%	10.55%	-8.32%
2000	27.60%	14.07%	13.53%	20.38%	12.98%	7.41%
2001	4.99%	9.48%	-4.48%	6.57%	8.47%	-1.90%
2002	17.46%	6.94%	10.52%	15.83%	5.98%	9.85%
2003	31.88%	8.29%	23.59%	20.40%	7.30%	13.10%
2004	33.39%	12.14%	21.24%	22.24%	11.09%	11.16%
2005	13.45%	20.35%	-6.90%	9.89%	19.11%	-9.22%
Geometric Mean (87-05)	6.48%	8.73%	-2.25%	8.93%	7.66%	1.28%
Standard Deviation (87-05)	21.38%	6.66%	14.72%	10.56%	6.58%	3.98%
Sharpe Ratio (87-05)	0.092	0.633	-0.541	0.418	0.477	-0.059
Geometric Mean (95-05)	16.48%	12.72%	3.76%	13.31%	11.63%	1.68%
Standard Deviation (95-05)	14.50%	3.82%	10.68%	8.73%	3.74%	4.99%
Sharpe Ratio (95-05)	0.874	2.331	-1.457	1.087	2.087	-1.001

Note: Diff. = REIT - NPI

Table 13: Summary on Return Restating Effects - Industrial

Restating Item	From 1987 to 2005				From 1995 to 2005			
	Geometric Mean		Difference on GM		Geometric Mean		Difference on GM	
	REIT	NPI	Value	Chg	REIT	NPI	Value	Chg
Original	6.48%	8.73%	-2.25%	-	16.48%	12.72%	3.76%	-
De-leverage	9.24%	8.73%	0.51%	2.76%	13.58%	12.72%	0.86%	-2.90%
Private Market Asset Mgmt Fees	9.24%	7.66%	1.59%	1.07%	13.58%	11.63%	1.96%	1.09%
REIT Index Investment Costs	8.93%	7.66%	1.28%	-0.31%	13.31%	11.63%	1.68%	-0.28%

Note: GM = Geometric Mean
   Chg = Change on Value

Figure 9: Cumulative Return Comparison (Before Restatement)
Industrial 1987 - 2005

Base Value (1986) = 100

Legend: REIT Industrial, NPI Industrial
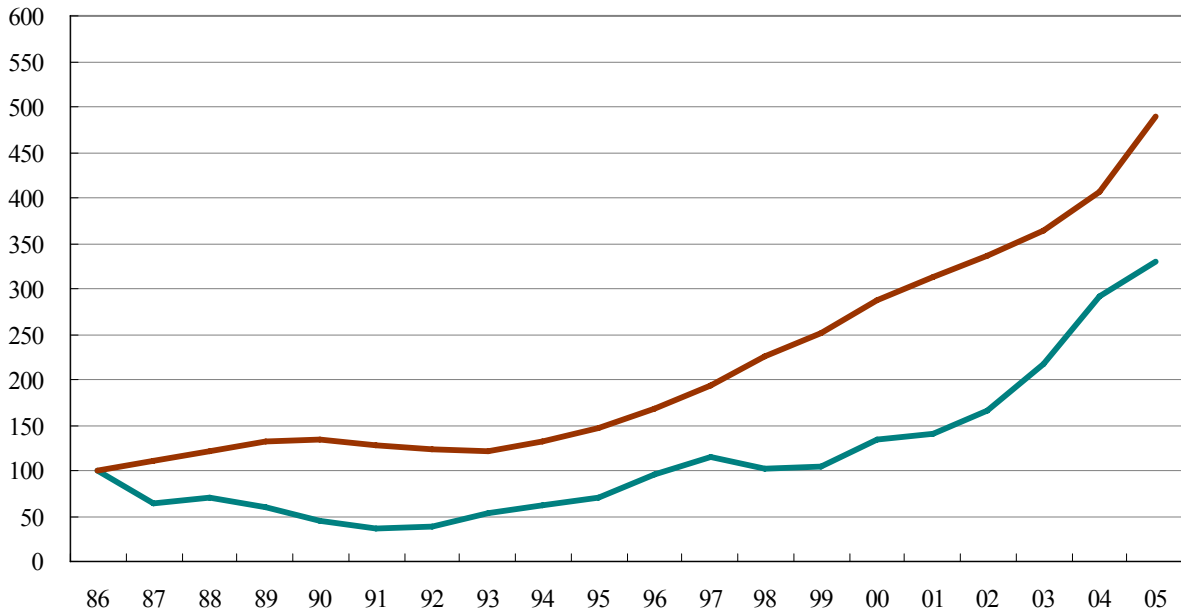
Figure 10: Cumulative Return Comparison (After Restatement)
Industrial 1987 - 2005

Base Value (1986) = 100

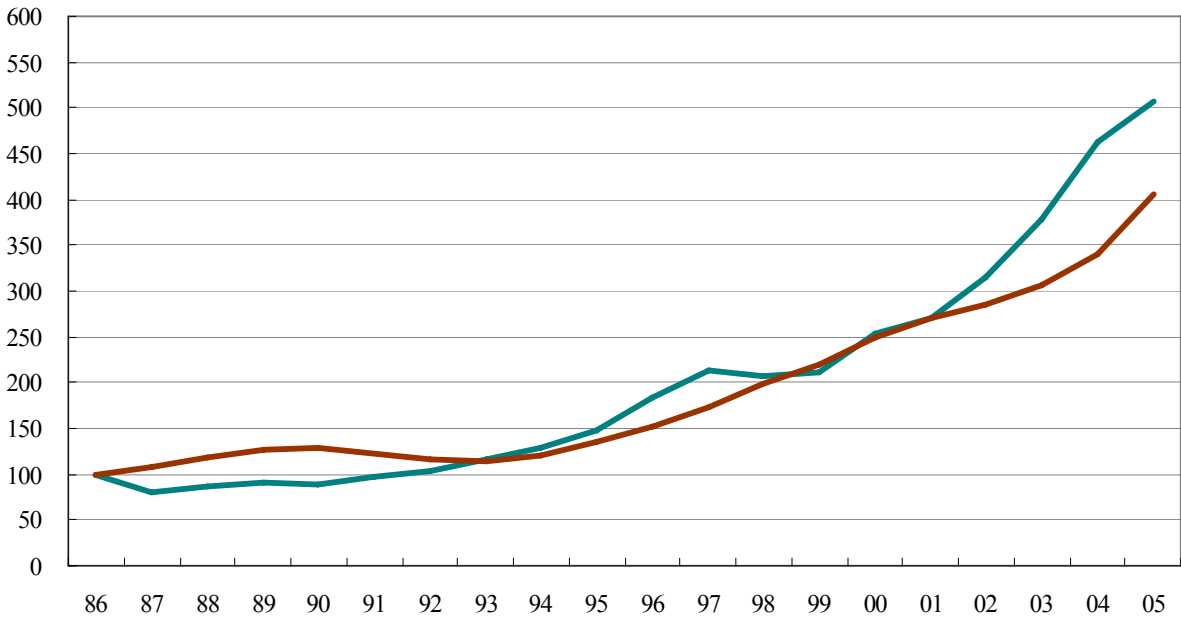Legend: REIT Industrial, NPI Industrial

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Table 14: The REIT Index versus NPI Returns - All Sectors (Before and After Restatement)

Year	Before Restatement			After Restatement		
	REIT[25]	NPI	Diff.	REIT	NPI	Diff.
1987	-3.64%	8.02%	-11.66%	-7.75%	6.88%	-14.62%
1988	13.49%	9.77%	3.71%	13.61%	8.63%	4.98%
1989	8.84%	7.95%	0.90%	5.52%	6.83%	-1.30%
1990	-15.35%	2.26%	-17.61%	-12.38%	1.25%	-13.63%
1991	35.70%	-5.81%	41.50%	10.34%	-6.72%	17.06%
1992	14.59%	-4.29%	18.88%	11.07%	-5.23%	16.30%
1993	19.65%	1.28%	18.38%	18.25%	0.26%	17.99%
1994	3.17%	6.43%	-3.26%	4.14%	5.36%	-1.22%
1995	15.27%	7.39%	7.87%	17.64%	6.29%	11.35%
1996	35.27%	10.00%	25.26%	25.36%	8.83%	16.54%
1997	20.26%	13.74%	6.52%	19.11%	12.57%	6.54%
1998	-17.50%	16.25%	-33.76%	-3.97%	15.12%	-19.09%
1999	-4.62%	11.35%	-15.97%	1.72%	10.24%	-8.52%
2000	26.37%	12.36%	14.00%	21.31%	11.27%	10.04%
2001	13.93%	7.49%	6.44%	9.14%	6.49%	2.65%
2002	3.82%	6.79%	-2.97%	10.09%	5.82%	4.27%
2003	37.13%	9.26%	27.87%	19.66%	8.27%	11.39%
2004	31.58%	14.67%	16.90%	18.73%	13.62%	5.11%
2005	12.16%	20.19%	-8.03%	9.21%	18.95%	-9.74%
Geometric Mean (87-05)	12.01%	7.98%	4.04%	9.57%	6.90%	2.66%
Standard Deviation (87-05)	16.23%	6.49%	9.75%	10.25%	6.42%	3.84%
Sharpe Ratio (87-05)	0.462	0.534	-0.072	0.493	0.373	0.120
Geometric Mean (95-05)	14.57%	11.70%	2.86%	13.12%	10.61%	2.51%
Standard Deviation (95-05)	17.03%	4.19%	12.84%	8.99%	4.13%	4.86%
Sharpe Ratio (95-05)	0.631	1.882	-1.251	1.034	1.644	-0.610

Note: Diff. = REIT - NPI

**Table 15: Summary on Return Restating Effects - All Sectors**

Restating Item	From 1987 to 2005				From 1995 to 2005			
	Geometric Mean		Difference on GM		Geometric Mean		Difference on GM	
	REIT	NPI	Value	Chg	REIT	NPI	Value	Chg
Original	12.01%	7.98%	4.04%	-	14.57%	11.70%	2.86%	-
Property-sector Mix	10.49%	7.98%	2.51%	-1.53%	16.52%	11.70%	4.82%	1.95%
De-leverage	9.88%	7.98%	1.90%	-0.61%	13.39%	11.70%	1.69%	-3.13%
Private Market Asset Mgmt Fees	9.88%	6.90%	2.97%	1.07%	13.39%	10.61%	2.79%	1.09%
REIT Index Investment Costs	9.57%	6.90%	2.66%	-0.31%	13.12%	10.61%	2.51%	-0.28%

Note: GM = Geometric Mean
     Chg = Change on Value

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[25] The returns are the original NAREIT Equity REIT Index returns including both core and non-core property sectors, not calculated by the author.

Figure 11: Cumulative Return Comparison (Before Restatement)
All Sectors 1987 - 2005

Base Value (1986) = 100

REIT All Sectors
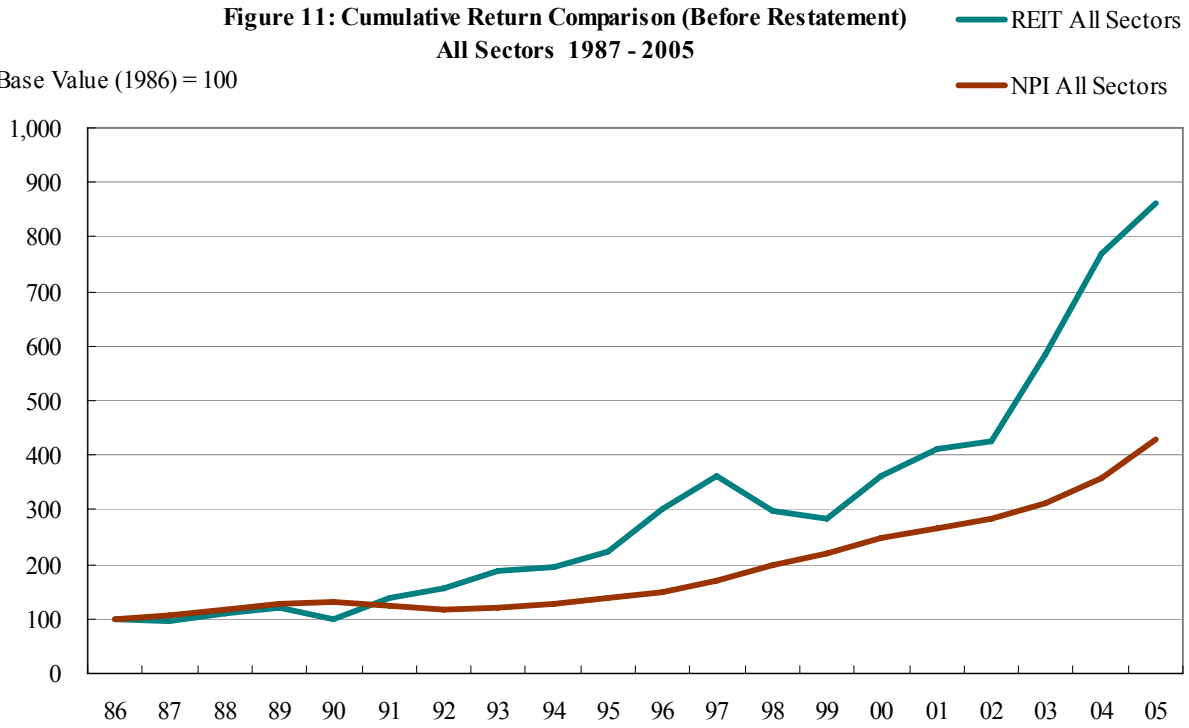
NPI All Sectors

Figure 12: Cumulative Return Comparison (After Restatement)
All Sectors 1987 - 2005

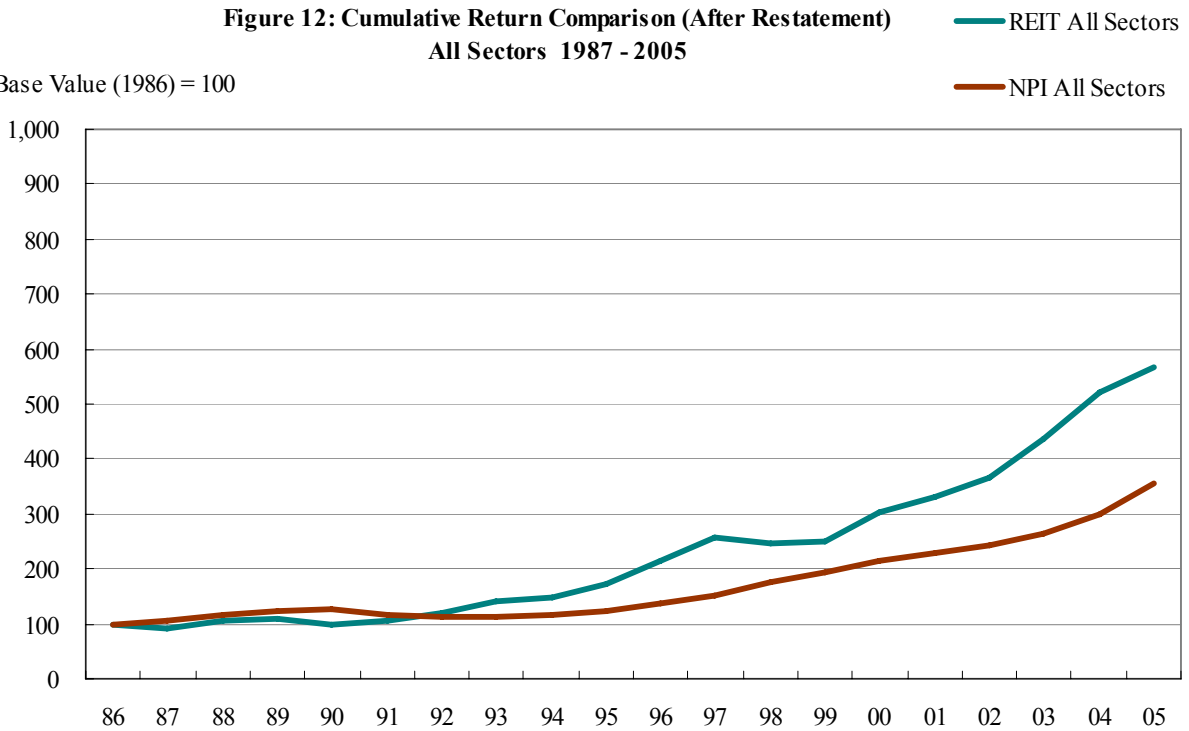Base Value (1986) = 100

REIT All Sectors

NPI All Sectors

Figure 13: Cumulative Return Compariosn on Restated REIT Index
The Author, Riddiough et al., and Pagliari et al.
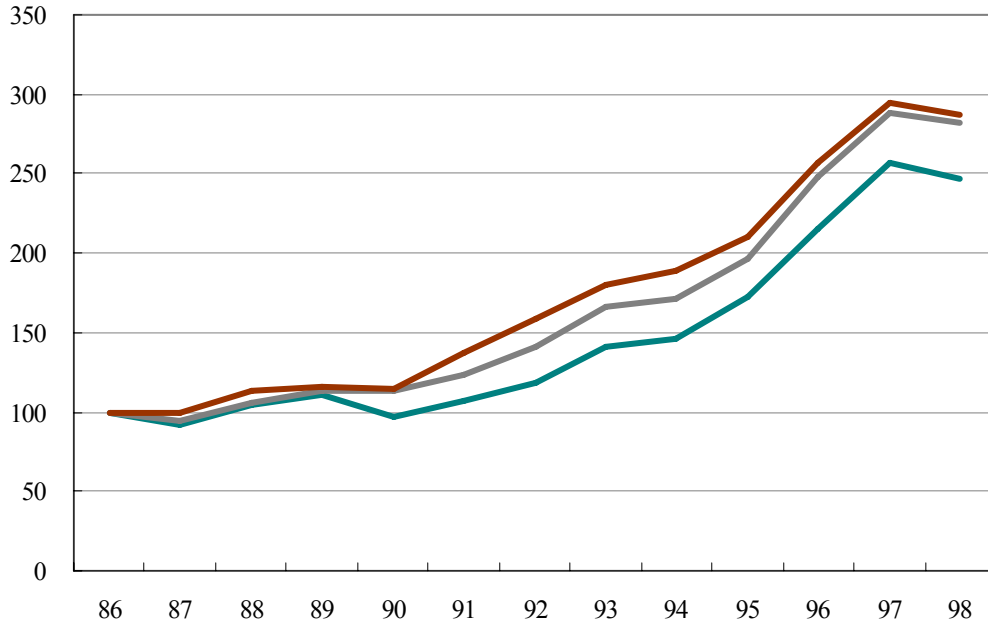**1987 - 1998**

Base Value (1986) = 100

Figure 14: Cumulative Return Comparison on Restated NPI
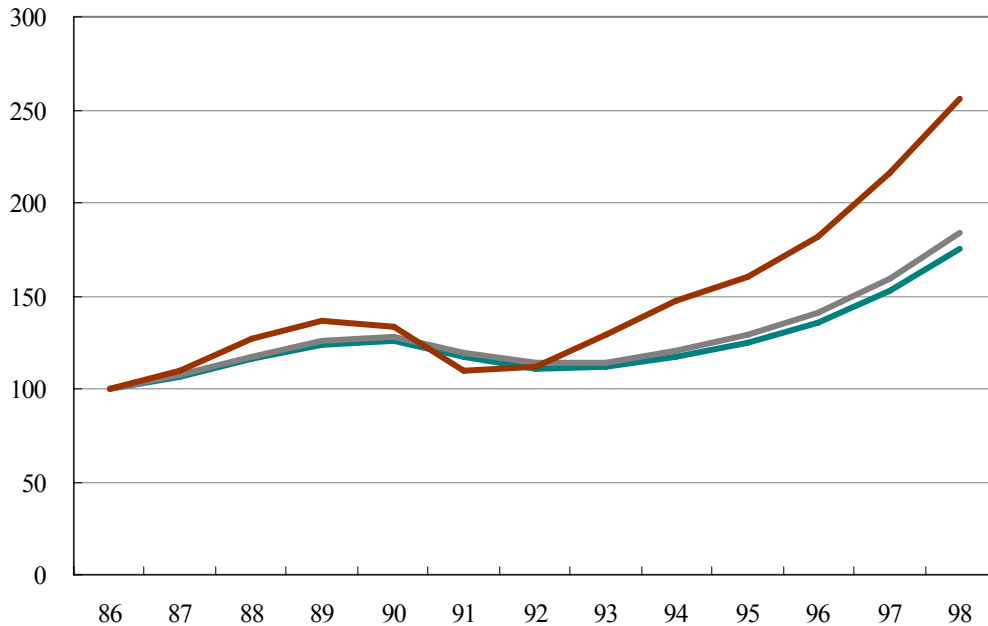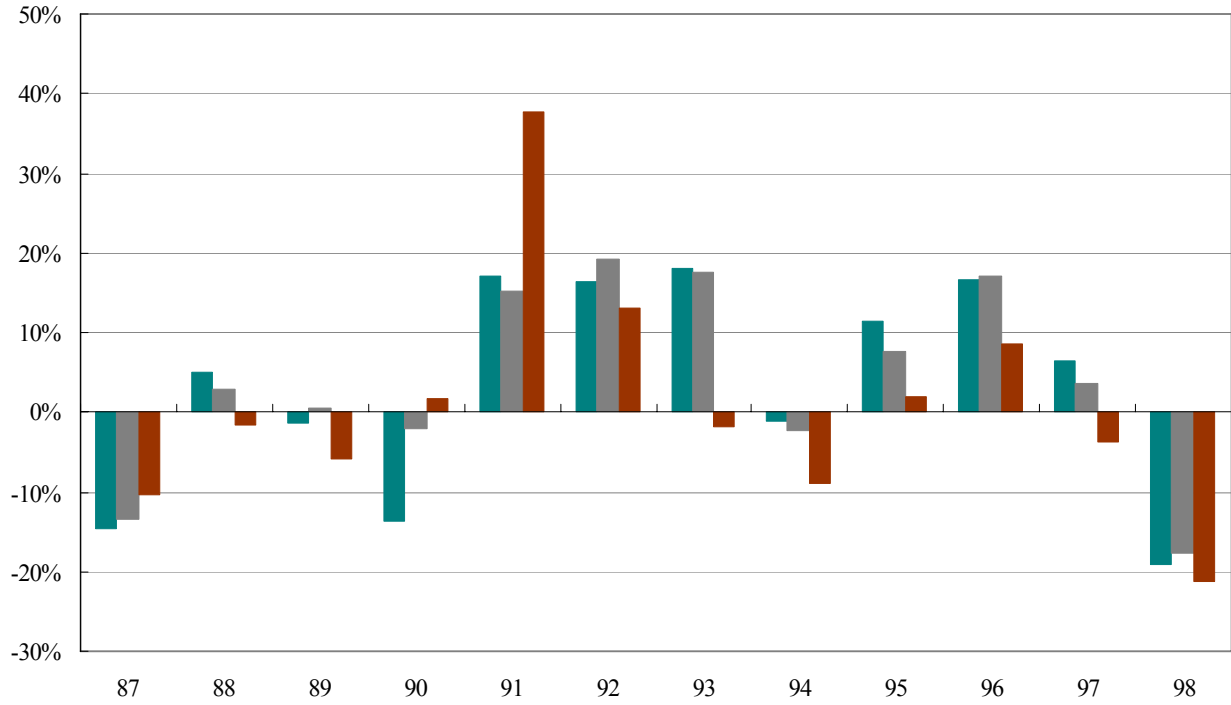**The Author, Riddiough et al., and Pagliari et al.**
1987 - 1998

Base Value (1986) = 100

**Figure 15: Annual Difference between Restated REIT Index and NPI Returns
The Author, Riddiough et al., and Pagliari et al.
1987 - 1998**

5.   RESULTS – TBI VERSUS NPI VIA BENCHMARKING WITH THE REIT INDEX

In this section, TBI is compared with NPI in terms of their respective consistency with the REIT Index. The returns on the three indices were all restated for leverage and asset management fees before compared at the property-sector level. For comparison at the aggregate level, additional restatement was made to have the returns comparable in property-sector mix. (The NPI property-sector weights were used to restate the REIT Index and TBI returns.) Indeed, the fact that the TBI property-sector returns are not available before 1995 limits the author's comparative period to the 11 years ended in 2005. Although the data are based on a relatively short period, TBI and NPI are found behaving differently in terms of their consistency with the REIT Index. The results, which are summarized in Table 17 to 18 and Figure 16 to 20, are reviewed at the property-sector and aggregate levels subsequently.

5.1   Retail and Apartment

In both the retail and apartment sectors, the mean returns on TBI are the highest, followed by the REIT Index and then NPI. Nevertheless, inconsistent results on the REIT Index's proximity to TBI and NPI are identified when different statistical indicators are used for comparisons. In terms of mean return, TBI is closer to the REIT Index than NPI is in the retail sector though a contrary result is observed in the apartment sector. As for standard deviation, TBI manifests a lower consistency with the public market benchmark than NPI does in the retail sector. In the apartment sector, however, the difference in standard deviations between TBI and the REIT Index is found smaller than that between NPI and the REIT Index. The comparison on Sharpe ratios also provides conflicting results: NPI is more consistent with the REIT Index in the retail rector whereas TBI is the closer one in the apartment sector.

Figure 16 and 17 present the cumulative returns on the REIT Index, TBI, and NPI in a graphical form. In the retail sector, TBI obviously follows the REIT Index more closely than NPI does. In the apartment sector, a different story comes in play as NPI has a better co-movement with the public market benchmark.

Although theoretically the REIT Index should have a closer relationship with TBI than NPI, the author's findings in the retail and apartment sectors do not completely support this argument. Considering that the research timeframe only covers 11 years, further studies utilizing the data of a longer period may be able to provide more insights on the differences between TBI and NPI in these two sectors.

5.2 Office and Industrial

In the office and industrial sectors, the REIT Index has the highest mean return, followed by TBI and then NPI. Other comparative results in the sectors are straight and simple: TBI is closer to the REIT Index than NPI is in terms of either mean return, standard deviation, or Sharpe ratio. The results are further evidenced by Figure 18 and 19, in which TBI apparently has a more consistent movement with the REIT Index than NPI does.

5.3 All Sectors

Both the REIT Index and TBI property-sector returns were aggregated to derive the all-sector returns in accordance with the NPI property-sector weights. The all-sector returns of the three indices from 1995 to 2005 are tabulated in Table 18 and cumulatively plotted on Figure 19. At the aggregate level, the highest mean return is provided by the REIT Index, followed by TBI and then NPI. The difference in mean returns between the REIT Index and TBI, however, is as low as 0.09%. With regard to standard deviation and Sharpe ratio, their differences are also found to be very small (i.e. 0.19% and 0.032 respectively). On the other hand, NPI apparently deviates from the REIT Index more in terms of these statistical indicators. The differences in mean returns, standard deviations, and Sharpe ratios between the REIT Index and NPI are 2.51%, 4.86%, and 0.610 respectively.

The cumulative returns plotted on Figure 20 carry the same implication. During the period of 1995 to 2005, TBI is always more proximate to the REIT Index than NPI is. The argument that TBI, as a transaction-based index, should move more closely and consistently with the public market benchmark than should the appraisal-based NPI is fully supported at the all-sector level.

5.4 Leading and Lagging Effects between Indices

As the REIT Index, TBI, and NPI returns have all been restated for comparability enhancement, it should be meaningful to test the leading and lagging effects between different pairs of them. Although the study is limited by the insufficient samples due to the relatively short research timeframe (i.e. from 1995 to 2005), the author utilizes the calculation of correlation coefficients between different return series (all-sector basis) to complete a simple test. The test result is presented in Table 16. (The subscripted t-1, t, and t+1 next to the index names indicate "previous-year value", "current-year value", and "next-year value" respectively.)

Table 16: Correlation Coefficient between Index Returns

y \ x	$REIT_t$	y \ x	$REIT_t$	y \ x	TBI_t
TBI_{t-1}	-0.64	NPI_{t-1}	-0.72	NPI_{t-1}	0.10
TBI_t	0.08	NPI_t	-0.26	NPI_t	0.71
TBI_{t+1}	0.52	NPI_{t+1}	0.28	NPI_{t+1}	0.62

Note: x = Independent Variable
          y = Dependent Variable

In the table, the REIT Index's leading effects on TBI and NPI can be identified from the positive correlations between $REIT_t$ and TBI_{t+1} (0.52) and between $REIT_t$ and NPI_{t+1} (0.28). They confirm the advantage of the public market at liquidity and information efficiency which enable timely reflections on the market conditions for real estate investors. Also, the REIT Index has a stronger leading correlation with TBI than NPI, which is consistent with the author's findings in the previous sections. On the other hand, the current REIT Index's highly negative correlations with the lagging TBI and NPI (-0.64 and -0.72) are not easy to interpret and may be just randomly caused by the insufficient samples.

With regard to the correlation between TBI and NPI, highly positive relationships are found both between TBI_t and NPI_t and between TBI_t and NPI_{t+1}. Although TBI does manifest its leading effect on NPI through the latter relationship, TBI_t actually has a higher correlation coefficient with NPI_t (0.71) than with NPI_{t+1} (0.62). Therefore, TBI's leading position relative to NPI does not seem to be fully identified in the result. Again, as the dataset used for the test is insufficient, it is difficult to draw a definite conclusion here.

Overall, the author is satisfied with the findings which generally confirm the leading position of the public market and TBI's closer correlation with the REIT Index.

Table 17: The REIT Index, TBI, and NPI Restated Returns by Property Sector

Year	Retail			Diff. from REIT		Apartment			Diff. from REIT	
	REIT	TBI	NPI	TBI	NPI	REIT	TBI	NPI	TBI	NPI
1995	12.21%	-0.19%	2.89%	12.40%	9.32%	13.63%	4.91%	10.56%	8.72%	3.06%
1996	18.40%	6.32%	3.68%	12.08%	14.72%	17.15%	18.22%	10.36%	-1.07%	6.79%
1997	15.13%	20.04%	7.35%	-4.91%	7.78%	13.37%	23.77%	11.72%	-10.40%	1.65%
1998	0.89%	15.48%	11.77%	-14.59%	-10.88%	-0.64%	13.26%	12.96%	-13.90%	-13.60%
1999	-3.80%	9.27%	8.43%	-13.07%	-12.22%	6.16%	2.18%	10.59%	3.98%	-4.43%
2000	14.99%	-5.37%	6.72%	20.35%	8.26%	23.35%	13.21%	11.84%	10.14%	11.50%
2001	18.01%	11.10%	5.84%	6.90%	12.17%	8.26%	10.93%	8.32%	-2.67%	-0.06%
2002	18.07%	25.56%	12.69%	-7.49%	5.38%	5.05%	6.71%	7.76%	-1.66%	-2.72%
2003	26.25%	10.01%	16.63%	16.24%	9.61%	15.08%	6.42%	7.94%	8.66%	7.14%
2004	22.19%	27.52%	22.02%	-5.33%	0.17%	19.37%	15.16%	12.03%	4.21%	7.34%
2005	9.23%	36.44%	18.72%	-27.21%	-9.49%	9.20%	36.36%	20.06%	-27.16%	-10.86%
Geometric Mean	13.45%	13.59%	10.45%	-0.14%	3.00%	11.62%	13.37%	11.24%	-1.76%	0.38%
Standard Deviation	8.86%	12.41%	6.31%	-3.55%	2.55%	6.98%	9.78%	3.39%	-2.80%	3.59%
Sharpe Ratio	1.087	0.787	1.051	0.300	0.036	1.117	0.977	2.187	0.141	-1.070

Year	Office			Diff. from REIT		Industrial			Diff. from REIT	
	REIT	TBI	NPI	TBI	NPI	REIT	TBI	NPI	TBI	NPI
1995	28.14%	15.11%	6.09%	13.03%	22.05%	15.35%	16.57%	11.20%	-1.21%	4.16%
1996	37.90%	14.03%	12.39%	23.87%	25.50%	23.86%	7.69%	12.38%	16.17%	11.48%
1997	26.80%	33.54%	16.69%	-6.73%	10.11%	16.30%	30.43%	14.72%	-14.13%	1.59%
1998	-8.75%	9.04%	18.48%	-17.79%	-27.23%	-3.21%	1.16%	14.75%	-4.37%	-17.96%
1999	3.19%	3.97%	11.09%	-0.78%	-7.91%	2.23%	7.05%	10.55%	-4.82%	-8.32%
2000	24.47%	10.51%	13.07%	13.96%	11.40%	20.38%	18.05%	12.98%	2.34%	7.41%
2001	6.12%	0.31%	5.22%	5.81%	0.91%	6.57%	5.71%	8.47%	0.87%	-1.90%
2002	6.07%	9.69%	1.87%	-3.61%	4.20%	15.83%	9.54%	5.98%	6.29%	9.85%
2003	18.25%	7.27%	4.84%	10.97%	13.41%	20.40%	14.29%	7.30%	6.10%	13.10%
2004	14.78%	12.53%	11.02%	2.25%	3.76%	22.24%	11.04%	11.09%	11.20%	11.16%
2005	8.86%	35.77%	18.42%	-26.90%	-9.56%	9.89%	25.64%	19.11%	-15.75%	-9.22%
Geometric Mean	14.34%	13.33%	10.70%	1.02%	3.64%	13.31%	13.08%	11.63%	0.23%	1.68%
Standard Deviation	13.55%	11.17%	5.73%	2.38%	7.82%	8.73%	8.80%	3.74%	-0.07%	4.99%
Sharpe Ratio	0.777	0.851	1.201	-0.075	-0.425	1.087	1.052	2.087	0.035	-1.001

Note:
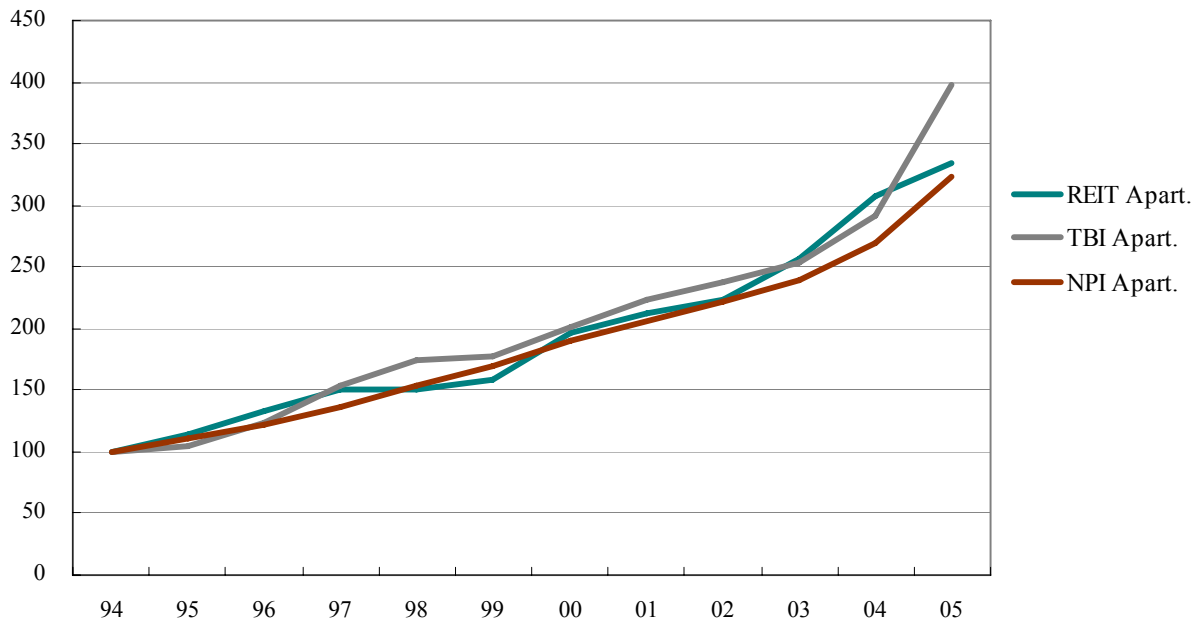Diff. from REIT
= REIT – TBI or
= REIT – NPI

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Figure 16: Cumulative Return Comparison (After Restatement)
Retail 1995 - 2005
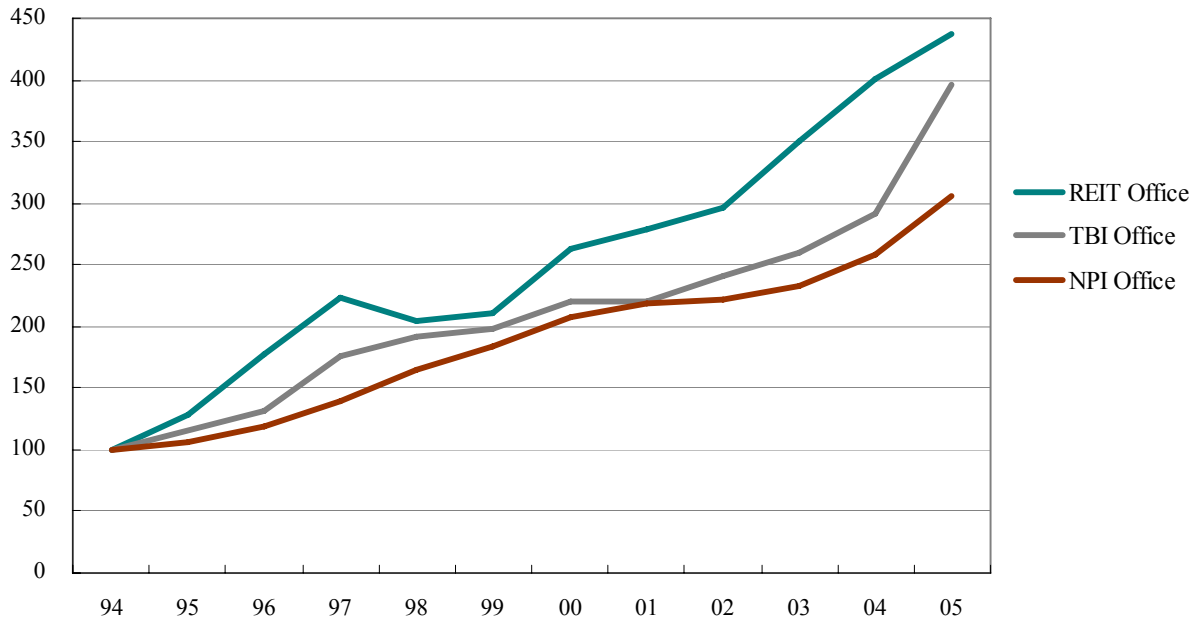
Base Value (1994) = 100
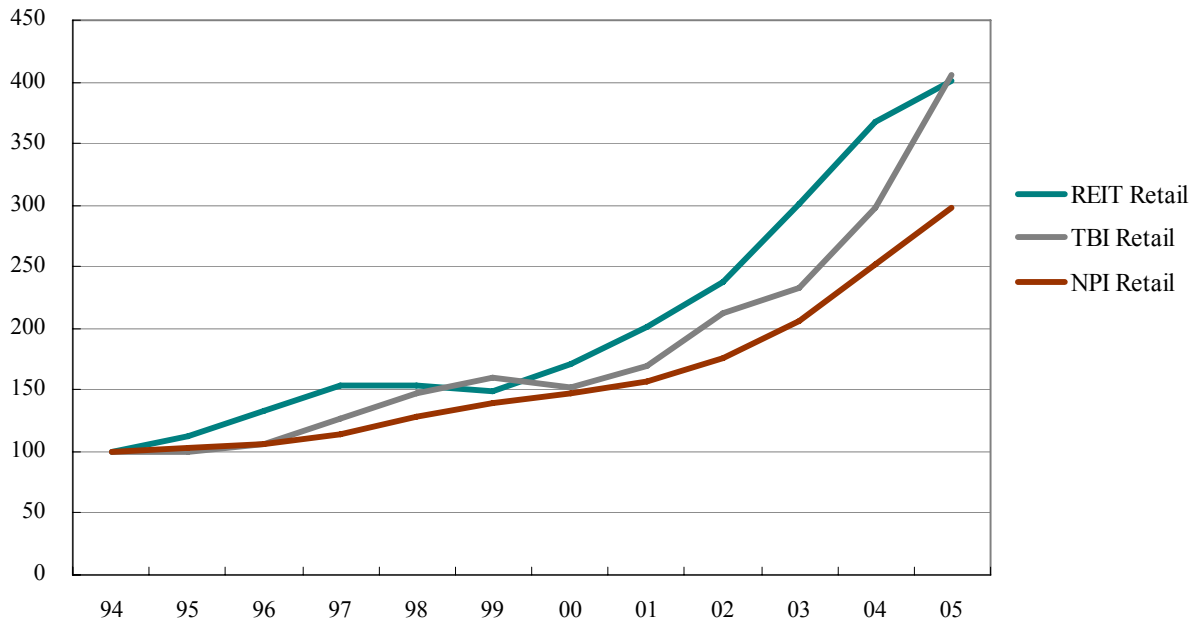
Figure 17: Cumulative Return Comparison (After Restatement)
Apartment 1995 - 2005

Base Value (1994) = 100

Figure 18: Cumulative Return Comparison (After Restatement)
Office 1995 - 2005

Base Value (1994) = 100

Figure 19: Cumulative Return Comparison (After Restatement)
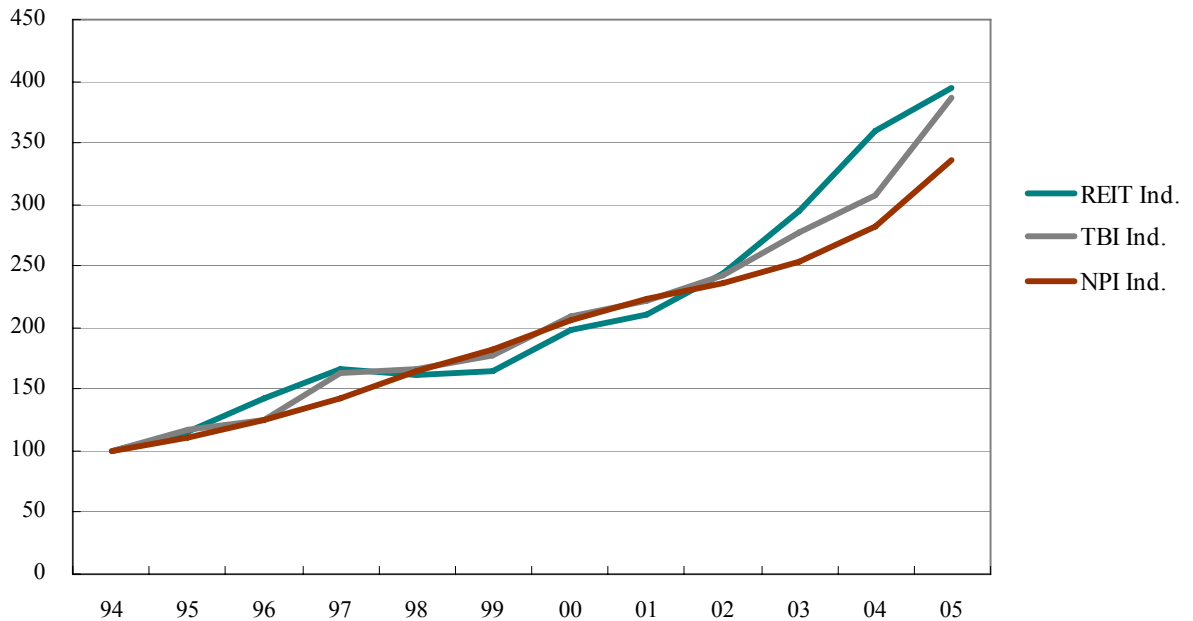**Industrial 1995 - 2005**

Base Value (1994) = 100

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Table 18: The REIT Index, TBI, and NPI Restated Returns - All Sectors

Year	REIT	TBI	NPI	Diff. from REIT	
				TBI	NPI
1995	17.64%	7.88%	6.29%	9.76%	11.35%
1996	25.36%	10.77%	8.83%	14.59%	16.54%
1997	19.11%	27.13%	12.57%	-8.03%	6.54%
1998	-3.97%	10.18%	15.12%	-14.15%	-19.09%
1999	1.72%	5.53%	10.24%	-3.81%	-8.52%
2000	21.31%	8.33%	11.27%	12.98%	10.04%
2001	9.14%	5.56%	6.49%	3.58%	2.65%
2002	10.09%	12.11%	5.82%	-2.03%	4.27%
2003	19.66%	9.06%	8.27%	10.60%	11.39%
2004	18.73%	16.06%	13.62%	2.67%	5.11%
2005	9.21%	34.14%	18.95%	-24.93%	-9.74%
Geometric Mean	13.12%	13.03%	10.61%	0.09%	2.51%
Standard Deviation	8.99%	9.18%	4.13%	-0.19%	4.86%
Sharpe Ratio	1.034	1.003	1.644	0.032	-0.610

Note: Diff. from REIT = REIT – TBI or REIT – NPI

Figure 20: Cumulative Return Comparison (After Restatement)
All Sectors 1995 - 2005

Base Value (1994) = 100
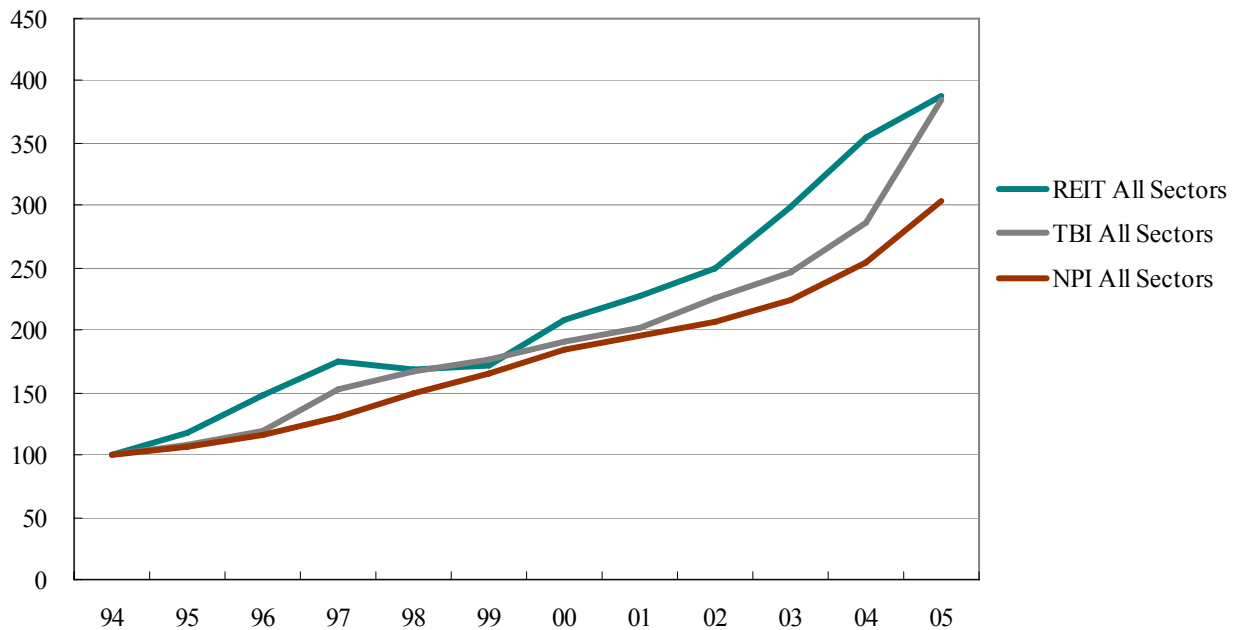
6.   CONCLUSION

The research has a two-fold objective. First, it intends to analyze the performance difference between public and private real estate equity investment. NAREIT Equity REIT Index and NCREIF Property Index returns from 1987 to 2005 are utilized to represent the respective market performance. To obtain a clearer picture on the influence of the investment vehicles, the indices are restated to eliminate their discrepancies in leverage, property-sector mix, and asset management fees. The restatement involves using the WACC formula to transform REIT returns unlevered, re-weighting the all-sector REIT Index in accordance with the NPI property-sector weights, and deducting asset management fees from both return series. Subsequent comparisons between the index returns are made both by property sector (i.e. retail, apartment, office, and industrial) and at the all-sector level.

After return restatement, public and private markets have more consistent performance across most property sectors as measured by their closer mean returns and standard deviations. The only exception comes from the office sector where an increasing difference in mean returns is observed. As this unexpected result disappears when only the sub-period of 1995 to 2005 is considered in the research, it is possibly caused by the undiversified and insufficient REIT samples during early years. At the all-sector level, the difference in mean returns between the REIT Index and NPI is found to be 2.66% after return restatement, sufficiently decreasing from the original 4.04%. The return restatement also exerts a positive effect on reconciling the standard deviations of the indices. Compared with the two relevant researches previously conducted, the author and Riddiough et al. have more similar results and their differences from Pagliari et al. may be caused by the latter's restatement for smoothing on the NPI returns.

Overall, the results confirm the value of the author's effort on return restatement and produce a more precise measurement on the performance difference between public and private real estate equity investment. The research, however, is not able to provide a definite view as for which investment vehicle offers higher risk-adjusted returns because the comparisons on their Sharpe ratios generate inconsistent results in different property sectors and timeframes.

Second, the research aims for comparing the transaction-based TBI with the appraisal-base NPI and further supporting the argument that transaction-based indices are better data sources for some analytical purposes. After TBI goes through a similar restatement process, comparisons by property sector and at the all-sector level are made through respectively benchmarking TBI and NPI with the REIT Index from 1995 to 2005.

In terms of mean return, standard deviation, and Sharpe ratio, TBI constantly has closer performance with the REIT Index than NPI does in the office and industrial sectors though some conflicting results are found in the retail and apartment sectors. As the research is based on a relatively short period (i.e. only 11 years), future work utilizing a longer-period dataset may help to conclude whether TBI and NPI really have unique performance in some property sectors. At the all-sector level, TBI performs much more consistently with the REIT Index than NPI does whichever statistical indicator is used for comparison. Specifically, the difference in mean returns between TBI and the REIT Index is as low as 9 basis points. The trend lines plotted with the cumulative returns on the indices also imply a closer co-movement between TBI and the public market benchmark. Finally, the REIT Index's leading effects on both TBI and NPI are identified through the calculation of correlation coefficients between different return series. Not surprisingly, it is also found that the REIT Index has a higher correlation with TBI than NPI.

Overall, the results confirm that TBI basically moves more consistently with the REIT Index than NPI does. Evidenced by its relative proximity to the index recognized for information efficiency, the transaction-based index should have an advantage over the appraisal-based index for some analytical purposes such as portfolio optimization and studies on market turning points, in which responsive reflections on private market conditions are necessary.

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Appendix One:

NAREIT's Original Property-Sector Returns and the REIT Common Equity Returns Calculated by the Author

Year	Retail			Apartment		
	Original	Calculated	Diff.	Original	Calculated	Diff.
1994	2.98%	3.16%	-0.18%	2.19%	3.03%	-0.85%
1995	5.10%	8.58%	-3.48%	12.26%	11.66%	0.61%
1996	34.60%	32.14%	2.46%	28.93%	27.92%	1.01%
1997	16.95%	19.30%	-2.36%	16.04%	15.47%	0.57%
1998	-4.94%	-4.63%	-0.31%	-8.77%	-8.44%	-0.34%
1999	-11.77%	-11.05%	-0.72%	10.73%	10.14%	0.59%
2000	17.97%	17.16%	0.81%	35.53%	34.63%	0.90%
2001	30.42%	31.27%	-0.85%	8.66%	8.53%	0.13%
2002	21.07%	21.63%	-0.56%	-6.15%	-4.96%	-1.19%
2003	46.77%	46.52%	0.25%	25.49%	25.31%	0.18%
2004	40.23%	38.20%	2.03%	34.71%	32.33%	2.38%
2005	11.80%	14.49%	-2.69%	14.65%	13.71%	0.94%
Geometric Mean	16.30%	16.87%	-0.57%	13.65%	13.33%	0.33%
Standard Deviation	18.10%	17.30%	0.80%	14.63%	13.88%	0.75%

Year	Office			Industrial		
	Original	Calculated	Diff.	Original	Calculated	Diff.
1994	2.86%	-0.51%	3.37%	18.67%	13.81%	4.86%
1995	38.80%	37.22%	1.58%	16.21%	15.48%	0.73%
1996	51.80%	51.09%	0.71%	37.22%	35.00%	2.22%
1997	29.01%	32.74%	-3.73%	19.02%	20.13%	-1.10%
1998	-17.35%	-19.76%	2.41%	-11.74%	-11.37%	-0.38%
1999	4.25%	4.23%	0.02%	3.90%	2.77%	1.13%
2000	35.46%	34.84%	0.61%	28.62%	27.60%	1.02%
2001	6.65%	4.20%	2.45%	7.42%	4.99%	2.43%
2002	-6.82%	-2.84%	-3.98%	17.32%	17.46%	-0.14%
2003	34.01%	33.03%	0.98%	33.14%	31.88%	1.26%
2004	23.28%	23.51%	-0.23%	34.09%	33.39%	0.70%
2005	13.11%	13.66%	-0.55%	15.42%	13.45%	1.97%
Geometric Mean	16.20%	15.84%	0.36%	17.46%	16.26%	1.20%
Standard Deviation	20.72%	20.94%	-0.22%	14.07%	13.86%	0.21%

Note: Original = NAREIT's original property-sector returns
Calculated = The property-sector returns calculated by the author and used in the research
Diff. = Original - Calculated

Appendix Two:

The Methodological Differences among the Author, Riddiough et al., and Pagilari et al.

The methodological differences among the 3 groups of researchers mainly exist in the following aspects:

(1) REIT Samples

(2) Restatement for Index Investment Expenses on REIT Returns

(3) Calculation of Return on Debt in De-leverage of REIT Returns

(4) Inclusion of Minority Interest in De-leverage of REIT Returns

(5) Restatement for Property-Sector Mix on REIT Returns

(6) Restatement for Asset Management Fees on NPI Returns

(7) Restatement for Smoothing on NPI Returns

(8) Restatement for Property-Sector Mix on NPI Returns

(9) Performance Comparisons between Indices by Property Sector

The following table summaries the methodological differences.

Researcher	Methodological Difference
The Author	(1) Retail, apartment, office, and industrial REITs were included in the samples. (2) The historical expense ratios of Vanguard REIT Index Fund were used to approximate the expenses for REIT index investment. (3) Return on debt was based on Giliberto-Levy Commercial Mortgage Performance Index. (4) Minority interest was added to the equity component in the leverage ratio. (5) REIT returns were restated to include only core-property sectors and in accordance with the NPI property-sector weights. (6) NFI-ODCE historical fee ratios were used to approximate the asset management fees for NPI investors. (7) No restatement for smoothing was made on NPI returns. (However, transaction-based TBI returns were introduced for comparison with REIT returns in addition to NPI returns.) (8) No restatement for property-sector mix was made on NPI returns. (The NPI of core-property sectors was directly obtained from NCREIF's online database and used for research.) (9) Performance comparisons between indices were available by property sector.

Researcher	Methodological Difference
Riddiough et al.	(1) Retail, apartment, office, and industrial REITs were included in the samples. (2) No restatement for index investment expenses was made on REIT returns. (3) Return on debt was based on the REIT's "Interest Expenses / Debt Book Value". (4) Minority interest was not considered in de-leverage. (5) REIT returns were restated to include only core-property sectors and in accordance with the NPI property-sector weights. (6) An asset management fee ratio of eighty basis points was assumed for NPI investors. (7) No restatement for smoothing was made on NPI returns. (8) NPI returns were restated to include only core-property sectors. (9) Performance comparisons between indices were available by property sector.
Pagliari et al.	(1) Besides retail, apartment, office, and industrial REITs, mixed and diversified REITs were included in the samples. (2) No restatement for index investment expenses was made on REIT returns. (3) Return on debt was based on the REIT's "Interest Expenses / Debt Book Value". (4) Minority interest was not considered in de-leverage. (5) REIT returns were restated to include only core-property sectors. (6) No restatement for asset management fees was made on NPI returns. (7) Geltner's approach was utilized to restate NPI returns for smoothing. (8) NPI returns were restated to include only core-property sectors and in accordance with the REIT index's core-property sector weights. (9) No performance comparison between indices was available by property sector.